INVERNESS RESEARCH
P.O. Box 313 Inverness, CA 94937 T 415.669.7156
www.inverness-research.org

DRL RESOURCE CENTERS: INFERRING A THEORY OF ACTION
0943423
Inverness Research
July 2010

This Memo

The National Science Foundation's Division of Research and Learning in Formal and Informal Settings (DRL) has invested in several resource centers and networks[1] in the past several years. In 2010, The National Science Foundation awarded a small Early Concept Grants for Exploratory Research (EAGER) grant to bring together the Principal Investigators (PIs) and evaluators of these resource centers to collaborate and share ideas and lessons learned. As part of that EAGER grant, and our participation in the evaluation group, Inverness Research[2] agreed to undertake a very small and limited exploration of the theory of action that underlies the DRL Centers.

To evaluate any program or project it is very useful to understand the intention of the investment that is made in that program or project. A more detailed and mechanistic description of intention is typically found in the theory of action or logic model of the project or program. Very often it is the role of the evaluator to help elicit and articulate the theory of action that underlies the investment; not only does this clarification process often help the project, but it also provides the foundation for evaluating the efficacy of the investment. We thought it would be useful to explore and explicate the *theory of action* underlying the NSF investment in these resource centers. Our thinking is based upon our own work with CAISE and our interviews with Center PIs, program officers and evaluators.

This memo describes the very initial stages of becoming clearer about the theory of action that underlies the DRL Centers, and it highlights some questions and issues that arise as one looks across all five funded DRL centers. The DRL Centers are a

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[1] Both terms are used to describe the DRL support projects. Throughout this memo we refer to the DRL centers and networks as DRL Centers.

[2] Inverness Research is the evaluator for the Center for the Advancement of Informal Science Education (CAISE).

unique investment in the NSF portfolio, and, we believe, are worthy of further study and development.

The DRL Centers

The DRL Centers are designed to support and add value to specific NSF programs within the DRL division. They include:

- Community for Advancing Discovery Research in Education (CADRE), in support of the Discovery Research K-12 (DR-K12) program (award number 0822241)
- Center for the Advancement of Informal Science Education (CAISE), in support of the Informal Science Education (ISE) program (award number 0638981)
- Innovative Technology Experiences for Students and Teachers Learning Resource Center (ITEST LRC), in support of the ITEST program (award number 0737638)
- Center for Advancing Research and Communication in Science, Technology, Engineering and Mathematics (ARC), in support of the Research and Evaluation on Education in Science and Engineering (REESE) program (award number 0815295)
- Learning and Youth Research and Evaluation Center (LYREC), in support of the Academies for Young Scientists (AYS) projects (award number 0639656)

Investing in DRL Centers is quite different from investing in a project. The resource centers are value-added propositions, intended to enhance and amplify the effectiveness and reach of a related group of NSF-funded projects. The rationale behind the DRL Centers, we believe, centers around a few underlying premises about ways to leverage NSF's current funding of its programs and projects:

1) <u>There is untapped synergy in every DRL program</u>. Hundreds of grantees bring expertise, experience and knowledge to their individual projects; each project also is doing innovative and creative work. DRL mechanisms and resources can better connect the projects to enhance communication and the sharing of knowledge.
2) <u>There is untapped knowledge in every DRL program</u>. Every project is generating both formal and informal knowledge; there are too few mechanisms for identifying, sharing and disseminating that knowledge. Centers can help optimize the degree to which NSF investments generate and share knowledge.
3) <u>NSF does not have the personnel, time, resources or license</u> to perform all the functions it would like to, both in supporting and learning from its grantees. Resource Centers provide various structures and mechanisms to optimize the quality and output of NSF educational investments.

Commonality Across Centers

The DRL Centers are at different stages of development and evolution, and vary greatly in the way they operate, communicate and are organized. But they do share some common underlying goals and features relating to the premises we describe on the previous page.

1) A Focus on Community Building

It is clear from our interviews that all the centers are seeking to realize the potential for synergy that exists in the pool of funded NSF projects. The DRL Centers have pursued strategies that help to create "learning communities" and "communities of practice" whereby the grantees assist each other. All the DRL Centers, to varying degrees and in different ways, have worked to create mechanisms and structures that allow grantees to share with each other, to work together on shared critical issues, and to identify key knowledge emerging from their projects. As one PI noted,

> "There is an emphasis on trying to facilitate connections among grants, to figure out who ought to be talking to who and where there are similarities. Building a community of people doing work in similar areas."

This focus on community building stems from a couple of specific circumstances. One, the DRL Centers recognize the depth of the experience and expertise that resides in the grantees. Hence, DRL Centers have sought to improve the work of the funded projects by providing more than just "traditional" forms of technical assistance, whereby Centers offer different forms of help to the PIs.

Also, Center PIs and Program Officers understand that the grantees have a lot of expertise and may not initially want the assistance the Centers may be offering. As the PI and program officer for one center noted:

> "This is a project the PIs never asked for. These are people that are quite savvy. If they want support, they usually know how to get it."

> "These people apply for grants, they have strong proposals, and they know how to do what they are going to do. The notion that they need to call somebody and say, 'How do I do my project?' is always a little bit awkward."

In addition, the competitive and individual nature of NSF funding contributes to the fact that most PIs work in isolation from one another – hence, it is difficult for most PIs to know what is happening with other projects. The DRL Centers seek to address this disjuncture by convening grantees in different types of meetings, and in creating infrastructure (face-to-face and on-line) to help them maintain conversations and collaborations.

As a result, the DRL Centers host PI meetings, and convene special interest, working, and/or inquiry groups (both online and in person) around key topics of interest to their community of funded projects, NSF, and in many cases, the broader field. Some examples of mechanisms to date include:

- Inquiry groups (CAISE)
- Working groups (CADRE, ITEST LRC)
- Special interest groups (CADRE)
- On-line forums (CAISE)

2) A Focus on Knowledge Building, Sharing and Dissemination

Closely related to the idea of community is the shared focus of the DRL Centers on knowledge building, sharing and dissemination. NSF projects in both the sciences and education are intended, at least in part, to generate knowledge that can serve the broader field. The DRL Centers all work to identify, encapsulate and then share the knowledge emerging from the projects. The DRL Centers specifically seek to address the untapped potential of knowledge that exists in the projects and the experience of the project leaders.

A few examples of such knowledge "tapping" and sharing include:

- Inquiry groups and their reports (white papers and briefings from CAISE);
- Working groups and their reports (a variety of reports generated from ITEST LRC groups on lessons learned from working with teachers and students)
- The conference and soon-to-be published proceedings on out-of-school time (LYREC)
- Webinars and forums (CAISE, ITEST LRC)
- Websites (ARC, CADRE, ITEST LRC, CAISE)

3) A Focus on Educating NSF and Other External Audiences

Each DRL program wishes to share and promote the work of the domain it is supporting. The collective output and benefit of the portfolio of projects within each program is not immediately clear or obvious to either inside or outside audiences. The DRL Centers are a mechanism by which the NSF-funded program can reach out to the broader field, as well as the rest of NSF and other key policymaking audiences. One program officer noted the importance of the center's role in helping NSF to communicate the value of its investments:

> "So (they can) answer the questions to ourselves and to others about what all of this has yielded. Have you made a difference in the world in some form or another? A center can help create the knowledge base on which one makes the case."

Examples of such outreach include:

- Inquiry groups from CAISE focused on large, over-arching themes related to making the case for informal science education
- Websites (ARC, CADRE, ITEST LRC, CAISE)

The Audiences to be Served

Who, then, are the intended beneficiaries of the investments being made in DRL Centers? To varying degrees they are intended to serve three different primary audiences:

1) The DRL Centers provide insights which NSF program officers can use to better understand the educational landscapes they work within, their own program portfolios, communicate with grantees, and educate external audiences about the value of their programs.
2) DRL centers seek to assist the funded projects within each DRL program by convening them, better connecting them with each other, and providing them with opportunities for further learning and evolving their work.
3) DRL centers also seek to contribute to the broader STEM field by disseminating the knowledge and lessons learned from the funded projects, and by helping them better understand and be prepared to seek NSF and other sources of funding.

The DRL Centers vary in the ways in which they prioritize these audiences. And there is also variation within NSF itself about the priority of these audiences.

Serving NSF

The products and resources resulting from DRL Centers can inform NSF and, hopefully, help NSF improve its own grantmaking as well as better understand the investments it has made. Program officers also often oversee projects in multiple programs and don't always have knowledge of the composition of projects that make up an entire program's portfolio. Quite broadly, the DRL Centers products and resources can help NSF know more about the diverse portfolio of projects that comprise each of its major programs – what has been invested in to date, what areas might warrant future investments, and what the key findings have been to date about those investments. In addition, Centers can help program officers gain insight into the educational domain (e.g., informal science education) they seek to improve. As the CADRE PI explained,

> "We are doing targeted studies of sub-groups of the portfolios in areas that NSF might want to make greater investments. For example, one of them is on ELL, which is comparing the existing research with that in the larger field. Are we filling any gaps? Are they funding areas that need more work?"

One program officer noted the key role these DRL Centers play in this regard:

> "The (DRL Centers) are funded to help the program directors make sense out of the program... Portfolio analysis is a very key function – I see that as their main priority…"

The DRL Centers are also a mechanism that can potentially better connect programs within the division at NSF. As one program officer noted, the DRL Centers' work in helping programs within DRL better understand their portfolios can help inform the larger division, and help identify gaps and redundancies.

> "It's important to understand not only our own portfolios within our individual programs, but across all the programs within the Division. Are we funding the same PIs for the same kind of work? Are there synergies we could be building on, now and down the line? The centers are a mechanism to help us understand that, and that helps create a Division and not just a set of programs. How can we build on our individual program strengths and also work to create a coherent Division on research and learning in formal and informal settings?"

NSF also does not have the staff capacity to provide the types of supports they envision might be beneficial to the implementation of their projects. DRL Centers can facilitate annual or bi-annual PI meetings, provide project-specific as well as portfolio-wide technical assistance aimed at improving the quality of projects' work, and help generate, synthesize and share broader findings about the work and contributions of the projects with the broader STEM field.

> "Program officers work with maybe three of four programs, and we don't have the time to provide some of the support, especially to very new grantees."

> "Essentially, our center is a resource for grantees – this is a resource that might otherwise reside within the federal agency, but clearly doesn't. NSF does not have the capacity internally to provide this level of ongoing support and facilitation, and it is a critical function. Without a center, you would have a lot of grants funded without much information coming out of them, and no capacity for benefitting from the synergy that is potentially there among them."

Serving the PIs

There is strong agreement amongst PIs and the NSF program officers that the centers should be serving PIs. As one program officer noted,

> "The primary role of the center is providing technical assistance for the grantees."

As we described earlier, the major strategy for serving PIs centers on the creation of communities of practice. In addition, several of the DRL Centers conduct needs assessments with PIs; offer webcasts, forums and webinars on areas of mutual need, concern or interest; and regularly evaluate the services they provide to PIs and adjust them as a result.

Serving the Broader Field

Beyond the NSF program and program officers, and the PIs of the projects, these DRL Centers are also engaged to a certain degree with the broader field in which their projects reside. Some DRL centers see the audience of the field as more of a long-term and indirect audience; others place the field as the primary audience they are trying to serve.

CAISE, for example, set out from the beginning to help create a shared informal science education identity, connections and collaborations not only with the NSF-funded ISE PIs, but with the broader world of people engaged in providing informal science education experiences. The NSF ISE PIs are seen not so much as a separate audience but are folded in with the broader ISE field. As the PI said,

> "Our mission is to strengthen and connect the entire ISE field. We have a field-building mission, and by working to connect the broader field, we are indirectly serving NSF."

Similarly, LYREC set out to influence the broader field of out-of-school time STEM providers from the very beginning.

The ITEST LRC and CADRE have focused much more of their efforts on the PIs of their projects. As one program officer noted:

> "I think field building has been less of an issue to the DR-K12 and education research folks."

For some DRL Centers, the starting point is clearly the NSF-funded PIs, with the theory being that serving as a resource to them, and connecting and empowering them, is a mechanism for improving the NSF program. Other centers seek to work with the entire field as a mechanism for improving the NSF program, and the work of the PIs within that.

It's important to note that not all the DRL Centers have NSF as an explicit component/collaborator for their work. Per their funding mechanisms, cooperative agreements, centers don't advise NSF. Instead, the center and NSF work

cooperatively such that the centers can support and enhance the impact of NSF investments.

Challenges for the Centers

Many of the perceived challenges and issues that arise for the Center PIs, evaluators and NSF program officers result from different and even conflicting visions for the DRL Centers. The challenges we discuss here are a result of newness of the centers/ relationships (for some of the Centers), lack of clarity, ambiguity, and confusion around the theory of action, and the assumptions and logic embedded in that theory of action that may or may not be valid. The theory of action is typically not explicit and it is not uniform across centers.

It is important to remember that NSF itself originated the concept of DRL Centers and is primarily responsible for defining what it that the centers are supposed to accomplish. To date, it is clear that the vision for the centers is evolving and being modified through the reality of practice. In this section of the memo, we briefly identify some of the challenges and issues that we encountered in our interviews.

1) serving multiple audiences with different or changing priorities

One challenge for the centers is balancing out the audiences/functions and the relative weight and priority given to each. As the PI for the ARC center noted:

> "You want to put as a priority your own research, yet at the same time, you have this training and development and coordination function. So figuring out how much effort you give to each..."

The extent to which the center sees NSF as a "client" they are trying to serve is a related area of challenge for the centers. As the evaluator for one center that has had a lot of turnover in the position of primary program officer noted:

> "The fact that there isn't a strong, ongoing relationship with a client is a challenge. It presents opportunities and creates challenges and impacts productivity. Too much time is devoted to figuring out who the client is..."

Finding ways to serve these two primary audiences – the PIs and the NSF program – with limited resources is difficult. One center PI mentioned trying to figure out how to request information from PIs for a portfolio analysis/management information system that in turn will benefit not only the program, but the PIs themselves.

2) ***working under the affordances and constraints of the cooperative agreement arrangement***

The DRL Centers operate under cooperative agreements with NSF. These are generally five-year grants that are reviewed every year, and NSF program officers are more actively involved in these centers than they would be with a grant. While there is some variation among the DRL Centers, in most cases, there are constant and fairly ongoing discussions between the center PIs and the program officers about the tasks to be performed by the center. Some PIs and program officers described this as collaborating, while others described it as negotiating. As one center PI noted:

> "Typically, we have weekly scheduled calls with our program officer and she meets regularly with her cluster. We suggest ideas, she takes them back to the cluster for input. We are constantly collaborating."

3) ***working with and responding to clusters of program officers***

Most centers collaborate with one or perhaps two key program officers who represent an entire "cluster" of program officers; others engage more frequently with the entire cluster of program officers. Each of these scenarios presents challenges. In the first, it isn't always clear that the representative program officer represents the opinions of the rest. As one PI noted, the likelihood is that is not the case:

> "When we get input from a program officer, I can't tell you that it represents that whole cluster, because I don't think that cluster has one view. They are lone rangers, and they will tell you that."

Where more of the program officers in a cluster are actively involved, the many diverse opinions can lead to difficulties in sorting out what NSF would like to see from the center. As one PI said,

> "The cooperative agreement has been vastly complicated by the internal structures at NSF."

4) ***Nature and scale of the funded field in different programs***

One question that emerged for us is, what is a manageable scale for the DRL centers in terms of the number of projects they can effectively and legitimately serve? Some of the centers work with more than 300 projects.

> "Under the IERI (Interagency Education Research Initiative) community, we worked with somewhere around 100 projects. We've tripled our portfolio. That does have different implications. The biggest challenge for us has been the size of the community we are serving, and the clear differences with the

community, with respect to experience with research, size and types of grants, and the areas they cover."

Another area of concern, particularly to center PIs, is the available resources. Centers struggle to meet the agendas and needs of the PIs in their programs, the program officers, and the field with the resources at hand. As one PI said,

> "We were under-funded to do all that is needed to be done."

One program officer agreed:

> "The demand is way more than the supply. In most cases, the size of the cooperative agreement is based on what you can get through NSF in terms of the approval system, not necessarily on the need and what it really costs to make things happen."

5) ***timing and positioning of the centers vis a vis the PIs***

We also think there are challenges in setting up the relationship between centers and PIS. It is a challenge for a center to co-evolve with the projects it was designed to serve. Also, mapping a resource center onto an existing set of projects, who may or may not feel they need technical assistance, or mapping a resource center onto a very large field that may not even see itself as a field, are significant challenges.

6) ***working under the constraints of the NSF restrictions***

Another clear challenge is the conflict of interest inherent in this work. If not carefully designed, those leading the DRL Centers can be seen as competing with the projects and fields they are serving for funding from NSF.

7) ***creating center leadership, organization and capacity***

Centers are meant to support very sophisticated projects. Consequently, they require multiple forms of capacity and demand hybrid leadership skills. Centers must have skills (and stature) in the domain of the program (e.g., informal science education); they must have expertise in professional and organizational development; they must have the connections and relationships needed to convene the field and guide the development of communities of practice.

The five centers we studied bring very different types and levels of skills to the task. What emerged from our conversations is a portrait of the center leadership skills required. Center leaders have to be knowledgeable about the PIs and the field they are trying to serve, and knowledgeable about how to both set up the infrastructure by which the PIs in the program can work together, and to provide the technical assistance needed by the diverse set of PIs and projects in their portfolios. In the case of CAISE, because of the field-building agenda, center leaders also have to be

skilled at field building. In the case of ARC, which is also charged with conducting original research, yet another set of skills is required. As the PI said:

> "ARC is different from other Centers and we have been all along. Having a center that is guided by a set of active researchers suggests a different type of collaboration with NSF. One of the reasons they are so actively involved with what we do is that, because we are researchers, our interests are very much directed at the same kinds of goals that NSF has which have to do with rigor and evidence and impact."

8) evaluation of the centers

Another important question is how you evaluate a center such as these. Most DRL Centers' evaluations focus on the fairly straightforward tasks of documenting the activities of the center, through annual and event-based PI meetings and interviews. What is more difficult is assessing the long-term, value-added impact of a center. As one PI noted:

> "How do you look at impact and if a big part of this work is supposed to be dissemination, what are the best indicators of that?"

> "We are continuing to get feedback from PIs and others about the nature and quality and value of what the LRC does, and trying to dig a little deeper into what changes occur or don't occur as a result of all that technical assistance. Another area for the evaluation is the dissemination part: getting a handle on what projects individually put out into the field about their work. What does the LRC do to support projects to put out their own findings, and what does it do itself about gathering info and putting it out there. And finally, what is the effect in the field broadly? Getting a handle on what the appropriate level to measure is. What is the LRC's role in student learning and feelings about STEM? Hard to say that because of the ITEST project, this student went on to get a master's degree. We are still grappling with it."

ARC is engaged in a self-evaluation:

> "We have a set of metrics, so in the area of outreach, how much in terms of web presence have we really had. We do evaluations of every activity we undertake. We are using these metrics we have been working on with NSF."

Some DRL Centers are engaged in gathering data about the set of projects as a whole. ARC and CADRE collect data across their projects. The ITEST LRC is implementing mechanisms to gather yearly data across all projects as a means to help key audiences understand the portfolio as a whole and the contributions of the projects' work. CAISE, on the other hand, is not engaged in this type of activity as NSF had already contracted with WESTAT to create an online project management system. CAISE has served more to publicize and disseminate NSF products of

interest to the broad ISE field, such as the Frameworks for Evaluating Informal Science Education Projects, and the two NRC publications: Learning Science in Informal Environments: People, Places, and Pursuits, and more recently, Surrounded by Science.

Summary Thoughts

The DRL Centers represent an investment by NSF to make its educational investments better. They are a means to improve and leverage the investments the Foundation makes in hundreds of other projects. They are highly ambitious in that they seek to serve NSF, the funded projects, and the fields within which they work.

There are multiple factors that shape the vision, form, strategies and work of each Center. Some of the most salient factors include:

1) the overarching NSF vision of the DRL center role and function
2) the vision, skills, interests and capacity of the Center leadership
3) the vision of the cognizant program officer
4) the nature, extent and quality of the interactions with the program cluster
5) the nature and scale of the projects and PIs within the program
6) the nature and scale of the field(s) represented in the program

All of these factors work together to shape each center differently. Centers are not and should not be identical: their fields, missions, and domains widely vary. They must be highly responsive and adapt to what is needed by NSF, the projects and realities of the educational world they all work within.

We think the Centers are a wise investment, but they need constant work to continue to evolve their purpose, strategies, composition, and activities. This work needs to be collaborative between NSF and the Centers so that they can each contribute to each other and to the fields they serve.