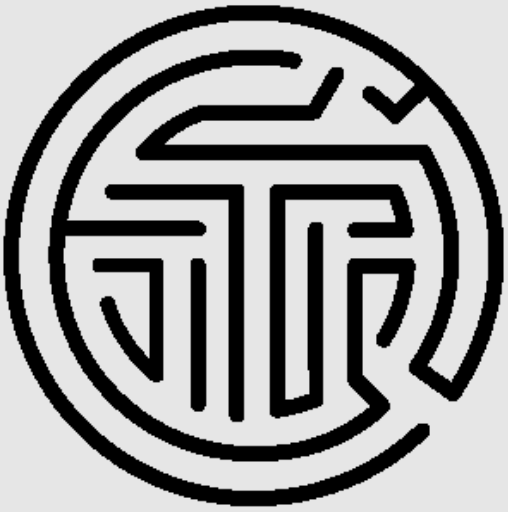

FORMATIVE EVALUATION OF THE INTEL® DESIGN AND DISCOVERY CURRICULUM

REPORT

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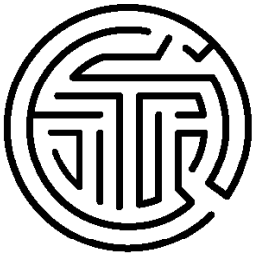

CCT REPORTS
FEBRUARY 2004

FORMATIVE EVALUATION OF THE INTEL® DESIGN AND DISCOVERY CURRICULUM

REPORT

PREPARED BY

KATIE MCMILLAN CULP
JULIE THOMPSON KEANE
TERRI MEADE
HANNAH NUDELL

CENTER FOR CHILDREN & TECHNOLOGY

EDUCATION DEVELOPMENT CENTER, INC. 96 Morton Street, 7th floor New York New York 10014 *tel* 212] 807.4200 *fax* 212] 633.8804 *tty* 212] 807.4284 *web* www.edc.org/CCT

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EXECUTIVE SUMMARY

Between May 2003 and January 2004, Education Development Center's Center for Children and Technology (CCT) undertook a formative evaluation of *Design and Discovery*, a hands-on, project-based design and engineering curriculum being disseminated as part of the Intel Innovation in Education initiatives. The *Design and Discovery* curriculum invites 11- to 14-year-olds to explore engineering by engaging in hands-on design activities. The curriculum's goals are to build young people's knowledge of engineering, design and science, to support the development of their inquiry skills, and to involve them in sustained problem solving. *Design and Discovery* was created in part to serve as a preparatory experience for young people interested in participating in the Intel International Science and Engineering Fair, a major competition for pre-college students that Intel sponsors.

This formative evaluation was guided by the following four main goals:

- Explore whether and how the core activities and concepts of the *Design and Discovery* curriculum are communicated and carried out with young people in a range of programmatic settings.
- Determine whether and how available resources, training experiences, and/or local contextual factors support or impede program coordinators' choices about how to implement the curriculum, and their ability to implement it effectively.
- Explore, to the extent possible given levels of program implementation, how engaged young people are by the curriculum's core concepts and activities; and whether this experience sparks participants' interest in further exploring science and engineering.
- Gather lessons learned regarding implementation and support strategies from other recent efforts to support science and engineering learning in informal learning environments through delivery of curriculum and training. A separate report has been prepared addressing this goal, so this topic is not addressed in this report.

Key findings from this evaluation include the following:

- Of the 38 sites (36 Girl Scout councils and two other sites) included in this study, eight had completed an implementation by the conclusion of the evaluation period; 21 had begun or were just about to begin an implementation; and nine were still developing plans for a Spring or Summer 2004 implementation.
- Of the 29 sites included in this study that had planned for, begun, or completed an implementation of this curriculum, slightly less than half (13) used the entire curriculum and maintained a focus on the design process throughout their program. Most but not all of these implementations are happening in two-week summer camp settings. Experience or local resources have helped the facilitators of these camps recognize the importance of the design process to the goals of this curriculum and offer a program that is designed to support that process.

- The remaining 16 of these 29 sites are using portions of the curriculum, in camp, long-term workshop or course-type structures. These sites typically engage their participants in a range of hands-on activities drawn from the curriculum. Facilitators of these programs are generally seeking to increase their participants' general awareness of science and science-related careers and do not choose to emphasize the design process *Design and Discovery* seeks to support.
- Local facilitators who chose not to implement the entire curriculum did so because of a number of challenges they encountered or anticipated. The primary challenge was securing adequate access to content experts who could either help facilitate a local program or act as mentors to participants. Other challenges included a perception that the curriculum was too difficult for the populations youth facilitators serve, did not match goals of existing local programs, or required more time 45 hours than available.
- Implementations that were most consistent with the intent of *Design and Discovery* were carried out in settings where:
  - Programs were at least two weeks long.
  - Facilitators recruited participants from the intended age group and with a pre-existing interest in science and/or engineering.
  - Facilitators had enough prior experience leading project-based curricula to maintain a leadership role during the implementation.
  - Facilitators had access to multiple individuals with relevant content expertise to support implementation and act as mentors to participants.
  - Facilitators were familiar enough with science fairs to understand how to link the design process featured in this curriculum to the requirements of a science fair, and to support their participants in moving from one experience to the next.
- Recommendations for supporting future implementations of this curriculum include providing support and training for both facilitators and mentors, possibly including the creation of an online training resource that could provide sustained support over time; developing a more modular approach to the curriculum that would maintain the sequential structure of the design process while allowing for shorter implementation periods when appropriate; and providing more guidance to local programs about the intended audience for the curriculum.

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INTRODUCTION

Between May 2003 and January 2004, Education Development Center's Center for Children and Technology (CCT) undertook a formative evaluation of *Design and Discovery*, a hands-on, project-based design and engineering curriculum being disseminated as part of the Intel Innovation in Education initiatives. The curriculum was initially developed for, and implemented by, the Girl Scouts USA, but in Fall 2003 Intel expanded its efforts to provide support to a range of other formal and informal educational settings interested in using the curriculum. This evaluation examines both the Girl Scouts USA experiences with the curriculum and those of other informal and formal organizations.

About Design and Discovery

The *Design and Discovery* curriculum invites 11- to 14-year-olds to explore engineering by engaging in hands-on, design activities. The curriculum was originally designed for young women, but Intel is now inviting organizations to use the curriculum with any group of young people in the targeted age range. The curriculum's goals are to build young people's knowledge of engineering, design and science, to support the development of their inquiry skills, and to involve them in sustained problem solving. The curriculum is available for download at the Intel Innovation in Education website (in the United States) at no cost, and comes with a set of resource materials to support implementation in both formal and informal education settings. *Design and Discovery* was created in part to serve as a preparatory experience for young people interested in participating in the Intel International Science and Engineering Fair, a major competition for pre-college students that Intel sponsors.[1]

About this evaluation

This report presents findings and recommendations based on data collected between May and December 2003. This formative evaluation was guided by the following four main goals:

- Explore whether and how the core activities and concepts of the *Design and Discovery* curriculum are communicated and carried out with young people in a range of programmatic settings (including those led by adults who received face-to-face training and those who did not).
- Determine whether and how available resources (at the website and in print), training experiences, and/or local contextual factors support or impede program coordinators' choices about how to implement the curriculum, and their ability to implement it effectively.
- Explore, to the extent possible given levels of program implementation, how engaged young people are by the curriculum's core concepts and activities; and whether this experience sparks participants' interest in further exploring science and engineering.

[1] For more information about *Design and Discovery*, visit http://www.intel.com/education/Design/index.htm. For more information about the Intel International Science and Engineering Fair, see http://www.intel.com/education/isef/index.htm

- Gather lessons learned regarding implementation and support strategies from other recent efforts to support science and engineering learning in informal learning environments through delivery of curriculum and training. A separate report has been prepared addressing this goal, so this topic is not addressed in this report.

METHODS

This formative evaluation draws on observations of a facilitator training, *Design and Discovery* camps and after-school sessions, and phone interviews. Sites involved in this study include a subset of 45 Girl Scout councils that received implementation grants in Spring 2003 from Intel to support their use of *Design and Discovery*, and two other sites where facilitators did not receive training on the curriculum. One of these other sites was a middle school, where a math teacher led an implementation, and one was an after-school program. Conversations with regional education managers supplied a broader view of the range of formal and informal education contexts in which the program is currently being implemented.

All of the Girl Scout-sponsored implementations were delivered to girls only. The other two sites served both boys and girls.

Forty-five Girl Scout councils received implementation grants from Intel, but sites were at various points in the implementation process during the timeframe of the evaluation. The 36 councils that submitted implementation plans to Girls Scouts USA and Intel were included in this formative evaluation. Of these 36, eight sites completed implementation during the evaluation; 19 councils began implementation during the evaluation period or were about to do so; and nine had developing plans for implementing at a future date (Spring or Summer 2004). Of the nine not included in the evaluation, one council dropped the program and eight sites did not submit an implementation plan. See Table 1 for a summary of implementation status.

Table 1: Girl Scout councils' follow up on implementation grants

Implementation Stage	Number of Councils
Completed implementation	8
Started implementation/near future	19
Planning implementation for future date	9
Missing as of Fall 2003	1
No implementation plan submitted	8
Total	45

Two non-Girl Scout sites were also included in this evaluation. These sites were in the midst of long-term implementations (spanning all or most of a school year) at the conclusion of the evaluation.

Site visits

Site visits were made to one facilitator training and to five local sites implementing the *Design and Discovery* curriculum with young people.

In-person training for facilitators. Researchers observed a training for informal educators planning to implement the *Design and Discovery* curriculum. All of these educators were from Girl Scout councils that had received implementation grants from Intel to support their use of the *Design and Discovery* curriculum. Observations focused on documenting how future trainers were introduced to the content and core messages of the *Design and Discovery* curriculum; future facilitators' perceptions of the goals of the program and of the core concepts of the curriculum; and how prepared facilitators felt at the conclusion of the training to conduct their own *Design and Discovery* camps. Researchers also discussed with the facilitators what suggestions they had for improving the training, their perspective on what elements of the curriculum would be most important to emphasize in their own camps, the extent to which they already engage with science and engineering content in their current program, and any changes they planned to make to the curriculum to fit into their organizations and the needs of participating youth.

Implementation sites. The central goal of the implementation site visits was to explore how both program coordinators and participating youth responded to the curriculum and its core messages, how trainers communicated the curriculum content to participants, how trainers sought to engage young people with the material, and how the group engaged with and pursued particular activities. Interviews with program staff explored how program facilitators chose to implement the curriculum and why. Site visits also helped to identify what resources facilitators drew on to support their implementation, what resources might offer additional support, and program goals facilitators associated with their current and future implementations of the curriculum.

Researchers visited five sites using a range of implementation models, in order to gain an understanding about the strengths and weaknesses of various formats and structures for implementing this curriculum. These sites were selected through consultation with the Intel Innovation in Education web development team, Intel regional education managers and information collected from preliminary phone interviews with Girl Scout councils. Sites were selected with a goal of including sites that varied widely in the scope of their implementation of the curriculum, geographic location, and level of content knowledge present among adults leading the program. Three sites were Girl Scout council programs, including one summer camp, one two-day overnight event, and one once-a-week Saturday program. One site was an after-school implementation at a middle school, and one was a weekly school-based implementation with two 6th grade classes in a public middle school.

Researchers spent between two and five days at each of four of these sites, and one day at a fifth site. During site visits, interviews were conducted with participating coordinators, instructors and other relevant administrative staff, and researchers observed relevant workshops, sessions, and presentations. At two sites, final presentations or science fairs were observed.

During observations, particular attention was paid to identifying those aspects of the curriculum that generated the most activity or interest among participants, as indicated by evidence such as time on task and the kinds of questions being asked. Researchers also sought to document whether and how program facilitators were using the available print materials and the website.

Phone interviews

Phone interviews were conducted with relevant personnel from 33 of the 36 Girl Scout councils that received implementation grants and completed a written description of their plan for implementation. Of the remaining three councils, two were included in site visits with interviews conducted face-to-face during those visits, and one no longer had a relevant contact person and was not planning on implementing the curriculum this year. In most cases interviews were conducted with the individual who had attended the training and was then responsible for planning and delivering an implementation of the curriculum. In some cases, the interview subject was a council leader who had not attended the training or who did not expect to facilitate the program. In these instances, facilitators were coming from organizations outside the council such as a local chapter of Society of Women Engineers or a local university. In light of this, interviews focused on how training information and materials had been shared to help plan for use of the curriculum.

Eight Girl Scout sites had completed implementation before their interviews occurred. Other sites were either beginning an implementation, or were developing plans to do so in the future. Depending on the stage of implementation at the time of the interview, interviews ranged from a brief conversation about plans for future implementation, to longer conversations with councils that were currently, or had already finished, implementing the curriculum. These interviews sought to document the following:

- Expectations and interests that led Girl Scout facilitators to participate in the *Design and Discovery* training.
- Facilitators' plans for implementing the curriculum locally.
- How and why facilitators' implementation plans have changed, or may be changing, over time.
- Facilitators' perceptions of the key resources needed in order to implement the curriculum effectively (such as adequate training, access to mentors, computer access, incentives for participation), and the extent to which they feel those resources are locally available.

SUMMARY OF FINDINGS

Response to facilitator training

Representatives from 45 Girl Scout councils that received implementation grants from Intel were invited to participate in a *Design & Discovery* facilitator training in Spring 2003. Over the course of the three-day training, participants worked in small groups through many of the activities included in the curriculum. Participants were generally enthusiastic about taking on the role of the learner, and persevered with the challenge of understanding difficult concepts and mastering new skills. For example, an activity that involved creating a variety of types of circuits using a breadboard was particularly challenging for many, but each group engaged in extended discussion and experimentation as they sought to understand how to arrange the circuits correctly. Eventually, each group did master this task. The large majority of participants expressed strong interest in the content and were engaged by the hands-on activities presented.

Although participants were largely enthusiastic about exploring the content presented, the majority had come to the training unprepared for the breadth and depth of the curriculum itself. The implementation grant that they received (which had initiated their involvement in this training) had originally been intended to support any type of science event. Participants were aware that Intel would be providing them with materials to support their efforts to engage 11- to 14-year-old Girl Scouts with science, but did not understand prior to the training that the material being disseminated was an ambitious, sequential, 18-session curriculum. Several participants expressed concern that they did not have adequate science training to lead several of the activities and felt that they would need more training and/or additional support before they could feel adequately prepared to deliver the curriculum. Some participants were already developing, during the training, plans for bringing in outside experts to help them facilitate their camp or event.

Toward the end of the training, groups were organized according to the type of program implementation that had been planning: those intending to deliver one- or two-day programs, for example, worked together, as did those planning longer camps. Participants developed action plans that were intended to help facilitators articulate connections between their own council's programmatic goals and the *Design and Discovery* curriculum, and to use these connections as the basis for developing an implementation plan. A review of these action plans reveals that, despite the expectation expressed at the training that each council would implement the entire curriculum, most facilitators planned to take a more selective approach to integrating this curriculum into their existing programs. Action plans often include plans for delivering individual science activities drawn from the *Design and Discovery* curriculum, and stress the importance of these experiences as opportunities to raise girls' awareness of science, generally, and to give them hands-on exposure to scientific processes. These plans reflect the existing priorities of these councils, which generally involve offering girls broad exposure to a wide range of types of experience, rather than engaging them in substantial, sustained investigations. These action plans were discussed within small groups, but feedback was not provided systematically to council representatives from Intel or from

other Girl Scout leaders that indicated any preference for one type of implementation over another.

Local implementation of the curriculum

This section discusses how *Design and Discovery* is being delivered locally. The following programmatic features are discussed: implementation model used; scope and organization of curriculum use; populations targeted and reached for participation; resources used or needed to support implementation; and availability and preparedness of facilitators and mentors to lead the program.

Implementation models

The *Design and Discovery* curriculum is designed to be delivered in 18, two and a half hour long sessions. Data collected from the 38 (36 Girl Scout councils and two other sites) organizations included in this evaluation demonstrate that they are using a range of timeframes and organizing structures (referred to here as "implementation models") to deliver those 45 hours of activity (or some subset of them). It is important to note that most of these implementation plans were developed by Girl Scout council facilitators prior to the facilitators' training, and were planned without substantive knowledge of the scope, recommended timeframe, or focus of the curriculum.

The implementation models these organizations are using, or are planning to use, can be grouped into three main categories:

- *A one- or two-week camp*: A total of 21 Girl Scout councils ran, or planned to run, a one- or two-week camp. Three of these councils planned to offer two, three or four camps within a short period of time, such as a single summer or fall. In order to accommodate a broader age group, one council held two separate camps simultaneously (one was for middle school and one for high school aged girls), and morning and afternoon sessions, using one for 6- to 8-year-olds and one for 11- to 14-year-olds.

- *Long-term course:* 16 sites (including the two non-Girl Scout sites) planned long-term implementations, moving through the curriculum session by session on a schedule varying from twice weekly to monthly meetings. These sites included a variety of after school programs as well as the one in-school implementation included in this study. Eight of these sites (all Girl Scout councils) were planning to offer their after-school programs at multiple locations simultaneously. The three programs involving one meeting a month were all Saturday programs. Weekly or bi-weekly offerings were sometimes designed by after-school programs that wanted to align their programs with local school calendars and were seeking to fit *Design and Discovery* into a semester- or quarter-long period of time.

- *Other models used:* One site delivered a two-day camp, a structure they chose in order to accommodate the organization they had invited to help them facilitate their program. Twelve Girl Scout councils also delivered brief, one- or two-day events featuring highlights from the curriculum in addition to their main implementations. These events were generally recruitment

opportunities, intended to interest either active Girl Scouts or other young women in participating in the program.

The following section discusses how the implementation models used relate to the amount of curriculum delivered by each.

Scope and organization of curriculum use

Sites used the curriculum in many different ways in the context of their various camps, special events and ongoing courses. Table 2 presents a summary of how curriculum use varied across implementation models being used or planned for at 27 Girl Scout council sites that had begun or completed an implementation, or had substantial plans in place for their implementation (the remaining nine Girl Scout council sites had not yet planned in enough detail to determine how they would use the curriculum). The one school site included in this study is using most of the curriculum, integrating it into a two-semester course. The non-Girl Scout after-school site used selected activities from the curriculum, in a twice-weekly format.

TABLE 2: IMPLEMENTATION MODELS AND SCOPE OF CURRICULUM USE FOR GIRL SCOUT COUNCILS

Implementation Model	Entire/Most	Curriculum Use Parts/ Activities	As a Reference	Total
One or two week Camp	10	7	0	17
Course	2	5	2	9
Two-day Camp	0	1	0	1
Total	12	13	2	27

The following paragraphs describe in more detail the three most common strategies sites used for adapting the curriculum to meet their local needs and priorities.

Delivering all or most of the curriculum. The most common implementation model for implementing the entire curriculum was the two-week camp. Both phone interviews and site visits to two organizations implementing the entire curriculum indicate that these facilitators have a clearer understanding of the goals of the curriculum than other sites. For half of these sites, their knowledge of the curriculum was enhanced by their previous use of an earlier version of the curriculum.[2] Facilitators at these sites modified the current curriculum for their programs, adding back in some material from the earlier version. For example, one council added problem-solving challenges to their program that had been presented in the first version curriculum and that they thought worked well the previous year. Another council added a field trip to their program to reinforce one of the *Design and Discovery* concepts.

[2] Intel worked with a small number of sites in 2002-2003 on a pilot of an earlier version of the curriculum, which is not addressed in this formative evaluation.

Facilitators of these camps clearly saw as goals for using this curriculum 1) implementing the entire curriculum in sequence, 2) guiding girls in the development of their own design model and prototype, and 3) encouraging participants to enter a local and/or national science fair. To support these goals, they used several strategies when organizing their programs that facilitators of other types of implementations did not use. For example, many of these facilitators specifically sought to recruit girls who had a pre-existing interest in science. They also made it an explicit requirement that participants agree to attend the entire camp.

Incorporating various curriculum elements into another program structure. Facilitators who were not previously familiar with the curriculum were most likely to choose to condense the curriculum significantly, either by picking out individual sections or activities to deliver, or by delivering each broad theme but truncating the activities associated with them. For example, during a face-to-face interview one facilitator discussed using several activities with his participants, but not delivering them in any particular order. The young people involved in this program found the activities interesting and challenging, but their experience of the curriculum did not involve developing or creating their own designs, and there was no culminating project for the implementation as a whole. This facilitator saw the curriculum as a valuable set of resources that he could use to engage youth in science activities, which was a central priority for the after-school organization. In another example, a facilitator had a short (less than one week) timeframe for her implementation, so she chose to deliver a condensed version of the whole curriculum. During a site visit to this organization, evaluators observed that although young people at this site did move sequentially through each main theme, they did not have enough time to pursue the hands-on activities or discussions in enough depth to build connections between the individual activities and the overarching concept of the design process that structures the curriculum. This implementation also did not culminate in participants creating working models of a product. Instead, possible ideas for products were generated and used briefly in various activity contexts, but were not sustained or developed over time.

Many organizations that used this approach to the curriculum already had established science programs in place. Although the presence of such programs might seem to indicate that an organization would be well-prepared to implement *Design and Discovery* comprehensively, these facilitators did not perceive a strong mandate from Intel or from the Girl Scouts USA that they should use the curriculum in a particular way. Instead, they chose to integrate various isolated activities from the curriculum into other, existing programs. For example, one site decided to dedicate two to three full days of a weeklong science camp to work on *Design and Discovery* themes. This site already had an existing summer camp program, but liked the *Design and Discovery* curriculum and planned to blend aspects of the two programs together at their 2004 summer camp.

For several of the Girl Scout councils in this group, the decision to use the curriculum selectively was driven by collaborators from local universities or professional organizations who had been recruited to support the facilitation of the camp or other programming the council was developing. These outside facilitators sometimes chose to integrate *Design and Discovery* activities into pro-

grams they were already familiar with and were already prepared to lead.

Using the curriculum as a point of reference. Two sites planned to use the *Design and Discovery* curriculum as a point of reference to guide the development of their own science and engineering programs or activities for their young people. These sites did not implement any of the specific activities included in the curriculum. Instead, these sites reported that they had shared the core ideas and structure of the curriculum with collaborators from local professional organizations or universities, who had copies of the *Design and Discovery* curriculum, to inform the programs they were developing. As one program leader stated, these sites are "following the intent of the curriculum but not necessarily the specific activities." At one of these sites, this meant that the program facilitators picked up on the idea of using the design process to interest girls in engineering from *Design and Discovery*, but developed their own activities reflecting this process rather than using the existing curriculum. At the other site, the program facilitators did not want to focus on engineering, because they had already chosen to focus on science and the environment. This site reported that they had adopted some ideas for supporting young people in the design process from *Design and Discovery*, but adapted these ideas to other content areas.

Distinctions between complete and partial curriculum implementations. The *Design and Discovery* curriculum is focused on motivating youth to become familiar with the design process, to understand related core science content, and to then use this new knowledge to become designers themselves. Almost half of the Girl Scout sites (12 of 27, see Table 2), and one of the two other sites included in this study, have indicated that they are aware of the core goals of the curriculum, and have (or are planning to) put several key program elements in place to ensure that their programs will engage young people in the design experiences the curriculum is intended to support. These sites delivered the entire curriculum in sequence, focused explicitly on engineering as a theme for their program, targeted the appropriate age group, and were specifically seeking to connect their participants' experiences to consequent participation in a science fair (or described these elements when reporting their plans for Summer 2004 implementations). Phone interviews and site visits suggest that facilitators at these sites are drawing on a range of local resources (including, as discussed above, prior experience with the curriculum) to help them to engage with and support the design process at the heart of this curriculum.

Many other organizations also worked hard to find an effective way to integrate this curriculum into their existing programs, but in these cases the curriculum-specific goals of *Design and Discovery* were often set aside in favor of pre-existing organizational goals. At these sites, partial or condensed implementations, or "implementations" that only involved indirect reference to the curriculum, were most likely to occur.

The most common goal these facilitators discussed when explaining the choices they made regarding curriculum use and implementation model was a desire to motivate girls to become more interested in science in general. Facilitators often perceived that this general goal of raising awareness and interest could be met effectively by engaging young women in discrete activities.

These facilitators were aware that *Design and Discovery* took a different approach to motivating girls' interests, by helping them pursue sustained design and development projects, and addressed engineering as well as general science. However, they did not perceive that a significantly greater benefit could be gained by making the investments of time and resources that would be needed to implement the entire curriculum. Instead, these facilitators felt confident that the best use of the curriculum, given their goals and the resources available locally, was to use it as a "grab bag" of activities that participants would enjoy and that would engage them with important science concepts.

Some facilitators did explain other motivations for choosing not to deliver the entire curriculum. A few explained that they felt their youth would find the full curriculum intimidating, especially young people without a strong science background or familiarity with science fairs. Some Girl Scout program leaders also identified an organizational goal to increase or retain the number of older girls participating in the Girl Scouts. In these cases, councils talked about using *Design and Discovery* as a means to accomplish this goal, in addition to an overall program goal of increasing interest and knowledge in science.

Participant populations targeted and reached

Overall, *Design and Discovery* was used in diverse environments and with diverse populations of girls. Program facilitators knew their local communities well and were able to draw on extensive networks of contacts to help them recruit participants. Overall, sites' particular mandates and the nature of their local populations led them to target a wide range of populations that varied by type of geographic area (urban, rural, suburban), age, socio-economic and ethnic backgrounds, and level of previous interest in science or engineering.

Three main strategies drove program facilitators' choices about who they were seeking to recruit for participation and how they went about recruitment. First, in the two non-Girl Scout implementation settings included in this study, facilitators chose to use the curriculum with an already existing group of youth (a school and an after-school group). These were also the two cases in which the curriculum was used with both boys and girls. Second, as mentioned above, many Girl Scout councils are seeking to increase the number of early adolescent-aged girls participating in their programs, and these sites sought to publicize *Design and Discovery* as an inviting opportunity that would bring new young women into their councils. In these cases, facilitators sought to reach as wide an audience as possible with the program, by featuring individual activities from the curriculum in a much broader daylong science fair, for instance, or by holding a science-oriented open house for the community that featured hands-on activities including some drawn from *Design and Discovery*. Finally, those Girl Scout councils that were primarily focused on *Design and Discovery* as an opportunity to engage young women with science and engineering concepts often focused their recruitment efforts on local networks of colleagues at local schools, science museums and other after school programs. In these cases, colleagues often passed the information along to young women who were already expressing a strong interest in science or engineering.

The disparate motivations driving facilitators' recruitment strategies generated very different groups of young people participating in *Design and Discovery* events, camps and workshops. Youth varied widely in the level of prior background knowledge, the level of motivation, and the kinds of expectations that they brought to their participation in the program. Specifics about recruitment priorities and strategies used to support recruitment are provided below.

Number of girls served by a single program. The number of girls involved in each of these implementations varied widely and was closely related to the type of implementation structure each site had chosen. Sites sought to work with anywhere from 12 participants for a one-week camp to more than 100 participants at a science day event. Councils that planned to run a camp or after-school or weekend program generally sought to recruit between 15 and 25 participants, with the exception of one camp that planned to accommodate up to 40 girls. One-day science events and workshops were used to reach larger numbers of girls - anywhere from 100-450 participants. For example, one council held a weekend recruitment event that drew about 200 girls.

Age ranges. The curriculum is being used with girls from as young as eight to as old as 17. While most sites planned to target a narrow age group within this range, five sites were planning to work with eleven to 17 year olds in a single program. Two sites wanted to reach a broad age range, but in order to do so developed multiple programs, each targeting narrower age-specific groups (for instance, one site offered a program for middle school aged girls and another for high school aged girls).

Targeting special populations. The majority of sites did not use this program either to target underserved youth who might have little opportunity to pursue this kind of hands-on inquiry and exposure to engineering, or to cultivate youth with a pre-existing interest in science and engineering. However, some sites did use the program to reach underserved youth (including low-SES and minority girls), and others specifically used it as an enrichment program for young women already demonstrating a strong interest in science and engineering. One organization running multiple implementations used both of these strategies in different locations within their community.

Recruitment strategies. Local facilitators worked hard to publicize their programs and recruit participants. The most common strategies used for publicity and recruitment were:

- For Girl Scout councils, using Girl Scouts resources and publications to share information about the program. These resources included newsletters, flyers, brochures, event calendars, council website, troop leaders, and introductory activities
- Working with personal contacts within local schools to "get the word out" to science teachers in the appropriate grades
- Working collaboratively with other existing after-school programs or community centers to offer the program to their existing populations

- Advertising in community publications such as local newspapers
- Word of mouth dissemination through networks of after-school program staff, school staff, or Girl Scout leaders

Incentives. Sites used a range of incentives to motivate young women to participate in local *Design and Discovery* programs. Offering meals and snacks throughout the program was the most common incentive used. For example, one Saturday program provided both breakfast and lunch to participants. A desirable location was also considered an incentive by some facilitators, such as one who offered her program at a university and said, "It gives the girls the opportunity to see the campus and opportunity to see first hand what the university had to offer to the girls." With an eye to retention as well as recruitment, some councils also planned to award Intel QX3 Microscopes to participants upon completion of the program.

Resources used or needed to support implementation

Program facilitators and other staff of organizations hosting *Design and Discovery* programs described a range of resources that they felt were necessary to a successful implementation of this program. Many of these were needs specific to understanding and delivering this particular program (training and resource materials), while others were needs that would arise around delivering any in-depth, content-focused curriculum, such as this one, particularly in an informal educational setting. Specific needs facilitators discussed included adequate training for themselves; access to, training for, and incentives for mentors; access to computers; and financial support for the process of publicizing and recruiting for the program, for buying materials required for various activities, and for providing transportation for participants.

In the case of Girl Scout councils, many of these facilitators chose to create or build on pre-existing relationships with outside institutions to support their implementation of *Design and Discovery*. A major benefit of some of these relationships (particularly with universities) was access to superior facilities and material resources, and sometimes mentors. For example, one council decided to collaborate with a community center because it solved their problem of not having a computer lab or the means to provide transportation for field trips. These relationships also had consequences for the way the curriculum was actually delivered to participants (see Facilitators and Mentors Discussion). However, many sites did not have the benefits of these kinds of collaborations and reported that seemingly minor costs related to this program, such as providing materials for activities, were major obstacles to their ability to make use of the program. In several cases, facilitators reported that they were choosing to use only some parts of the curriculum in order to avoid those portions that required the use of materials they could not afford to purchase. These sites reported focusing instead on activities such as "Make a better paper clip" or sections on mechanical engineering.

Resources made available by Intel. Those program facilitators who had benefited from participating in face-to-face training consistently reported that that experience had significantly

enhanced their ability to lead youth through the curriculum. Facilitators were less consistent in their reactions to the website and the resources available there, which many of them had not explored extensively or drawn into their program implementation (apart from the curriculum itself). Generally, program facilitators were not aware that the website offered resources other than the curriculum itself, and once they had downloaded hard copies of the curriculum they did not return to the website.

A few facilitators and other staff of local programs did use the website in other ways to support their *Design and Discovery* implementation. For example, program leaders described using the website to print materials to use with participants or to demonstrate an activity. Researchers observed one group of participants watching a video illustrating how to create a crankshaft toy, and then conducting research on the Internet to find other relevant inventions. One program leader printed out some of the *Design and Discovery* hands-on activities to share with troop leaders, who could sign them out to use as standalone activities during regular troop meetings.

The roles of facilitators and mentors

Strategies for providing adequate facilitation. *Design and Discovery* is a challenging curriculum to deliver because it requires access to substantive content knowledge in multiple STEM fields, an appreciation of the importance of the design process as a learning experience for young people, the ability to motivate and engage adolescents in sustained problem-solving, and experience managing multiple groups pursuing hands-on activities simultaneously. Training for facilitators, which could potentially address some of these needs, is not an established part of the current instantiation of *Design and Discovery*. Although many facilitators included in this evaluation did attend a special training for grantees, the curriculum is generally provided for use with associated print support materials but no structured training experiences for facilitators.

Of the 36 Girl Scout sites included in this evaluation, 14 planned to run the program themselves with outside help from collaborating institutions; 12 decided to have an outside organization other than a local K-12 school facilitate the program; and four councils planned to have a science teacher run program activities. Six sites had not yet identified program instructors.

TABLE 3: FACILITATORS USED FOR GIRL SCOUT COUNCIL IMPLEMENTATIONS

Curriculum facilitation	Number of councils
Girl Scout facilitator is primary facilitator, with some outside support	14
Outside collaborator is primary facilitator	12
Collaboration with a K-12 science teacher	4
Had not yet identified program facilitator	6
Total	36

Even for those who had participated in the three-day Spring 2003 training, providing adequate facilitation of this curriculum seemed to be a major challenge. These challenges influence the decision many sites made to deliver only portions of the curriculum. For example, of the eight Girl Scout sites that completed implementation, only one program was solely facilitated by Girl Scout staff. The other seven collaborated in various ways with local universities, professional organizations and/or museums to identify instructors to help lead activities. One of these sites outsourced program facilitation entirely to a third institution.

Overall, sites are taking two main approaches to the challenge of providing adequate facilitation. Some facilitators are choosing to lead the program themselves, drawing on whatever resources they have available to enhance their content knowledge, and on their own experience working with young people (whether as a teacher, a counselor, or some other role) to guide them in leading the hands-on activities and the process of project development. Other site staff are inviting outside experts, such as local university faculty, local members of the Society for Women Engineers, or local high school science teachers to act as facilitators for the program. The primary motivation local program facilitators cited for inviting in a collaborator to support their program was wanting to ensure that the curriculum was led by someone with an adequate background in science and engineering.

While inviting in outside facilitators injected needed content expertise into many local programs, it also often led indirectly to further limitation of the scope of the *Design and Discovery* curriculum that was actually presented to students. Outside facilitators were brought in by local site staff who had participated in the Spring 2003 training, but little of the content of that training experience was passed on to these new facilitators. Further, many arrived at local sites with their own curricula or programs in hand and chose to incorporate elements of *Design and Discovery* into their own program rather than to deliver the full *Design and Discovery* curriculum. For example, several Girl Scout councils shared the curriculum with local chapters of a professional engineering society and asked them to lead a science camp for young women using the curriculum. These volunteers generally thought highly of the curriculum, but rather than implementing it on its own, drew from it and integrated individual activities or sessions into science camp formats they were already familiar with delivering. This scenario was common among those sites that chose to collaborate with outside institutions to provide program facilitation.

Some sites did attempt to familiarize outside facilitators with the scope and emphasis of the curriculum, but in most cases the focus this curriculum places on the design process was not retained when outside facilitators led local programs. One program leader, reflecting on her experience with an outside trainer, explained: "I think a new person would need to go to the training. I don't think you could really do it on your own. I think you would need to have a little support in [determining] what you would need to cover in the amount of time [available]."

Strategies for developing effective mentors. The resource materials included with the *Design and Discovery* curriculum encourage the use of mentors to enhance the program and support fol-

low-up with youth after the conclusion of the program. Some sites implementing substantial portions of the curriculum did report using mentors, but their roles varied widely. For example, some mentors were invited to lead specific activities, while others provided ongoing support throughout the program, working closely with participants to support the hands-on activities. At other sites, mentors played more narrowly defined roles, acting as guides during field trips or being guest speakers.

Although some sites did report in interviews that they were working with mentors in their programs, observations and interviews suggest that mentors are not playing a prominent role in many of the current implementations of this curriculum. This is closely related to the fact that many sites have made a decision not to attempt to support the entire design process outlined in the curriculum. *Design and Discovery* emphasizes the mentor as a key contributor to the final stages of the design process, and specifically to the creation of a prototype of the invention the young person has been developing throughout their camp or workshop series. During site visits, researchers observed two programs in which young people were definitely working toward the creation of a prototype; one in collaboration with mentors at a Girls Scout council; and one in an in-school implementation that did not involve mentors.

Some sites that are still in the planning stages of their implementations hope to have mentors help them to cover this last stage of curriculum. These facilitators described plans for matching young women who had completed the program with mentors and charge them with the development of a prototype as an extra, separate project after their *Design and Discovery* program had ended.

Among those sites that used mentors more for day-to-day support of activities, a wide range of individuals were invited to act as mentors. Mentors included high school students, undergraduate science or engineering students, local young professionals who had individually expressed an interest in volunteering, and members of professional institutions or local corporations. In a few cases youth who had participated in earlier implementations of the curriculum mentored younger participants, supporting them as they engaged in hands-on activities.

Program facilitators who are working with mentors generally reported that they found mentors to be valuable to the program, explaining that they were important role models and provided participants with concrete information about "what it takes" to pursue engineering or science professionally. However, many sites report having difficulty recruiting and retaining mentors. This is especially common among sites without strong pre-existing relationships with outside organizations, such as universities or local corporations, working in science and engineering fields. One site had such difficulty recruiting mentors for the first implementation of the curriculum the previous year, they did not try to involve mentors this year.

A few sites invested time and energy in providing mentors with training or exposure to the curriculum before they began their involvement with the program. For example, at one site the program facilitator has been asking some mentors to arrive before the start of each session for a

review period, so they will be aware of the key concepts participants will be addressing during that session. Facilitators who have made these investments report that they have been very worthwhile, increasing mentors' motivation, focus, and effectiveness in working with participants.

DISCUSSION

Girl Scout council facilitators, formal and informal educators, and participants themselves were uniformly excited about the *Design and Discovery* curriculum. Facilitators believed it provided an excellent opportunity for girls, and youth in general, to engage in hands-on science activities, get exposed to what it means to be an engineer, and get the chance to be designers themselves.

However, actual implementation of this curriculum varied very widely from site to site. Sites varied in the length of time they devoted to *Design and Discovery*, the amount of the curriculum they actually covered, and the level of emphasis they placed on the design process. Some sites did the entire curriculum, and guided their participants through a complete or near-complete design process. Other sites are planning to do this during upcoming summer camps in the summer of 2004. Facilitators who have led these full implementations or who plan to do so had both the experience and the resources to support this process, and in interviews and during observations their familiarity with the curriculum and confidence in their ability to lead participants through the design process were evident.

Many other sites viewed the curriculum as a valuable "grab bag" of science activities that could be used to enhance their existing programs or to draw in an older population of girls to become active in their organization. The decision these facilitators made not to use the entire curriculum was driven by a range of concerns and constraints. Most prominently, these decisions were based on their perceptions that goals for their local programs could be adequately met, and met within the scope of their available resources (including time, materials, and most importantly facilitator expertise), by delivering isolated activities and without pursuing a sequential, design-driven implementation.

The unique feature of *Design and Discovery* is its focus on engineering and design. There are many programs that offer science experiences for under-served populations, but there are fewer opportunities for these populations to learn about design and engineering and to take on the role of being designers themselves. In addition to scaffolding that design process, the *Design and Discovery* curriculum also provides activities that expose participants to core content relevant to the design process, drawing on mechanical and electrical engineering concepts. However, in part because *Design and Discovery* takes this unusual approach of combining content-focused activities with design activities, facilitators need to see a compelling reason to invest in delivering the entire sequential curriculum and need to be adequately prepared to support the design process and the sustained project work that it involves.

RECOMMENDATIONS

The following recommendations are based on this formative evaluation.

Provide more extensive support when full curriculum implementation is expected. If Intel wishes to ensure that the curriculum is fully implemented as intended by sites that choose to use this curriculum, more training and resource support will be needed to ensure that facilitators feel prepared to use these materials with participating youth. Because organizations tend to merge the resources into already existing programs, clear guidelines need to be provided for curriculum implementation and clear goals need to be identified, such as participation in local and national science fairs. In addition to resource support, participating organizations will likely also need help finding knowledgeable professional engineers and scientists to act as additional program facilitators or as mentors to youth. These outside experts will also need opportunities to learn about the structure, goals and intent of the curriculum so they can support young people's work effectively.

Consider providing online training and support. Online training modules could be added to the existing *Design and Discovery* website to support facilitators when face-to-face trainings are not available. Other programs have experimented with using online training environments for educators and mentors. For many of these programs, online access to training and facilitation materials has been a successful component in scaling these projects nationally. For example, the NSF-supported *Expanding Your Horizons in Science and Mathematics* program supports daylong events to promote girls' interest in math and science. The program provides facilitated online discussions and program materials to support local sites implementing their own Expanding Your Horizons conferences. IBM's MentorPlace links young people to IBM employees as mentors and provides extensive support for mentors. The website provides online training materials directly for people interested in becoming mentors as well as facilitation materials for people that are training mentors. Developing similar online environments for both just-in-time training and ongoing support to facilitators and mentors may be a sustainable approach to supporting implementation over the long-term.

Support other, more flexible implementation models. This evaluation demonstrates that informal learning organizations generally seek to adapt available resources to fit into and complement their existing programs. Intel could choose to design and disseminate a more modular approach to the curriculum that describes multiple pathways through the 18-session curriculum sequence. A modular approach to the curriculum would allow Intel to maintain an emphasis on moving through the curriculum sequentially, while making clear that a particular site could pick and choose among activities within each stage of the curriculum. For example, Intel might choose to define an introductory phase, a development phase, a testing phase, and a final design stage within the curriculum, and make clear that any implementation requires engaging with each of the four stages. However, within each stage facilitators would be able to pick and choose among the multiple activities available, so that a single implementation could vary from as few as four sessions to as many

as the full eighteen. This approach could potentially allow informal and formal educators to pick and choose activities within modules based on their organizational priorities and the depth of implementation they choose to support, while maintaining the focus of the curriculum on design and engineering and on the importance of the design and development process for participants.

Further define the intended target population. This evaluation found that several of the most comprehensive and design-focused implementations of this curriculum were also specifically targeted to young women with an active interest in science and engineering as possible career paths. *Design and Discovery* is not currently explicitly intended for that kind of highly motivated audience, but those facilitators most familiar with the curriculum expressed through their actions a view that the curriculum could serve this population of young women well. In contrast, other facilitators working with broad populations of young people expressed concern that it is too challenging to be motivating for their participants, leading those facilitators to limit their use of the curriculum. Intel should provide guidance to local facilitators, expressing a specific view about what populations of young people the program is intended to reach and providing examples of how other facilitators have succeeded in recruiting those young people and leading them through the program.

APPENDIX

Portraits of use

Because this curriculum was used in many different ways and in a wide variety of contexts, it can be difficult to communicate a sense of how individual implementations came together. In fact, many of these programs met their local facilitators' goals and expectations and were well received by the girls participating in them. The portraits presented here are intended to convey a sense of how various factors, such as facilitators' prior level of knowledge of engineering, populations targeted, and resources available at a particular site, came together to produce individual implementations with their own unique strengths and weaknesses.

Young Engineers Camp

This camp was held by a Girl Scout council that had participated the previous year in a pilot of an earlier version of the *Design and Discovery* curriculum. This site emphasized the design process throughout their two-week camp, moving sequentially through almost the entire curriculum and using a range of additional resources and coaching strategies. An engineer, who had also been involved in the pilot program the previous year, facilitated the camp. This Girl Scout council had an existing relationship with the Society for Women Engineers (SWE), as well as other local engineering professionals and companies that they called upon throughout implementation to work with participants. In addition to the primary facilitator, these connections allowed the council to locate an additional volunteer instructor (also an engineer) and a paid assistant, both of whom helped to lead various activities during the camp,

This camp was held on the campus of a nearby university. Fifteen girls had been recruited for the program because they had expressed an interest in science and engineering and were doing well in science and math courses at their school. The local council had sent flyers home to parents, explaining the program and encouraging girls with an interest in these fields to participate.

During the camp, the group spent the first week on Sessions 1-8. They spent the second week on Sessions 9-18, and gave their final presentations. After the camp, participants had the option of continuing to build on their design idea by being matched with a mentor and participating in ongoing monthly sessions to help them bring together their projects for an upcoming science fair.

Participants at this camp were fully engaged by all aspects of the program, including field trips and discussions but particularly by the hands-on activities. Girls worked hard to solve the problems presented to them in the course of the design process, and often continued to discuss possible solutions to problems during breaks and after the end of camp sessions. Many girls' projects involved improving domestic equipment, such as a design for a showerhead on a movable track (to accommodate people of different heights), and personal items, such as a tooth-flossing tool for people with braces, and gel-dispensing hairbrushes.

The engineer who facilitated the camp felt the program was successful, saying:

> *"As an engineer, I've had a lot of the basic background. So the curriculum is great and we have a good time with it and they get to make stuff … they like when we let them loose on their own projects, and…they discover how cool engineering can be, because the point is not to learn something but to solve something."*

Engineers in science class

At the one school-based site included in this study, a math teacher used the curricular sections that explicitly addressed the design process with two of her 6th grade math classes (35 students total: 22 boys, 13 girls). This experienced teacher noted that she was able to introduce this project into her regular science curriculum because she did not feel pressure from her school or district regarding her curriculum and felt confident that she would be supported in her choice to use part of her math class time for the students' project work. This teacher received no training from Intel, but volunteers from a local Intel campus volunteer regularly in her school, and her local Intel education manager had brought *Design and Discovery* to her attention. She described the process of reviewing the curriculum and planning an implementation of it as relatively simple and straightforward. After reviewing the curriculum, she decided that the design process presented in the curriculum was important for her students to experience, and would be a good introduction for her students to the idea of pursuing an independent inquiry, something they would be doing more frequently as they moved through junior high and high school. She developed an approach to the curriculum that involved moving students through the design stages during the fall semester, culminating with the Design Fair at which students displayed and discussed their prototypes. This portion of her implementation included steps in the design process such as using the SCAMPER process, conducting a needs survey, developing and testing a model, and developing a prototype. During the spring semester, this teacher plans to cover more of the content-focused engineering activities.

Students worked through a series of sessions from the curriculum once a week for the entire fall semester. Once during the fall semester, math students from a nearby high school visited her class and helped the sixth graders as they worked on redesigning a common household object. During these student-to-student collaborations, students broke out into groups, with each sixth grader working with a high school student to assess and make design decisions about a common household object. Throughout the lessons students seemed actively engaged as they tested out different potato peelers, and worked collaboratively brainstorming design ideas, creating a poster, and presenting their prototype to the class. The teacher plans to invite the high school students back during the spring semester for a similar collaboration.

This classroom implementation concluded with a Design Fair, which involved students presenting their work to visiting judges. In the evening, parents and community members were invited to review students' work and test their prototypes. Based on observations and interviews during this Design Fair, students were engaged by the design process, were aware of and understood the steps

they had gone through to design and test their prototype, and were able to think critically about the design decisions they had made. Student prototypes included a fork that dispensed salad dressing and improved screw tops for pickle jars. Notably, this Design Fair included models students had created that had been proven to be ineffective during the testing process. One of these was a backpack with helium pads attached that the student had hoped would lighten the load she had to carry between school and home, though she had learned from her testing process that this solution was not actually successful.

Engineering overnight

At another site, the local Girl Scout council sought help in facilitating this curriculum from an undergraduate chapter of the Society of Women Engineers, a group they had previously collaborated with. This group had been looking for an opportunity to work with middle-school-aged girls, and was eager to work with the Girl Scout council on this implementation. Through this collaboration the council gained access to a motivated group of undergraduate facilitators who had relevant content knowledge, and were young enough to relate easily with and be role models for participants. The collaboration also gave the council access to the local university campus, where this two-day, overnight camp was held. Most of the 30 girls participating in this camp, who came from all over the state, already had a particular interest in science. The council publicized the event by sending information to middle school science teachers throughout the state, inviting them to send girls with an interest in science to the event.

The undergraduate program facilitator coordinated almost twenty undergraduate volunteers. They divided the curriculum into three main sections: the first day was spent on initial design activities, such as the SCAMPER process and the "Design a Better Paperclip" activity. During the second day, volunteers led electrical engineering activities in the morning, and mechanical engineering activities in the afternoon. In addition, participants heard from three different engineering professionals. The program used a mix of large group activities, and periods when multiple activities were being simultaneously presented and girls worked in pairs. Observation indicated that participants found most of the activities presented to them to be interesting, and enjoyed sharing their results with the group. Participants were particularly responsive to a presentation by a young woman who spoke about her engineering career.

Over the course of the two-day event it became evident that the undergraduates were not adequately prepared to lead the activities, in part, because they were not familiar enough with the curriculum and, in part, because they did not have experience working with large groups of young people. With more time and preparation, the undergraduate facilitators would likely have had more success leading the program. For example, undergraduate students often led activities that were not necessarily related to their own undergraduate focus and were at times struggling to figure out how to do activities themselves alongside the girls. In addition, they had not been prepared to structure the brainstorming process as participants discussed the importance of keeping design relevant to their lives.

Because these facilitators took an approach to implementation that stressed the presentation of various individual hands-on activities, there was little emphasis during the camp on how activities might tie together or how they contributed to the overall notion of design as a process closely tied to engineering. This loss of focus was best demonstrated during the culminating activity for the camp, which involved creating a model of a "designed object" using modeling clay. For example, participants created objects such as robots, a computer, or a cell phone that functioned as a scanner. These projects, because they did not reflect workable ideas for prototypes, exhibited students' imaginations but did not indicate that they had taken on the challenge of creating products that responded to identified needs and could be testing and further developed. Although participants had completed many of the electronic and mechanical design activities in the curriculum over the previous two days, the content they had addressed lost its relevance in the context of this activity.

Design and engineering at an after-school program

One site using the *Design and Discovery* curriculum was an after-school program with a specific mission to reach underserved youth in a rural community. This site had a well-established, comprehensive science and technology program for middle school students, and sought to integrate *Design and Discovery* into its existing programs. In part, the program coordinator was interested in *Design and Discovery* because she had previously used a similarly themed curriculum but had found it to be too difficult to use with his program participants.

After being introduced to *Design and Discovery* online by an Intel regional education manager, she reviewed the curriculum and decided that would be easier to implement than another curriculum she was familiar with, which she felt required more planning and more extensive materials. She shared *Design and Discovery* with a 6th grade science teacher from the school who ran several of the existing after-school science programs. This teacher decided to use the curriculum primarily as an activity resource, to supplement the material he was already teaching at the after-school program. In an interview, he explained that he was considering integrating the curriculum into his school curriculum.

Observations revealed that nearly all of the participants (seven students attended one day, and eight the next) were actively engaged as they worked in two separate groups that competed with each other to complete several electrical engineering activities. During these activities, on several occasions the program leader provided alternative language to explain concepts covered in the curriculum, in order to relate the material to cultural imagery that was common for this group (which was entirely Native American). For example, when discussing the flow of electricity, he used metaphors involving water and circular cycles, which the facilitator felt were images that would be familiar and useful to his students.

Although this facilitator had fifteen years experience as a teacher and reported that he draw extensively on this experience to guide students through this curriculum, he also expressed a desire for some "real" training. He also reported that participation is not always consistent from day to day, requiring him to present some activities more than once.