Concord Evaluation Group

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Design Squad Global Summative Evaluation Report

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Executive Summary

Background

In 2017, Concord Evaluation Group (CEG) conducted a summative evaluation of Design Squad Global (DSG). DSG is produced and managed by WGBH Educational Foundation, a premier public broadcaster in the US, with major funding from the National Science Foundation. WGBH partnered with FHI 360, a nonprofit human development organizations working in 70 countries, to implement DSG around the globe.

In the DSG program, children in afterschool and school clubs explored engineering through hands-on activities, such as designing and building an emergency shelter or a structure that could withstand an earthquake. Through DSG, children also had the chance to work alongside a partner club from another country. Partner clubs shared their experiences by exchanging design ideas, photos, and videos. DSG's goal was to help children develop their global competency by learning more about each other's cultures, communities, and lives.

DSG strove to provide real-world engineering projects that were meaningful and socially relevant to communities around the world, with the goal of helping children begin to see themselves as young engineers with the power to make a difference. DSG was designed to help children see engineering as a dynamic career path and an achievable goal. To that end, DSG's objective was to help children learn creative problem solving, the design process, science and engineering concepts in context, global competency, and teamwork, listening, and sharing.

CEG's evaluation study was designed to assess the degree to which DSG achieved its intended impacts, which are listed below:

Youth Impacts

Impact 1: Youth demonstrate understanding of engineering, the design process, and science concepts in the Club Guide.
Impact 2: Youth demonstrate understanding of how engineering and invention can make a positive difference in the world.
Impact 3: Youth demonstrate motivation for participating in engineering activities, classes, or clubs.
Impact 4: Youth demonstrate an interest in people and places around the globe.

Impact 5: Youth demonstrate an ability and inclination to take different perspectives, others as well as their own.
Impact 6: Youth demonstrate confidence that they can solve problems and create change.

Club Leader (Educator) Impacts

Impact 7: Educators demonstrate comfort leading engineering activities.
Impact 8: Educators demonstrate comfort collaborating with educators from other cultures/countries.
Impact 9: Educators demonstrate understanding of global competence.

The evaluation design was two-pronged:

1. **Randomized Control Study (Post-test only):** We conducted a study in which 40 clubs across five countries (United States, Vietnam, Jordan, South Africa, and Malawi) were assigned to a treatment or control group.

2. **Observational Study:** The observational study was conducted in three countries, the United States, Jordan, and South Africa. CEG staff in the United States and FHI 360 staff based in Jordan and South Africa conducted the observations and collected data at 9 clubs.

Participants

Randomized Control Study

The study sample included 40 clubs worldwide (20 in the US and 20 international):

- United States - 10 treatment clubs and 10 control clubs partnered with clubs in South Africa, Malawi, Vietnam, Jordan, and Australia
- Jordan – 2 treatment clubs and 2 control clubs partnered with clubs in Malawi, South Africa, and the United States
- South Africa – 3 treatment clubs and 3 control clubs partnered with clubs in Jordan, Malawi, and the United States
- Malawi – 2 treatment clubs and 2 control clubs partnered with clubs in the United States
- Vietnam – 3 treatment clubs and 3 control clubs partnered with clubs in the United States and South Africa

Most of the clubs ran from either approximately October – December 2016 or January – April 2017. One club ran from February – May 2017. Most clubs ran

their programs during informal learning time, after school or on weekends and holidays (32 out of 40). Eight US clubs were offered in school as part of a formal class (5 control group clubs and 3 treatment group clubs). Club sizes also varied widely. Most clubs served between 11-14 children (19 out of 40) and 8-10 children (8 out of 40). Club sizes in the US tended to be larger, with an average of 15 children per club, than club sizes internationally, which had an average of 11 children per club.

The children in our sample spoke several different languages. Many children in the sample reported speaking English at home (60%), including children outside the US (for instance in South Africa). All of the Vietnamese children reported speaking Vietnamese at home. All of the Jordanian children reported speaking Arabic at home. Children from Malawi and South Africa reported speaking several different languages, with Chichewa, Tshivenda, and isiZulu being the most common. Twenty clubs reported serving a general population of children in their areas. An additional 15 clubs reported serving at risk or low income children.

The study sample was split evenly between males (51%) and females (49%). The majority of children in the sample were White or Caucasian (74%), Black or African-American (42%), and/or Latino/a (19%).

Almost half of the club leaders (18 out of 40) reported that they had at least some experience leading STEM activities with children prior to participating in the DSG program. Of the 22 that did not have such experience, seven were leaders in the control group and 15 were leaders in the treatment group. Thus, 75% of the treatment group did not have STEM experience.

Observational Study

The clubs included in the observational study were:

- United States – 4 clubs, including an elementary school classroom serving inner city, low income youth; an out-of-school program serving low income youth, and two out-of-school programs providing enrichment programming for all youth. These clubs were partnered with clubs in Vietnam, South Africa, and Malawi.

- South Africa – 3 clubs, all out-of-school programs serving disadvantaged youth, one focusing on children with special needs, partnered with clubs in the United States.

- Jordan – 2 clubs, both out-of-school programs serving all youth, partnered with clubs in the United States.

Findings Related to Impacts

Impact 1: Youth demonstrate understanding of engineering, the design process, and science concepts in the Club Guide.

- Children in the treatment group had a significantly greater understanding of "what engineering is" than did children in the control group. This was true even though children in the control group had high levels of understanding without exposure to DSG.

- There were no differences between the two groups with respect to their understanding of "what engineers do." Children in both groups demonstrated a high level of understanding.

- DSG had a positive impact on children's ability to design a solution to a problem. We compared the points earned by children in the control group to children in treatment group and found that children in the treatment group scored significantly higher than children in the control group.

- There were no differences between the groups with respect to how they felt about their designs (most children from both groups reported that they felt good about their designs) and with respect to whether children reported that their design ideas would have been helped with a team of people.

- Most children in both groups realized their designs would have been helped with the support of a team.

- Children in the treatment group clubs were significantly more likely (more than twice as likely) to know the correct answer to a science question about structural integrity than were children in the control group clubs. Forty-four percent of children in the treatment group answered this question correctly, while only 19% of children in the control group answered this question correctly.

Impact 2: Youth demonstrate understanding of how engineering and invention can make a positive difference in the world.

- We found that children in both groups demonstrated high levels of understanding that engineers and inventors can have a positive impact on the world. There were no significant differences between the groups.

Impact 3: Youth demonstrate motivation for participating in engineering activities, classes or clubs.

- The data indicated that DSG sparked children's motivation to participate in engineering activities. Nearly all (94%) of the children in the treatment group reported that they would join a DSG club again, if they had the opportunity to.

- Children in both groups were equally interested in designing things and creating and building things and in being part of a group of children that builds or creates something new.

Impact 4: Youth demonstrate an interest in people and places around the globe.

- We found strong evidence that the DSG club likely encouraged children who were exposed to the process of problem solving with children from other countries to help people in other countries solve problems in their communities. Children in the control group did not express the same level of interest, although they were still somewhat interested in doing so.

- We found that children in the treatment group were able to relate to children in other countries significantly better than children in the control group. For example, children in the treatment group were more likely to say things like, "The children in South Africa are just like me." Or "The houses in the US are just like the houses we have here."

- Regarding the characteristic of stereotypes, when we looked at treatment group clubs that had a foreign partner club versus those that did not have a partner club, we found that children in clubs with a partner club in another country were significantly less likely to use stereotypes when they described children from other countries than children from clubs that did not have a partner.

- We explored the data even more deeply and found that children who had partner clubs in another country AND were part of an afterschool program mentioned fewer stereotypes than children who had international partner clubs, but took part in a school-based club. Children who participated in DSG as part of a class used more negative stereotypes about their foreign peers than children who participated in an after or before school DSG club. This *may* have something to do with the fact that children participating in out-of-school clubs usually did so voluntarily, whereas

children in a classroom-based DSG didn't have a choice about whether to participate. But, this is a question to explore with future research.

- There was no difference between the treatment and control group on other measures: Children in both groups were equally (and highly) interested in traveling outside their country someday, meeting children from other countries someday, and knowing more about the lives of children from other countries.

Impact 5: Youth demonstrate an ability and inclination to take different perspectives, others as well as their own.

- We found that children in the treatment group reported significantly greater confidence than children in the control group with respect to helping their peers and respecting their peers' ideas.

- Children in both groups were equally interested in working in groups.

Impact 6: Youth demonstrate confidence that they can solve problems and create change.

- Children in both groups were equally confident that they could solve problems in their communities and, with engineering knowledge, improve things that people use every day.

- They were also equally interested in solving problems in their community.

Impact 7: Educators demonstrate comfort leading engineering activities.

- We have strong evidence that the DSG club leader training and Guide helped treatment group leaders feel comfortable leading engineering activities.

- Looking only at the treatment group leaders, 15 of whom had no experience leading STEM activities prior to DSG, we noted that all of them (100%) reported feeling comfortable or very comfortable after participating in DSG:

    - Leading hands-on activities with children,
    - Leading open-ended activities with children,
    - Talking with children about engineering and inventing,
    - Using a problem-solving process with children, and
    - Helping children work in teams to solve problems.

Impact 8: Educators demonstrate comfort collaborating with educators from other cultures/countries.

- Data revealed that treatment group leaders were more comfortable than control group leaders collaborating with leaders from other countries – likely due to the experience of troubleshooting and finding creative ways to communicate.

- Due to challenges outside the clubs' or WGBH's control, connecting partner clubs was not always easy. In some countries, like Malawi and South Africa, Internet connectivity and power outages were common. In other cases, language barriers existed. Regardless, club leaders demonstrated a willingness to get creative and reported that they managed to find ways around these challenges and communicate with their partner clubs. We asked treatment club leaders who were successful at connecting with their partners how they were able to do so. Their responses detailed the ways in which they tried different methods of communicating and didn't give up trying, even when different methods failed to work – thus showing the level of ownership and commitment the leaders demonstrated.

Impact 9: Educators will demonstrate understanding of global competence.

- For the evaluation study, we defined club leaders' understanding of global competence as being comfortable/capable of:

    - Helping children recognize their own perspectives,
    - Helping children recognize other's perspectives,
    - Helping children learn about what life is like for children in other places in the world,
    - Helping children learn to communicate and collaborate effectively with people from different places and perspectives, and
    - Knowing how to communicate ideas to others so they are clear to people from different backgrounds and who speak different languages.

- Treatment group leaders were slightly more likely to report having an understanding of global competence than control group leaders. However, it should be noted that most of the control group leaders came into the study reporting some understanding of global competence. This may be an artifact of the reality that educators who are interested in a program like DSG are likely to have a greater sense of global competence, or at least an inherent interest in such concepts, than

educators who are not interested and don't sign up for a program like DSG.

Findings across Case Studies

While each of the clubs we observed is unique in its own ways, there were many commonalities across clubs that we observed. For example, in all clubs, we observed that the club leaders consistently:

- Explained how the day's session was related to everyday life,
- Asked the children open-ended questions, and
- Made the engineering design process steps accessible at all times, either by using posters on the wall or displaying the design process on a blackboard or whiteboard.

As a result, we observed that most children in all the clubs seemed to understand how the hands-on activities related to real world problems and we heard them talk in empathetic ways about problems that people are facing in the world.

We also noted that most children seemed to grasp the steps of the engineering design process.

In most, but not all, clubs, we observed that club leaders:

- Let children try and fail as many times as needed,
- Started each session with a reminder of what they did in the previous session, and
- Ended each session with a preview of what they would be doing in the following session.

Time constraints seemed to play a role as to whether club leaders were able to let the children try and fail as many times as needed and whether the club leader spent time reviewing and previewing.

One of the significant differences between clubs that we observed was that some club leaders took a deliberately passive role, allowing the children to take the lead on the activities, while in other clubs, the leaders were far more directive, even lecturing the children and providing very explicit instructions and suggestions for addressing the engineering challenges.

In child-driven clubs, we observed that the children were more willing to innovate and that they came up with unique designs and collaborated in a very purposeful

way. In leader-driven clubs, we observed that the children were less willing to innovate, needed guidance, and looked to their club leaders to help them.

We did not observe any communication between clubs during our visits, but we did have an opportunity to observe one club during a session when the children were recording videos to send to their partner club. The children were significantly engaged in this task and were excited to exchange information with their partner club.

Other Feedback on the DSG Program

- Nearly all (98%) of the children in the treatment group clubs reported that they enjoyed the DSG club.
- Nearly all (95%) children reported that they believed their friends would enjoy the DSG club, too.
- All but two club leaders said would recommend DSG to other programs like theirs.

Summary

A summative evaluation of Design Squad Global (DSG), including a randomized control study and an observational study, found that the program had several positive and significant impacts on children in the US and internationally, as well as on their club leaders.

DSG successfully taught middle school-aged children in the US and abroad about engineering, including important science concepts related to structural integrity. DSG also had a positive impact on children's ability to design a solution to a real-world problem. Participating in DSG sparked children's interest in participating in more engineering activities in the future. In fact, during observations in South Africa, we noted two older youth who, it turned out, were DSG alumni who volunteered to return to the DSG clubs as mentors to the younger children because of the positive experience they had as DSG club members.

DSG encouraged children who were exposed to the process of problem solving with children from other countries to help people in other countries solve problems in their communities. Moreover, we found that children in the treatment group were able to relate to children in other countries significantly better than children in the control group. In fact, children in clubs with a partner club in

another country were significantly less likely to use stereotypes when they described children from other countries than children from clubs that did not have a partner. DSG also helped children gain greater confidence with respect to helping their peers and respecting their peers' ideas.

With respect to DSG club leaders, the study found strong evidence that the DSG club leader training and Guide helped treatment group leaders feel comfortable leading engineering activities. Even though 75% of DSG club leaders had no prior experience leading STEM activities, all of them (100%) reported feeling comfortable or very comfortable after participating in DSG.

DSG club leaders were more comfortable than control group leaders collaborating with leaders from other countries and their creative ways of solving communication challenges and making the DSG club experience a significant one for children demonstrated their levels of ownership and commitment.

This evaluation study demonstrated the positive promise of DSG on children and educators globally and identifies several challenges inherent to programs like DSG. These challenges, however, such as communicating with partners across the globe, working with partner clubs operating on different schedules, or the logistical struggle of sharing video in locations where Internet access is unreliable, were not insurmountable. This evaluation demonstrated that club leaders who are committed to the goal of providing real-world engineering projects that are meaningful and socially relevant to communities around the world, and the goal of helping children begin to see themselves as young engineers with the power to make a difference, can find innovative and effective ways to overcome such challenges and reap significant benefits for the children they serve.

Background

The Design Squad Global Program

With major funding from the National Science Foundation, Design Squad Global (DSG) was produced and managed by WGBH Educational Foundation, a premier public broadcaster in the US. FHI 360, a nonprofit human development organization working in 70 countries, conducted formative research on the project and was a partner on dissemination activities.

In DSG, children in afterschool and school clubs explored engineering through hands-on activities, such as designing and building an emergency shelter or a structure that could withstand an earthquake. Through DSG, children also had the chance to work alongside a partner club from another country. Partner clubs shared their experiences by exchanging design ideas, photos, and videos. DSG's goal was to help children develop their global competency by learning more about each other's cultures, communities, and lives.

DSG strove to provide real-world engineering projects that were meaningful and socially relevant to communities around the world, with the goal of helping children begin to see themselves as young engineers with the power to make a difference. DSG was designed to help children see engineering as a dynamic career path and an achievable goal. To that end, DSG's objective was to help children learn the following content and skills:

- *Creative Problem Solving.* To help children use their imaginations and analytical skills through open-ended, hands-on engineering challenges.
- *The Design Process.* To help children learn to use a series of tried-and-true steps to think through and work out a problem.
- *Science and Engineering Concepts in Context.* To help children apply science and engineering concepts as part of their own iterative design process.
- *Global Competency.* To help children explore our interconnected world and learn how to communicate and collaborate with people who have different perspectives, cultures, and backgrounds.
- *Teamwork, Listening, and Sharing.* To help children understand the importance of teamwork and develop an openness to new ideas, ways of thinking, and unfamiliar situations.
- *Making a Difference!* To provide a way for children to experience engineering and invention as powerful tools for change.

Evaluation Design

CEG was hired to conduct a summative evaluation of the project during the final year of the grant. The evaluation study was designed to assess the degree to which DSG achieved its intended impacts, which are listed below:

Youth Impacts

Impact 1: Youth demonstrate understanding of engineering, the design process, and science concepts in the Club Guide.
Impact 2: Youth demonstrate understanding of how engineering and invention can make a positive difference in the world.
Impact 3: Youth demonstrate motivation for participating in engineering activities, classes, or clubs.
Impact 4: Youth demonstrate an interest in people and places around the globe.
Impact 5: Youth demonstrate an ability and inclination to take different perspectives, others as well as their own.
Impact 6: Youth demonstrate confidence that they can solve problems and create change.

Club Leader (Educator) Impacts

Impact 7: Educators demonstrate comfort leading engineering activities.
Impact 8: Educators demonstrate comfort collaborating with educators from other cultures/countries.
Impact 9: Educators demonstrate understanding of global competence.

The evaluation design was two-pronged:

1. **Randomized Control Study (Post-test only):** We conducted a study in which 40 clubs across five countries (United States, Vietnam, Jordan, South Africa, and Malawi) were assigned to a treatment or control group. Youth and club leaders assigned to the treatment group participated in the DSG program and completed surveys at the end of the DSG program (Appendix A and B). Youth and club leaders assigned to the control group completed surveys *prior* to participating in the DSG program. All clubs were offered an honorarium of $100 for their participation and to help defray the cost of materials.

2. **Observational Study:** The observational study was conducted in three countries, the United States, Jordan, and South Africa. CEG staff in the United States and FHI 360 staff based in Jordan and South Africa conducted the observations and collected data at 9 clubs. Using an

observation protocol (Appendix C), staff visited DSG clubs and unobtrusively observed a single session from start to finish. Club leaders and children were informally interviewed as well.

Participants

Randomized Control Study

The study sample included 40 clubs worldwide (20 in the US and 20 international):

- United States - 10 treatment clubs and 10 control clubs partnered with clubs in South Africa, Malawi, Vietnam, Jordan, and Australia
- Jordan – 2 treatment clubs and 2 control clubs partnered with clubs in Malawi, South Africa, and the United States
- South Africa – 3 treatment clubs and 3 control clubs partnered with clubs in Jordan, Malawi, and the United States
- Malawi – 2 treatment clubs and 2 control clubs partnered with clubs in the United States
- Vietnam – 3 treatment clubs and 3 control clubs partnered with clubs in the United States and South Africa

Figure 1. Locations of study clubs.

Table 1 summarizes the characteristics of all the clubs in the sample. Most of the clubs ran from either approximately October – December 2016 or January – April 2017. One club ran from February – May 2017.

The majority of the clubs in the sample (35 out of 40) chose to do the 6-week DSG club option versus the 12-week club option. Five of the US clubs chose to do the 12-week DSG club option. Note that even if a club was chosen for the study, their international club partners were not necessarily included in the study sample.

Most clubs ran their programs during informal learning time, after school or on weekends and holidays (32 out of 40). Eight US clubs were offered in school as part of a formal class (5 control group clubs and 3 treatment group clubs). We analyzed these formal class-based clubs separately, when appropriate, to see if there were any differences in impact as a result of the club being part of a formal class versus an afterschool program.

The clubs served a wide range of ages, from seven to 18. The table below summarizes the actual ages of the children in the sample.

Club sizes also varied widely. Most clubs served between 11-14 children (19 out of 40) and 8-10 children (8 out of 40). There were a number of clubs that served more children, 15-20 at a time (6 out of 40) or even more than 20 at a time (4 out of 40). Two clubs were smaller, reporting that they served fewer than seven children at a time.

The children in our sample spoke several different languages. The table below summarizes the actual languages spoken by the children in the sample.

Almost half of the club leaders (18 out of 40) reported that they had at least some experience leading STEM activities with children prior to participating in the DSG program. Of the 22 that did not have such experience, seven were leaders in the control group and 15 were leaders in the treatment group. Thus, 75% of the treatment group did not have STEM experience.

Twenty clubs reported serving a general population of children in their areas. An additional 15 clubs reported serving at risk or low income children. The remaining five clubs served special populations such as Boy Scouts, gifted students, or homeschoolers.

Table 1:
Randomized Control Study Club Background and Contextual Characteristics

Country	Group	Cohort	Weeks	When	Ages	Club Size	Languages	Leader Experience Leading STEM?	Children Served
Jordan	C	2	6	Weekends	14-18	8-10	Arabic	No	All
Jordan	C	2	6	After school, Weekends	8-18	8-10	Arabic, some English	Yes	All
Jordan	T	1	6	After school, Weekends	8-13	8-10	Arabic, some English	Yes	All
Jordan	T	1	6	After school	8-13	11-14	Arabic	Yes	All
Malawi	C	2	6	After school	8-10	11-14	English	No	All
Malawi	C	2	6	After school	8-13	15-20	Chichewa, English	No	All
Malawi	T	1	6	After school	11-13	11-14	English	No	All
Malawi	T	1	6	After school	11-13	11-14	English	Yes	Orphaned and destitute
S. Africa	C	2	6	After school	8-10	20+	English	Yes	Rural, disadvantaged
S. Africa	C	2	6	After school	11-13	8-10	English	No	Scouts boys only
S. Africa	C	2	6	After school	11-18	11-14	Setswana, some English	Yes	Orphaned and vulnerable
S. Africa	T	1	6	After school, Holidays	8-13	20+	Tshivenda, English	Yes	Orphaned and vulnerable
S. Africa	T	1	6	After school	11-13	15-20	Sesotho, English	Yes	Disadvantaged

Country	Group	Cohort	Weeks	When	Ages	Club Size	Languages	Leader Experience Leading STEM?	Children Served
S. Africa	T	3	6	After school	8-18	11-14	isiZulu, some English	No	Rural, disadvantaged
US	C	2	6	After school	8-13	15-20	English, Spanish	Yes	All
US	C	2	6	In school	7-10	15-20	English	No	All
US	C	2	6	After school	8-10	15-20	English	Yes	All
US	C	2	12	In school	7-13	8-10	English	Yes	Homeschool
US	C	2	12	After school	8-13	11-14	English	Yes	Urban, low income
US	C	4	6	After school	8-10	7 or less	English, some Spanish	No	All
US	C	2	6	In school	8-10	11-14	English, Spanish	Yes	Low income
US	C	2	12	In school	11-13	15-20	English	Yes	Rural, disadvantaged
US	C	2	12	After school	11-13	11-14	English, Spanish	Yes	Low income
US	C	2	6	In school	7-13	20+	English	Yes	Gifted
US	T	1	6	In school	8-10	7 or less	English	Yes	Gifted
US	T	1	6	In school	8-13	11-14	English	Yes	Homeschool
US	T	1	12	After school	11-18	20+	English, Spanish	Yes	At risk and special needs
US	T	1	6	After school	7-18	8-10	English	No	Urban, low income
US	T	1	6	After school	11-13	8-10	English	Yes	All
US	T	1	6	After school	11-13	8-10	English	Yes	Rural, at risk

Country	Group	Cohort	Weeks	When	Ages	Club Size	Languages	Leader Experience Leading STEM?	Children Served
US	T	1	6	After school	11-13	11-14	English	Yes	All
US	T	1	6	In school	8-10	11-14	English	No	All
US	T	1	6	After school	11-13	11-14	English, some Spanish	Yes	Low income
US	T	1	6	After school	8-13	11-14	English	Yes	Urban, low-income
Vietnam	C	2	6	After school	11-13	11-14	Vietnamese, some English	No	All
Vietnam	C	2	6	After school	11-13	11-14	Vietnamese, some English	Yes	All
Vietnam	C	2	6	After school	11-13	11-14	Vietnamese, some English	Yes	All
Vietnam	T	1	6	After school	11-13	11-14	Vietnamese, some English	Yes	All
Vietnam	T	1	6	After school	11-13	11-14	Vietnamese, some English	No	All
Vietnam	T	1	6	After school	11-13	8-10	Vietnamese, some English	Yes	All

The sample included 528 children worldwide, with the majority in the US. In fact, club sizes in the US tended to be larger, with an average of 15 children per club, than club sizes internationally, which had an average of 11 children per club.

- United States = 312
- South Africa = 69
- Vietnam = 61
- Jordan = 46
- Malawi = 40

The study sample was split evenly between males (51%) and females (49%). As summarized in the table below, the majority of the children in the sample were White or Caucasian (74%), Black or African-American (42%), and/or Latino/a (19%). Questions about race and ethnicity can be sensitive, depending on the country. For instance, in Vietnam, we only collected data on ethnicity; 100% of children there reported they were Kinh. In Malawi, we only collected data on parents' countries of origin. All of the parents were from Malawi, and one parent was from South Africa. We did not collect race or ethnicity data in Jordan due to the sensitive nature of these types of questions. So, because we asked this background question differently in Vietnam and Malawi, we have reported those data separately in the table. Thus, the counts of Asian and Black students at the top of the table are lower than expected since Vietnamese and Malawi children are reported in a separate section.

Table 2:
Race and Ethnicity[1]

Characteristic	Count	Percent
US and South Africa only		
White or Caucasian	231	74.0%
Black or African-American	131	42.0%
Latino/a	59	18.9%
Asian	19	6.1%
American Indian or Alaskan Native	17	5.4%
Indian or Middle Eastern	13	4.2%
Native Hawaiian or Other Pacific Islander	6	1.9%
Vietnam only		
Kinh	61	100%
Parent's countries of origin – Malawi only		
Malawi	39	97.5%
Malawi and South Africa	1	2.5%

[1] Children could choose more than one race/ethnicity, so the total may be more than 100%.

Many children in the sample reported speaking English at home (60%), including children outside the US (for instance in South Africa). All of the Vietnamese children reported speaking Vietnamese at home. All of the Jordanian children reported speaking Arabic at home. Children from Malawi and South Africa reported speaking several different languages, with Chichewa, Tshivenda, and isiZulu being the most common.

Table 3:
Languages Spoken at Home[2]
(N = 528)

Characteristic	Count	Percent
English	318	60.2%
Vietnamese	64	12.1%
Arabic	50	9.5%
Spanish	40	7.6%
Chichewa	36	6.8%
Tshivenda	35	6.6%
isiZulu	13	2.5%
Setswana	8	1.5%
South Sotho	7	1.3%
North Sotho	7	1.3%
Chinese	3	0.6%
German	2	0.4%
French	2	0.4%
Other[3]	9	1.7%

[2] Children could choose more than one language, so the total may be more than 100%.
[3] Includes a single case each of the following: Indonesian, Korean, Laotian, Creole, Nigerian, Swahili, Cambodian, Amharic, and Tonga.

As summarized in the figure below, children' ages ranged from seven to 18, with a median age of 11 years old.

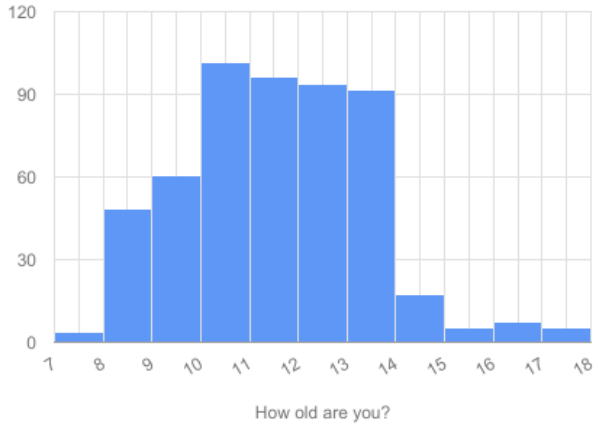


Figure 2. Age distribution of children in the sample.

The figure below summarizes the median ages for each country. There was a statistically significant difference between all of the countries with respect to age, except South Africa compared to Malawi.

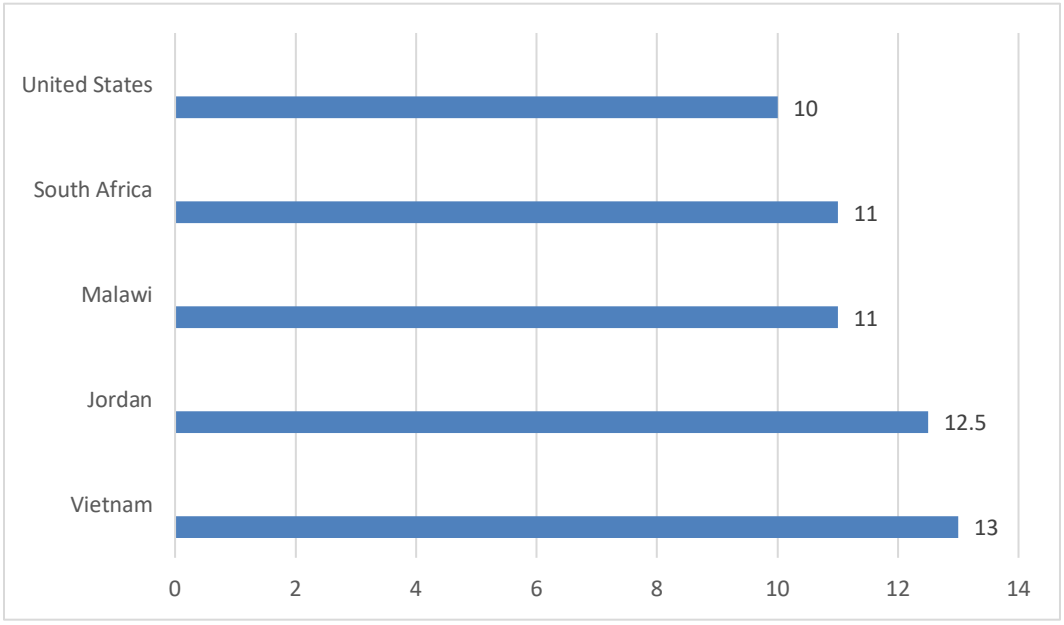


Figure 3. Median ages of children across countries.

We made the decision to include in our analyses only those children between 10 and 13 years of age. This is because this is the target age range for DSG and because a significant variation in ages (for instance, between seven year olds

and 18 year-olds) would have been problematic for our quantitative analyses, due to very significant development differences. This resulted in a smaller sample size for analysis of 381 children:

- United States = 222
- South Africa = 57
- Vietnam = 53
- Malawi = 26
- Jordan = 23

The figure below shows the new median values for each country, after removing children outside the DSG target age range. Vietnam has a median age of 13 years, which is significantly greater than all other countries. This is likely due to the fact that all other countries had an age range from 10 to 13 years of age, while Vietnam's sample did not contain any 10 year olds at all. When applicable, we have controlled for this difference in our analyses.

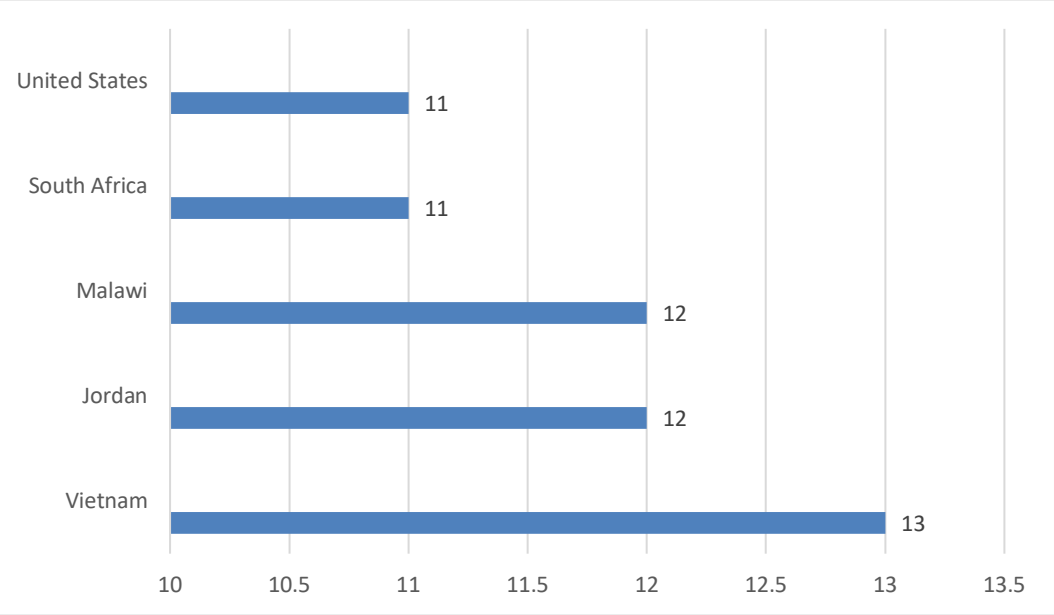


Figure 4. Median ages, after removing children outside DSG target age range.

Observational Study

The clubs included in the observational study were:

- United States – 4 clubs, including an elementary school classroom serving inner city, low income youth; an out-of-school program serving low income youth, and two out-of-school programs providing enrichment programming for all youth. These clubs were partnered with clubs in Vietnam, South Africa, and Malawi.

- South Africa – 3 clubs, all out-of-school programs serving disadvantaged youth, one focusing on children with special needs, partnered with clubs in the United States.

- Jordan – 2 clubs, both out-of-school programs serving all youth, partnered with clubs in the United States.

The table below summarizes the characteristics of the clubs in our observational study sample.

Table 4:
Observational Study Club Background and Contextual Characteristics

Country	Cohort	Weeks	When	Ages	Club Size	Languages	Experience Leading STEM?	Children Served
United States	2	12	After school	11-13	11-14	English	Yes	Low income
United States	2	6	Before school, After school	7-10	11-14	English	Yes	Elementary school enrichment
United States	2	6	Before school, After school	11-13	11-14	English	Yes	Enrichment
United States	2	12	During school	11-13	20+	English	Yes	Low income, inner city
South Africa	6	6	After school	11-13	15-20	South Sotho	Yes	Disadvantaged children and youth out of school
South Africa	6	12	After school	11-13	11-14	English, Zulu	Yes	Children with special needs
South Africa	6	6	After school	11-13	8-10	Zulu, Sotho, Tsonga, Venda	Yes	Disadvantaged children
Jordan	5	6	After school	8-13	11-14	Arabic	Yes	All children, after school
Jordan	5	6	Weekends	14+	20+	Arabic	Yes	All children

Findings Related to Impacts

The bulk of the results used to support the evaluation findings in this chapter comes from the Randomized Control Study. When available, we have included results from the Observational Study to supplement the data.

Impacts on Youth

The findings below are organized by the project's intended impacts on youth:

Impact 1: Youth demonstrate understanding of engineering, the design process, and science concepts in the Club Guide.
Impact 2: Youth demonstrate understanding of how engineering and invention can make a positive difference in the world.
Impact 3: Youth demonstrate motivation for participating in engineering activities, classes, or clubs.
Impact 4: Youth demonstrate an interest in people and places around the globe.
Impact 5: Youth demonstrate an ability and inclination to take different perspectives, others as well as their own.
Impact 6: Youth demonstrate confidence that they can solve problems and create change.

Impact 1: Youth demonstrate understanding of engineering, the design process, and science concepts in the Club Guide.

We asked children whether they (1) know what engineering is, and (2) whether they know what engineers do. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater understanding of engineering.

Children in the treatment group had a significantly greater understanding of "what engineering is" than did children in the control group. This was true even though children in the control group had high levels of understanding without exposure to DSG. There were no differences between the two groups with respect to their understanding of "what engineers do." Children in both groups demonstrated a high level of understanding. The table below summarizes the results.

Table 5:
Children's Understanding of Engineering

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219[4]	**N = 162**	
I know what engineering is.	3.29 (.707)	3.18 (.766)	$t_{(378)} = 1.415$, $p = .08$[5], effect size = .15
I know what engineers do.	3.30 (.711)	3.24 (.671)	$t_{(377)} = 0.798$, $p = .22$, effect size = n.s.

DSG had a positive impact on children's ability to design a solution to a problem. We asked children to design a shoe that you can wear AND can hold objects, like keys or money. Children were encouraged to explain their design in words or to draw their design. The responses were coded for level of detail and specificity. Codes were developed based on a thorough review of the responses *before* coding. During the initial review, we learned that responses were not highly detailed at all, with very few details to distinguish responses from one another. So, we determined that the best scale to use was a very basic scale of 0-2 points. For example, a response that was blank would receive zero points. A response that simply said, "A shoe" would receive only one out of two points. Likewise, a drawing of a shoe without any specific features designed to hold objects would also receive one out of two points. Responses that included more details, such as pockets, clips, magnets, or other features designed to hold objects received two points.

We compared the points earned by children in the control group to children in treatment group and found that **children in the treatment group scored significantly higher than children in the control group**. Treatment group children earned an average of 1.83 points (sd = 0.504) and control group children earned an average of 1.66 points (sd = 0.666).[6]

There were no differences between the groups with respect to how they felt about their designs (most children from both groups reported that they felt good about their designs) and with respect to whether children reported that their

[4] We restricted our quantitative analyses to only those children in the target age range of 10-13 years old.
[5] We have set $p < .10$ as the cutoff point for statistical significance.
[6] $t_{(df = 514.123)} = 3.424$, $p = .001$.

design ideas would have been helped with a team of people. Most children in both groups realized their designs would have been helped with the support of a team.

One important science concept covered in the DSG Club Guide was the concept of structural integrity. We asked children, when they are building something, what shape helps to make the strongest structure. The correct answer was "triangle." **Children in the treatment group clubs were significantly more likely (more than twice as likely) to know the correct answer than were children in the control group clubs.**[7] Forty-four percent of children in the treatment group answered this question correctly, while only 19% of children in the control group answered this question correctly.

During an interview for the observational study, a club leader from Jordan explained the progression in engineering knowledge that she saw demonstrated by the children in her club. The leader explained that when she introduced the children to the DSG Club, at first, she talked to them about what they were going to be doing in the club sessions, and the goals of each session--what they were going to be able to take away from the experience. She felt like the children didn't understand very much about engineering at the beginning, but after each session she felt more and more confident about being able to communicate engineering ideas with the children and as the club progressed, she felt that the children understood more and more. She explained her approach like this:

> *At the beginning, we tackle the thing we're doing and we bring it closer to something in real life, something in our life, then we start viewing solutions they created in reality, then we start talking about ideas and what we can do and things we can come up with. In the end, we brainstorm, then start building an experience and repeat the experience until we reach the main objective that we are seeking from this session.*

She has noted that, over time, the children are willing to try different ideas -- things she was not even expecting. For example, during one session, the children started putting popsicle sticks next to each other and attaching them together. She had never used popsicle sticks before, but loved the idea that they came up with something from the materials they had. So, she let them explore this novel approach on their own.

Over time, the club leader also noticed that the children were getting better at problem-solving.

[7] Chi-square $_{(df=1)}$ = 24.456, p = .000.

From the last session, they were a little lost and didn't know what to do. This session, they were better, they held objects and started thinking and started drawing as well. Some of them drew and showed us what they were going to do.

Impact 2: Youth demonstrate understanding of how engineering and invention can make a positive difference in the world.

We asked children to report the extent to which they agreed or disagreed that (1) engineers do work that helps their community and (2) Inventors solve problems that help people. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater understanding of how engineering and inventing can make a positive difference in the world.

We found that children in both groups demonstrated high levels of understanding that engineers and inventors can have a positive impact on the world. The differences between the two groups were small and not statistically notable. The table below summarizes the results.

Table 6:
Children's Understanding of Engineering/Inventing Impact on World

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219	**N = 162**	
Engineers do work that helps their community.	3.42 (.689)	3.39 (.655)	$t_{(377)} = 0.440$, $p = .33$, effect size = n.s.
Inventors solve problems that help people.	3.34 (.740)	3.39 (.761)	$t_{(377)} = -0.658$, $p = .25$, effect size = n.s.

A couple of examples from the observational study provide some evidence about the impact DSG had on children's understanding of engineering/inventing and its impact on the world. First, are two quotes from girls in Jordan that demonstrated how they made connections between the DSG activities and real world problems. One 12-year old girl explained her design,

> *Today we made this parachute. It shows how we can learn, as the teacher taught us, there are a lot of people who need this parachute to receive food in their area. So, we tried to mimic this.*

Another 12-year old girl explained why the challenge is relevant,

First thing regarding the parachute, it helps people, of course the real parachute, it helps people in the sense that they receive food through it during wars or disasters or situations where it's not possible to receive food through means of flying or cars. So, it's possible to send food through the parachute during wars.

Impact 3: Youth demonstrate motivation for participating in engineering activities, classes or clubs.

The data indicated that DSG sparked children's motivation to participate in engineering activities. **Nearly all (94%) of the children in the treatment group reported that they would join a DSG club again, if they had the opportunity to.**

Children in both groups were equally interested in designing things and creating and building things and in being part of a group of children that builds or creates something new. We asked children in both groups to report the extent to which they agreed or disagreed that (1) I am interested in designing things, (2) I am interested in creating or building things, and (3) I would like to be part of a group of children that builds or creates something new. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater level of interest in participating in engineering activities. We found that children in the treatment group did not report a significantly greater interest level than children in the control group. The table below summarizes the results.

Table 7:
Children's Interest in Engineering-Related Activities

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219	**N = 162**	
I am interested in designing things.	3.50 (.694)	3.44 (.721)	$t_{(347)} = 0.763$, $p = .22$, effect size = n.s.
I am interested in creating or building things.	3.51 (.635)	3.47 (.712)	$t_{(346)} = 0.521$, $p = .30$, effect size = n.s.
I would like to be part of a group of children that builds or creates something new.	3.43 (.757)	3.44 (.764)	$t_{(333)} = -0.180$, $p = .43$, effect size = n.s.

During our observations, we noted how engaged the children seemed to be in the activities. For example, in Jordan, one 12-year old girl told us that she enjoyed the DSG club,

> *…because they gave us new ideas, and, also there is entertainment. We had fun...I learned that person must have new ideas. One shouldn't stick to fixed ideas and should try different ideas, and to show innovation and have fun in life.*

One 12-year old boy in Jordan reported,

> *I had fun with DSG. There was no stress or anything. It makes you happy and doesn't make you gloomy and the teacher makes us happy, such as in school, we don't have to feel gloomy, we must be happy and interact with it. I mostly enjoyed the cooperation and group work.*

During our observation of a club in South Africa, we observed three older children (2 boys and 1 girl) who were helping the club leaders and the groups. As it turns out, these were students who participated in DSG clubs previously, both the 12-week and the 6-week clubs and they had an interest in design, so they volunteered to be mentors for subsequent sessions of the DSG Club. The female mentor stated, "It means that I can I can teach other younger children, everything that I was taught. I enjoy the part where I teach them, how to do things, and I love it."

At a different club in South Africa, the children in this club specifically asked for a DSG club to be run there because they heard of it from other children (the leader ran a club previously at one of the schools where some of these children attend). Now, other children in other schools are hearing about DSG and have asked for clubs, too. The leader plans to train another teacher (the technology teacher) at one of the schools to do DSG so they can offer clubs to more children.

During our observation at a US club that primarily served second graders, when the club leader told the children that the following week was their last week, they all exclaimed, "Noooo!" and one of the children reassured the others by telling them that they could sign up in the Spring for another session.

Impact 4: Youth demonstrate an interest in people and places around the globe.

We asked children in both groups to report the extent to which they agreed or disagreed that (1) I would like to travel outside my country someday, (2) I would like to meet children from other countries someday, (3) I would like to know more about the lives of children from other countries, and (4) I would like to help people in other countries solve problems in their communities. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater level of interest in people and places around the world.

We found strong evidence that the DSG club likely encouraged children who were exposed to the process of problem solving with children from other countries to help people in other countries solve problems in their communities. Children in the control group did not express the same level of interest, although they were still somewhat interested in doing so.

There was no difference between the treatment and control group on the other measures: Children in both groups were equally (and highly) interested in traveling outside their country someday, meeting children from other countries someday, and knowing more about the lives of children from other countries.

The table below summarizes the results.

Table 8:
Children's Interest in People and Places around the World

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219	**N = 162**	
I would like to travel outside my country someday.	3.48 (.798)	3.57 (.734)	$t_{(346)} = -1.068$, $p = .14$, effect size = n.s.
I would like to meet children from other countries someday.	3.50 (.750)	3.43 (.763)	$t_{(342)} = 0.841$, $p = .20$, effect size = n.s.
I would like to know more about the lives of children from other	3.38 (.751)	3.36 (.788)	$t_{(356)} = 0.183$, $p = .43$, effect size = n.s.

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
countries.			
I would like to help people in other countries solve problems in their communities	3.44 (.690)	3.30 (.776)	$t_{(336)} = 1.647$, $p = .05$, effect size = .17

We asked children an open-ended question designed to assess their perceptions of children in other parts of the world. We asked children "what do you think children in [South Africa or the United States, depending their location] and their homes look like?" Children in the United States were asked to describe their perceptions of children in South Africa and children in Jordan, Malawi, Vietnam, and South Africa were asked to describe their perceptions of children in the United States.

We coded all the responses, both written and drawn, across three different characteristics:

(1) Level of detail – Responses with no detail received zero points, responses with minimal detail (e.g., "A house" or a drawing of a house with no other detail) received one point, responses with more detail received two points.
(2) Stereotypes – Responses that contained stereotypes were flagged.
(3) Perceived similarity – Responses that explicitly noted that the children from another country or their houses were "like mine" or "like children in our country" were flagged.

Regarding "perceived similarity," we added that construct because our initial review of the data found that a number of the responses made references to similarities.

With regard to level of detail, we expected that there would *not* be a difference in the level of detail in their responses, but collected that information to provide context. That assumption was correct: we found no differences between the control and the treatment group children with respect to the level of detail they provided in their responses – they were equally detailed.

We found that children in the treatment group were able to relate to children in other countries significantly better than children in the control

group.[8] For example, children in the treatment group were more likely to say things like, “The children in South Africa are just like me.” Or “The houses in the US are just like the houses we have here.”

Regarding the characteristic of stereotypes, based on DSG’s formative evaluation findings, we expected that treatment group children might be less stereotypical in their responses than control group children. However, the treatment group used just as many stereotypes about children in other countries as children in the control group. But, when we looked at treatment group clubs that had a foreign partner club versus those that did not have a partner club, **we found that children in clubs with a partner club in another country were significantly less likely to use stereotypes when they described children from other countries than children from clubs that did not have a partner.**

We explored the data even more deeply and found that **children who had partner clubs in another country AND were part of an afterschool program mentioned fewer stereotypes than children who had international partner clubs, but took part in a school-based club.** Children who participated in DSG as part of a class used more negative stereotypes about their foreign peers than children who participated in an after or before school DSG club. This *may* have something to do with the fact that children participating in out-of-school clubs usually did so voluntarily, whereas children in a classroom-based DSG didn’t have a choice about whether to participate. But, this is a question to explore with future research.

[8] Chi-square (df = 1) = 6.829, p = .009.

Impact 5: Youth demonstrate an ability and inclination to take different perspectives, others as well as their own.

We asked children in both groups to report the extent to which they agreed or disagreed that (1) I like working in groups, (2) I am confident I can help my peers, and (3) I am confident I can respect my peers' ideas. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater ability and inclination to take different perspectives.

We found that children in the treatment group reported significantly greater confidence than children in the control group with respect to helping their peers and respecting their peers' ideas.

Children in both groups were equally interested in working in groups. The table below summarizes the results.

Table 9:
Children's Ability and Interest to Take Other Perspectives

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219	**N = 162**	
I like working in groups.	3.31 (.758)	3.22 (.775)	$t_{(345)} = 0.969$, $p = .16$, effect size = n.s.
I am confident I can help my peers.	3.44 (.666)	3.29 (.735)	$t_{(340)} = 1.963$, $p = .03$, effect size = .20
I am confident I can respect my peers' ideas.	3.52 (.593)	3.41 (.728)	$t_{(346)} = 1.451$, $p = .07$, effect size = .15

An excellent example of children working together in groups arose during our observation of a club in South Africa. In fact, the evaluator had never seen such cooperation among children prior to this. Within each group, the children all played roles and contributed to the designs and building. At any one time, there might have been six children working on the same building, all with their hands in the mix and not disturbing or interfering with one another. When asked about whether it's better to work alone or in teams, the children replied that it's always better to work in teams because they can "tell each other their ideas." Another child said, "I enjoyed this session because, it was easy and we did it as a team."

During our observation at a different club in South Africa, we observed the same level of collaboration. While the children worked, all of them were completely engaged. If one or two children were taping the sticks or cutting or trying something, the others were leaned over, closely watching every move. Everyone participated and not one child appeared to be left without a job. When asked if they liked working alone or as a team, the children responded that they liked working as a team, "...because we can help each other."

During our observation in Jordan, a 12-year old girl reported,

> *We were very cooperative together and she made teams so that people who didn't know each other would get to know each other and there wouldn't be troubles and we cooperated in cleaning once we finished and we cooperated in things because we had to.*

At a different club in Jordan, one 13-year old girl commented that she has loved engineering for a very long time because her father is an engineer. She said she was looking forward to "working cooperatively with the group to design solutions to problems that affect people."

During this same observation, the leader asked one of the children to demonstrate his team's Helping Hand (an assistive device used to grab an object out of reach). The child walked shyly up to place a paper cup on a plastic bin. He proceeded to pick up the cup with the Helping Hand and walked away smiling. When one group was asked about challenges they experienced designing and building its helping hand, one child described how his team first tried to make the Hand with a wire hanger, but it didn't work, so they had to redesign it. "We learned that together, we can do anything." His teammate said, "We learned that you can do anything if you put your mind to it."

Impact 6: Youth demonstrate confidence that they can solve problems and create change.

We asked children in both groups to report the extent to which they agreed or disagreed that (1) I can solve problems in my community, (2) If I learn engineering, then I can improve things that people use every day, and (3) I am interested in solving problems in my community. We compared children in the treatment group to children in the control group to see if children exposed to DSG (treatment group) reported having a greater level of confidence in their ability to problem solve and create change in their communities.

Children in both groups were equally confident that they could solve problems in their communities and, with engineering knowledge, improve things that people use every day. Moreover, they were equally interested in solving problems in their community. The table below summarizes the results.

Table 10:
Children's Confidence in Problem Solving and Creating Change

	Treatment Group Average and Standard Deviation	Control Group Average and Standard Deviation	Statistics
	N = 219	**N = 162**	
I can solve problems in my community.	3.12 (.734)	3.18 (.730)	$t_{(303)} = -0.695$, $p = .25$, effect size = n.s.
If I learn engineering, then I can improve things that people use every day.	3.41 (.718)	3.46 (.728)	$t_{(334)} = -0.589$, $p = .28$, effect size = n.s.
I am interested in solving problems in my community.	3.32 (.810)	3.35 (.719)	$t_{(317)} = -0.265$, $p = .40$, effect size = n.s.

An example of children's interest in solving problems using engineering arose in Jordan. During an observation there, a 13-year old boy explained that engineering makes him happy. He signed up for the club because he likes how engineering lets "young people take an idea from their minds and physically execute it." Engineering is appealing to him because engineers fix problems, and he's excited to learn about how engineering can be global.

Impacts on Club Leaders (Educators)

The following describes educators' experiences encouraging children to learn basic engineering skills and concepts, including the design process. Club leaders described how they injected discussions of the design process into their club's sessions at every opportunity. **Given that 75% of club leaders in the treatment group did not have prior experience leading STEM activities, their tendency to discuss the design process repeatedly is most likely due to their exposure to the Club Guide.**

- *We explained the design process to the children through the activities in the sessions. Each session started with an introduction about the concept being tackled in that session, and then the children will go through the design process to accomplish the "need" that was defined at the beginning of the session. [Jordan]*
- *We talked about the importance of all the steps in the design process and especially the importance of making changes when necessary. [US]*
- *I explained what the design process is all about and how important it was to follow it when doing a project. [Malawi]*
- *I encouraged every kid to give ideas or brainstorm and encouraged children to do the hands-on activities. [Malawi]*
- *My children are lacking in basic engineering skills and concepts. I showed them the design process and asked them to design things according the design process. When they found it difficult to make something, I suggested them the way. In fact, I tried to make them do as much as they could. The children could be wrong but it was a part of design process. [Vietnam]*
- *I explain to them the basic things about engineering and concepts, and give some examples. [South Africa]*
- *Every time we do the design we always tell them that engineering is good for them. [South Africa]*

Club leaders reported how much DSG resources supported them in teaching children about the engineering design process. For example:

- *I used the graphic supplied and would reiterate verbally that the sooner they failed, the sooner they'd redesign and get to success. [US]*
- *At the beginning of each meeting, we reviewed the design process. I broke it down into each step as we did the activities. At the end, I stressed the importance of doing each step and the benefits gained from each step. [US]*
- *We utilized videos on the Design Squad website in addition to printed materials. [US]*

In addition, club leaders reported on how they extended their club's learning, by encouraging them to use outside resources to learn about engineering. For example:

- *I asked them to come to our library and read books about this topic and start to think about if they like it and if they want to be an engineer in the future. [Jordan]*
- *We took a walk around the neighbourhood to look at examples of engineering in their world. [South Africa]*
- *They were made to get to know and find information about mechanism and architecture and the ways to invent a product or a construction. [Vietnam]*

The findings below are organized by the project's intended impacts on educators:

Impact 7: Educators demonstrate comfort leading engineering activities.
Impact 8: Educators demonstrate comfort collaborating with educators from other cultures/countries.
Impact 9: Educators demonstrate understanding of global competence.

Impact 7: Educators demonstrate comfort leading engineering activities.

Using the educator surveys, we found that club leaders in the control group were just as comfortable leading engineering activities as leaders in the treatment group, despite the fact that 75% of the treatment group leaders had no prior experience with engineering activities.

Table 11:
Educator's Comfort Levels Leading Engineering Activities

	Treatment Group Percent Agreed or Strongly Agreed	Control Group Percent Agreed or Strongly Agreed
	N = 20	**N = 20**
I am comfortable leading hands-on activities with children (where they do things with real materials rather than just reading or writing about them).	20 (100%)	19 (95%)
I am comfortable leading open-ended activities with children (i.e. activities that have many possible solutions or answers.	20 (100%)	19 (95%)
I am comfortable talking with children about engineering and inventing.	20 (100%)	18 (90%)
I am comfortable using a problem-	20 (100%)	19 (95%)

	Treatment Group Percent Agreed or Strongly Agreed	Control Group Percent Agreed or Strongly Agreed
solving process with children (for example: identifying a problem, brainstorming, designing, building, testing & evaluating, sharing solutions).		
I am comfortable helping children learn how to work in teams to solve problems.	20 (100%)	18 (90%)

Looking only at the treatment group leaders, 15 of whom had no experience leading STEM activities prior to DSG, we noted that all of them (100%) reported feeling comfortable or very comfortable after participating in DSG:

- Leading hands-on activities with children,
- Leading open-ended activities with children,
- Talking with children about engineering and inventing,
- Using a problem-solving process with children, and
- Helping children work in teams to solve problems.

Although we don't know how many came into the program already feeling comfortable (since the study was not designed to collect pre-test surveys), it is still a positive finding that all of them were comfortable after participating. Anecdotal feedback provided by treatment group club leaders suggests that this may be due to the guidance provided in the training resources provided by DSG and the Club Guide itself.

Leaders who reported having no prior experience all described how the DSG materials supported them:

- *The materials were basic or easy to find. I loved how SIMPLE it was! [US]*
- *It really helped me feel more confident because of all of the materials and information available on your site. [US]*
- *I developed more and more confidence as the weeks continued. I also began adapting how I facilitate an engineering class for an after-school setting. [US]*
- *I have never seen myself in this topic but I really enjoyed it. [Jordan]*
- *I feel more comfortable now. After participating in DSG, I believe that my students can learn more through activities. They can try and find the best way to solve a problem. They are creative and smart to have interesting solution. [Vietnam]*

- *This group taught me to be patient and simplify my questions. [South Africa]*
- *More especially it increased my creative thinking. [South Africa]*

We asked club leaders to describe how they encouraged children to work together as teams to solve problems. Club leaders reported:

- *We explained the idea at the beginning and arranged the children in different teams each time leading to a different group for each kid in each session. Before the end of each session, the children would discuss their projects with each other. [Jordan]*
- *I always tell them to work in groups so they learn that they have to collaborate sometimes so they can [achieve] success. [Jordan]*
- *Teamwork was a challenge at first, and sharing ideas and materials, but as one would get stuck, the other would have an idea to try. [US]*
- *The students did not work with the same person in every activity. It was interesting to hear their discussions and ideas they would propose to each other. I would ask their teammates what his/her thoughts were on the idea given. I would give them ways to look at the situation a little different. [US]*
- *Working together helps the team do projects better and teaches them discipline. [South Africa]*
- *By the time they were working in the project of engineering and invention a person had to ensure that no one stood by. Every individual had to participate, include his ideas on discussion, and work hand in hand. [South Africa]*
- *We always tell them to listen to each other and communicate to find different views from each other. [South Africa]*
- *I wanted every child to participate in the group and be active in all the activities. [Malawi]*
- *I encouraged the children to take ideas from every member and try them all and at the end discuss which one they think is the best idea. [Malawi]*
- *We did work in teams. I had them work with a different team for each project. We talked about the different solutions teams had to the challenge each time. [US]*
- *We encourage all students to respect everyone's ideas and input, plus no physical work began until an opened discussion occurred in the beginning, (if necessary) during and in the end of each project. [US]*

During an observation in South Africa, a club leader explained that DSG has helped him to lead more effectively but giving the children “the power to lead themselves.” The club leader emphasized that while the children are working, he only supervises. He makes it a point not to help the children or to tell them how to do whatever they are doing.

For them to make good designs. I can't give them information. I have to allow them so that they can be challenged. So, I allow them to do it and to make mistakes.

During an observation of a club in the US, we noted that the club leader was very relaxed and confident about helping and coaching the children through the engineering design process. First, he suggested that the children continue to "think of more ideas and we'll try and then make them better." He kept reinforcing this … that the children have an idea that they will try and then redesign if it doesn't work. The leader also reminded them constantly about teamwork … "coming together" to create a device. The children all appeared engaged, interested, and excited about the project. the club leader reminded them to "brainstorm" and "come up with ideas." He responded to the boys' suggestions with "good idea" and other encouragement.

In an interview with one of the Jordanian club leaders, the leader discussed the importance of emphasizing problem-solving during the sessions. She noted that they followed the steps of the engineering design process during each session. They also discussed real world problems with the children to make the process relevant to them. The club leader explained that it was important to her that the children not just see the sessions as "projects" but as problem-solving challenges.

Impact 8: Educators demonstrate comfort collaborating with educators from other cultures/countries.

As summarized in the table below, survey data revealed that **treatment group leaders were more comfortable than control group leaders collaborating with leaders from other countries** – likely due to the experience of troubleshooting and finding creative ways to communicate. Most control group leaders reported that they had not previously attempted to collaborate with educators from other countries. This may be why they expressed less comfort than the treatment group that they could collaborate effectively.

Table 12:
Educator's Comfort Levels Collaborating with Educators from Other Countries and Cultures

	Treatment Group Percent Agreed or Strongly Agreed	Control Group Percent Agreed or Strongly Agreed
	N = 20	**N = 20**
I am comfortable using web-based communication tools (such as Skype) to communicate with other educators.	19 (95%)	17 (85%)
I am comfortable with the idea of partnering with an educator from another country to lead an education program.	20 (100%)	18 (90%)
I feel confident that I could approach educators from other countries to collaborate on student programs.	20 (100%)	15 (75%)

We asked treatment group leaders to elaborate on the ways in which DSG helped them become more comfortable collaborating with leaders in other countries/cultures. They reported:

- *It did increase my comfort level. I was not sure how it was going to work with each of us speaking a different language. [US]*
- *DSG is definitely an easy gateway to collaboration. [US]*
- *DSG made it real and authentic...not removed. [US]*
- *DSG made me more comfortable in a way because I did not have the advanced ways of Internet communicating. [Malawi]*
- *We exchanged different educational methods. We practiced different ways to access students and we discussed many methods to put into full play the children' strengths and creativeness. [Vietnam]*

Some leaders reported not feeling comfortable going into the relationship with their partner clubs. One club leader reported that it had been daunting to communicate with US clubs that seemed so well prepared and made it seem effortless to communicate using tools like YouTube when. This club leader did not use YouTube and had to do a lot of preparation work to be ready to share with her partner club. She has been a club leader twice now and she reported that she has learned that she needs to explain their club limitations to their partners up front:

> *We have had understanding people and partners and there are times where we didn't have understanding people. We do the introduction, where we make it easy for them to understand where we come from. And sometimes we give them an environmental take on it, saying, "This is where we come from. These are the issues that we are facing but we would like to be in communication."*

Data like these have helped the DSG team learned lessons that may be shared with future DSG Club Leaders. For example, future training can emphasize the importance of leaders who are willing to be flexible and understanding. For example, if both club leaders themselves are excited about and genuinely interested in the relationship with their counterpart, including a willingness to work with and learn together, the relationship is more successful than those who communicate with their partner because it is a requirement or obligation of the program.

Due to challenges outside the clubs' or WGBH's control, connecting partner clubs was not always easy. In some countries, like Malawi and South Africa, Internet connectivity and power outages were common. In other cases, language barriers existed. Those clubs that had trouble communicating with their partners reported, for example:

- *Their school break came early in December so they ended 3 weeks before us so there was no conclusion. [US]*
- *Our partner club leader always responded promptly, but I got the feeling that they weren't able to execute the program on schedule and as a result, we didn't always get the information we were expecting. [US]*
- *The biggest challenge was language. The students were learning English but weren't fluent. [US]*
- *Yes, the partner was always late sending anything. Sometimes I couldn't do anything about it because we can't be that late. [Jordan]*
- *We did not communicate often due to power problem in Malawi and internet network problem. The other challenge was that children could sometimes not attend the DSG club due to heavy rains. [Malawi]*

- *The challenges were that it was difficult to communicate, because Malawi is experiencing serious electricity outages and I did not have a laptop or an advanced cellphone. [Malawi]*
- *I tried to communicate through Google Classroom and links on Google drive. My partner club thought we could communicate using WhatsApp. Supposedly, I should be able to use WhatsApp using my laptop but I did not seem to get it to work. [US]*
- *There was no response from our partner club. [US]*

Regardless, club leaders demonstrated a willingness to get creative and reported that they managed to find ways around these challenges and communicate with their partner clubs. For context, we asked treatment club leaders who were successful at connecting with their partners how they were able to do so. Their responses show the level of ownership and commitment the leaders demonstrated:

- *I have established a great relationship with my partner teacher in South Africa and this will continue. We wrote to each other frequently, and used WhatsApp on a regular basis. [US]*
- *We would email. We'd share pictures of the members building, we shared videos as introductions. [US]*
- *We used WhatsApp, Skype and E-mail. We communicated before and after each challenge and then had a lengthy communication by phone at the end of the program. [US]*
- *We communicated via email. [US]*
- *I was able to communicate well with the teacher. We sent them a few videos and the question sheets. They sent us the question sheets and two videos. I also shared our school FB page with her and she was able to keep up with things we do on there too. We emailed about once a week (more or less). We really didn't talk about much beyond the club activities. Maybe we will in the future though. [US]*
- *We decided on club days to share the videos and photos. [Jordan]*
- *By email. We communicated every 2 weeks. We shared [letters] and pictures. [Jordan]*
- *We were able to exchange photos which made the educators from here improve and have courage. [Malawi]*
- *We communicated through the country coordinator's email, we shared photos and videos. [Malawi]*
- *We communicated about once a week and discussed what our students experienced and how they achieved their projects. We also shared some photos, and from [their] side, videos of the students and the activities. [Malawi]*

- *When my children did the section 3: Helping hands, I had a lot of difficulties to explain the way helping hands work. Therefore, my students couldn't make the helping hands successfully. I shared my problem with my partner and received a video showing how his students make the helping hands. I learned how to explain and helping my students make a good helping hand. [Vietnam]*
- *We communicated via email first and then agreed to use "What app" to maintain. [Vietnam]*
- *I communicated with my partner through email and Facebook. We communicated at least one a week. We share the photos, videos about the students. There are some challenges: languages, delays. [Vietnam]*
- *We exchanged emails, discussed ways to collaborate and share information, pictures, and activities of students. The biggest challenge was the language barrier and I had to ask some English teachers for their help. [Vietnam]*
- *Communication became successful through emails and educators took great responsibility to answer our questions. [South Africa]*
- *We used email once or twice a week. [South Africa]*
- *We communicated using email which worked well, although several times we had Internet connection problems in the centre where we run the after care. But thanks to the director of the program who keeps the connection online going, we shared pictures and videos of our session that we were running. [South Africa]*
- *We were communicating on email. We did not communicate much but we did share everything about our country, community, and school. We resolved our challenges as we sent pictures and videos of us doing our structure. [South Africa]*
- *Next time I will work with our partner club leader to agree on a timeline in advance. [US]*

Impact 9: Educators will demonstrate understanding of global competence.

For the evaluation study, we defined club leaders' understanding of global competence as being comfortable/capable of:

- Helping children recognize their own perspectives,
- Helping children recognize other's perspectives,
- Helping children learn about what life is like for children in other places in the world,
- Helping children learn to communicate and collaborate effectively with people from different places and perspectives, and
- Knowing how to communicate ideas to others so they are clear to people from different backgrounds and who speak different languages.

As summarized in the table below, **treatment group leaders were slightly more likely to report having an understanding of global competence than control group leaders.** However, it should be noted that most of the control group leaders came into the study reporting some understanding of global competence. This may be an artifact of the reality that educators who are interested in a program like DSG are likely to have a greater sense of global competence, or at least an inherent interest in such concepts, than educators who are not interested and don't sign up for a program like DSG.

The data are trending in such a way that it appears that **DSG helped club leaders develop an even stronger understanding of global competence**. In the end, all club leaders (100%) who used DSG reported that they were comfortable helping children recognize their own perspectives and the perspectives of others, and helping children learn to communicate and collaborate effectively with people from different places and perspectives. All but one treatment group leader reported that DSG helped them learn how to communicate ideas to others so that they are clear to people from different backgrounds and who speak different languages.

Table 13:
Educator's Understanding of Global Competence

	Treatment Group Percent Agreed or Strongly Agreed	Control Group Percent Agreed or Strongly Agreed
	N = 20	N = 20
I am comfortable helping children recognize their own perspectives.	20 (100%)	18 (90%)
I am comfortable helping children	20 (100%)	18 (90%)

	Treatment Group Percent Agreed or Strongly Agreed	Control Group Percent Agreed or Strongly Agreed
recognize other's perspectives.		
I am comfortable helping children learn about what life is like for children in other places in the world.	19 (95%)	19 (95%)
I am comfortable helping children learn to communicate and collaborate effectively with people from different places and perspectives.	20 (100%)	18 (90%)
I know how to communicate ideas to others so that they are clear to people from different backgrounds and who speak different languages.	19 (95%)	17 (85%)

To provide some context, we asked all club leaders to give an example of an activity that they have led in their school or after-school program to understand how they have encouraged children to develop an interest in people and places around the globe. If they hadn't done an activity in the past, they were also asked to imagine how they might do it in the future. Below are the experiences both treatment and control group leaders reported, most of which involve doing research on other countries and cultures on the Internet or in libraries. There were no qualitative differences between the experiences of control and treatment group leaders:

- *We read non-fiction articles and texts about places around the globe and also people in different cultures. [US]*
- *We are a homeschooling group, so personally with my children, we incorporate international travel as much as possible and pair that with learning the geography, culture and history of the countries we visit. [US]*
- *As an advisor to our student council, we choose charities (around the world) to benefit from our fundraisers. We research various causes and organizations to make informed choices. [US]*
- *Many of my students are from other countries, therefore we research and discuss the difference in their lifestyles often, utilizing the resources within the library. [US]*
- *By [talking about] people and places and villages. [Jordan]*
- *I speak with children about what they know about countries and how it will impact life in our country. [Jordan]*
- *Read more about people around the world. [Jordan]*
- *[I haven't yet, but if I did] I would create a club where we will discuss people's culture, food, dressing, beliefs, what they value most, their schools, developments, communities, etc. It will be a recorded programme and it can be broadcasted at school e.g. cinema hour, that is*

to give a chance to some children who are not in the club to develop an interest in people around the globe. Or else a live performance at a school assembly can help too. As it grows big we can do a TV programme for the whole nation to see. [Malawi]

- *Help the learners previously to draw different types of objects used as teaching and learning in a class. [Malawi]*
- *I have encouraged them to respect each person's views by doing so, they will be able to develop an interest in people around the globe. [Malawi]*
- *Haven't done - but as an educator, I strongly feel that I can encourage children to develop interest in people and places by having Internet communication through Skype [for example] and inter-school exchange visits. [Malawi]*
- *I and my colleagues will design some topic about STEM to help my students "learning by doing." [Vietnam]*
- *I have encouraged children to research different educational methods in foreign countries, by which they find common and difference compared to Vietnamese method. [Vietnam]*
- *As an educator, I teach my children about the different landscape and culture around the globe via Internet video and pictures. I encourage my children to search more about that at home and share with their friends. I will open forum and discussion and give my students award for their learning. [Vietnam]*
- *Via Internet, I could introduce to my students about people and places around the globe with video clip and pictures, explain to them about the differences and diversity, assign them homework studying more about that. [Vietnam]*
- *I often raised ideas, told stories and encouraged my students to explore more about that. Sometimes, I give out assignment and home projects and gave assessment to evaluate as part of the extra curriculum. My students might find it hard at the beginning, but I worked with them and told them to seek assistance from various sources. [Vietnam]*
- *Through sharing the differences and similarities between countries and the different things that people do (e.g., type of food, clothing and also the weather conditions). [South Africa]*
- *I have encouraged children to develop interest in people and places around the globe through this same program, Design Squad Global and English Access Micro scholarship Program. English Access program promotes skills and knowledge in the English language, as well as giving students ability to compete and participate in future exchanges and study in the U.S. My role was to facilitate those sessions in more engaging and fun ways, for example going for camps outside the country and going around doing community service, which is a good way of interacting with people and realising our differences or needs and ways to solve them. [South Africa]*

- *I let the children have a discussion about what they think children in another country look and sound like. [South Africa]*
- *I've let the children think about other people's difficulties to help them wonder can they help them receive special need if they have experienced earthquake or certain climate change. [South Africa]*

To gain a deeper understanding of how club leaders approached communication with others who might have different viewpoints, we asked them to describe the interactions between their clubs and the partner clubs. They told us:

- *We taught students about how to get to know how their peers in other countries worked together as a team, by which they could learn precious lessons. [Vietnam]*
- *I've encouraged children to develop an interest in the club members from other country. I showed them the pictures and videos about other children and encouraged them to asked what they had been curious about the children from other country. [Vietnam]*
- *When we watched the videos from the other group, the children automatically had an interest in people and places around the globe. My students would like to learn more. [US]*
- *We Googled the country and started to look up things. Students found great video to share information about the country. It was an eye opener for them. [US]*
- *The most enjoyable part for the students was the contact with other students. They loved receiving letters and videos. [US]*
- *We have already agreed to continue the relationship between our groups after the program. We will be extending into literacy activities. As we run activities every week during school terms we are continually looking for ways to expand the scope of the children's outlook. Before running this program I hadn't thought about linking with children from other countries but if we could it would be a great idea. We work on a theme called personal growth and this type of activity would fit in nicely here. [South Africa]*
- *We did some research on Vietnam. We even went on Google street view and looked around the city of our partner school. We looked a little into the history and some basic facts... weather, economy, government, etc. [US]*
- *It was neat to see the video from our partner school - the ways their solutions were different from ours. The children were very interested in the way the other school looked at the problem. [US]*
- *I asked them to share with friends and family the things they learnt in DSG. [South Africa]*
- *Children got encouraged to think for others problem solving. They did safe landing which became the best access for them to assist others.*

They thought how they can help other countries rescue themselves from a situation that isn't good. More especially if a certain country is affected by climate change, they had to think how they could assist. [South Africa]

- *We always told them that it's good to communicate with other countries and at the end everyone wanted to travel. [South Africa]*
- *I told them that if they work hard they will be able to travel [to] other places and see how their friends work on engineering activities. [Malawi]*
- *Sometimes my children had argument[s] when they did the project. They had different ideas. When it happened, I told them to discuss themselves to find the good way. I told them to try both ways and compare the result. They would choose the better one. [Vietnam]*
- *Yes, we organized competitions between teams at each section. After that, we exchanged the members in each team, so children could collaborate with more people and they could develop their soft skills, flexibility, and understand their friends' strength, hobbies, and creativeness. [Vietnam]*

We asked club leaders to explain, what, if anything, they think they learned about global competence and how to nurture it in children as a result of participating in DSG. They told us:

- *I told them everyone has an important idea so the must take all ideas and put them together to make it happen. [South Africa]*
- *I've learned that even though we are in South Africa, a third world country, we are living closer to a large city and we have some privileges that people living in rural first-world countries do not have. [South Africa]*
- *Work in a group is one of the most successful ideas because you need help for the ideas to succeed. Communication, discussion, need a group of people to have bright outcomes. I will proceed to encourage children to work together as teams. [South Africa]*
- *Children get very happy when you tell them about children from other countries.*
- *I would like students to not only feel that they can do anything but also be an agent of change in this world. Engineering and design would be a way. [US]*
- *I did learn the importance of global competency for our students. Their general understanding of other countries around the world is limited. [US]*
- *I think it really helped my children see that children all over the world, despite the language differences, are really the same. They were AMAZED that the children in Vietnam played the same video games they play. It was an eye-opener for them. Before we started, they didn't think they would have anything in common with the other students. It was neat to see the reactions when they realized they had more than a few things in common! [US]*

- *I learned it is more difficult than I am used to communicating with groups in other countries. But, like the design process, it is just another problem to solve. [US]*
- *The idea of being creative and that every student has potential. [Malawi]*
- *Our children now know [what] structures/buildings or children from America look like. [Malawi]*

We asked club leaders to describe what, if anything, they learned from the DSG experience about cross-cultural collaboration. Club leaders shared:

- *At first, I felt nervous because my partner was from US, a modern country. The ways we teach students are different. My English is not good so communication is also a problem. However, participating in DSG wasn't difficult as I had thought. We can communicate in many ways: mail, photos, videos... and different language is no longer problem. Through Facebook, we can share more information about our school, activities in school or holidays in our countries... [Vietnam]*
- *That they have to practice communicating with other people around the world and try to learn other languages because it's a really good thing and will [be] needed in the future. [Jordan]*
- *The children worked with multiple teams. The children can maximize their strengths and creativeness. [Vietnam]*
- *Seeing photos of their compound makes me realize how much I and my students take for granted. [US]*
- *That it can be difficult but we must continue to expand our students' opportunity to learn more about other cultures. [US]*
- *I learned that students revel in the idea of meeting students in other countries. I need to do more. [US]*
- *I had never thought about it before the DSG program. Now that I know how easy and beneficial it is, I would like to do more. [US]*
- *Up until this point I had not developed programs to introduce my students to international classrooms, but after this experience I would like to do more. [US]*
- *Importance of making a friendship with other people internationally and always having positive attitude. [South Africa]*
- *That we are the same as other countries. [South Africa]*

Other Feedback on the DSG Program

Positive Feedback

Nearly all (98%) of the children in the treatment group clubs reported that they enjoyed the DSG club. Nearly all children (95%) reported that they believed their friends would enjoy the DSG club, too.

All but two club leaders said would recommend DSG to other programs like theirs.

- *Oh yes, easy to roll out and very well planned for the educator/coach to use. [US]*
- *Yes, I think the concept is great but just depends on the efforts of each partner club being aligned. [US]*
- *I think the future education of students should have more connections with other countries for students to understand how others live. How things are similar and how things are different. [US]*
- *It's a great experience. It introduces students to the science and engineering, and global competency at a young age. [US]*
- *Yes, it is a great way to introduce children to engineering and the design process, and to help them find their career path. [Jordan]*
- *Yes, because it's very important and fun at the same time. [Jordan]*
- *Yes I would, because it helps children to be creative and think deeply. Because I would love children always to work so that they are active. [Malawi]*
- *I would recommend DSG to other programs because it enables students to think critically and come up with solutions to solve problems. It is also good because children are exposed to hands on activities which enable them to have real experiences that stick in their minds for good. [Malawi]*
- *I'd recommend DSG to other programs because it is a wonderful [program] and [has] useful activities for children. [Vietnam]*
- *Yes. It would be healthy and exciting for students to experience their creativity and imagination. [Vietnam]*
- *I would recommend it to even children's television programs, to serve learners who live in areas that do not have after-school clubs. [South Africa]*
- *Absolutely, yes, it is full of creative, critical thinking, build the basic in engineering and invention. Helps the children think abroad. Children begin to know the importance of communication and the ways of communication. [South Africa]*

- *Yes, because it helps children to think for themselves and everything they do comes from their own thoughts and no one thinks for them. [South Africa]*

Finally, we asked club leaders to describe any special moments they may have experienced while leading DSG. Some club leaders shared the following moments:

- *The success and joy in the eyes of the children when they manage to accomplish their target. [Jordan]*
- *A girl was so happy because in school they don't let her participate in any activity and I was so happy for her. [Jordan]*
- *Seeing children excited with their own structures they had built and experiencing challenges to fix and find where it do not go well. [South Africa]*
- *Children were able to contribute different ideas how to work out a problem within their group and they respected each other's ideas. [Malawi]*
- *When the children ended up completing a project that worked after struggles, I felt excited just [like] the children. [Malawi]*
- *I found it interesting when my students had creative idea to solve problem. There are some unexpected ideas which are simple and effective such as: a group made safe landing object which was so good that keep the egg safe. [Vietnam]*
- *When students enjoyed the moment and felt happily when they finished creating a product. [Vietnam]*
- *With each activity, the students were very engaged. The moon landing activity was the favorite. I had students who continued to create and test designs even after we had moved onto the next activity. That tells me they truly had an interest in it. [US]*
- *Listening to our students realize that the students had no shoes and wanting to send them some. [US]*
- *The fact that all our club members want to do it again! [US]*
- *I enjoyed watching my students make shelters. In order to test the structures students had to remain inside during a mock storm. It was windy enough to test the structures strength but we tossed water at the structures using a broom to simulate rain. Students were so proud if their structure did not blow away and they survived dry. My students have never thought about needing to build a shelter. We discussed about what we take for granted and what could cause us to need to build a shelter. [US]*
- *My favorite class was "Pop Fly" class and how excited the teams were when they finally hit the target with their catapults. It was amazing. [US]*

Challenges and Suggestions

During the course of the study, club leaders shared with us the challenges they faced and some made suggestions for enhancing the program. As mentioned earlier, **connectivity and communication barriers were the most frequently mentioned problem**:

- *No many problems, just Internet connectivity on my side. But we managed to get the work done. [South Africa]*
- *Communicating in English is difficult. My students and I have a poor vocabulary about science. We have to learn a lot to improve our English about science. [Vietnam]*
- *Language - All the programs are in English, which limited the accessibility for students. If there were available Vietnamese documents or software, it would be much better. [Vietnam]*
- *The club leaders should be provided with gadgets such as laptops or advanced phones for use to communicate as well as an allowance to buy Internet bundles for communication. [Malawi]*
- *If I had it to do over again, I would familiarize myself more with the timeline before starting and communicate with my partner club leader more in advance to make sure they intended to complete the same activities in the same timeframe. [US]*
- *The main problem was connecting with my partner club. It was suggested that I post all my information on Facebook but I do not use Facebook. It may be good to have other means of communicating and transferring images. [US]*
- *No communication with partner club. There should be a[n] immediate replacement when that happens because some of the students became discouraged since they did not interact with other students from different places. [US]*
- *I was frustrated not being able to communicate better and get more out of the chance to connect my students with students from a different country and culture. [US]*
- *I was really hoping that this project would encourage them develop interest in diverse places and people around the globe. However, we had difficulty connecting with our partner school. [US]*
- *It was hard because we never heard from our partners. [US]*
- *We tried, but the partner club failed to assemble, so we didn't continue with that. [Jordan]*
- *The fact that the partner club failed to assemble didn't allow us to benefit in this aspect! [Jordan]*
- *It's not easy especially if English is not your first language. [Jordan]*

Other leaders mentioned **logistical challenges**:

- *In our centre we have lots of children and can only accommodate half of them in the club. [South Africa]*
- *We had only one hour for each section. I wish I could have more time. My students had many ideas and one hour was too short for them to experiment. [Vietnam]*
- *Time management. Children could fail to manage the time that we agreed to meet due to long distance walking. I hope next time it will be improved. [Malawi]*
- *Trying to match people who are on different time zones. [US]*

Three club leaders explained that they **had trouble understanding the Club Guide instructions**:

- *Not understanding the activity from the guide. [Jordan]*
- *We didn't have a clear guide line of how to do those experiments. [South Africa]*
- *Information was a bit overwhelming to start and might be easier to understand if it was broken down into separate documents. [US]*

A couple club leaders reported that they still were **not quite sure what was meant by the term "global competence" or that they really did not spend much time on the concept**:

- *I'm still not sure what is meant by global competence. [US]*
- *We needed most of our hour for design, building, and testing so only 5% felt global competency. [US]*

Finally, a couple club leaders mentioned challenges that were specific to their clubs:

- *Activities were a bit basic for the target age group but worked well for our group since we had younger siblings participating (ages 5-9). [US]*
- *Girls and boys working together in the same room. The boys sometimes discouraged the girls if they are struggling because they are competing, too. [South Africa]*
- *We have some students who get fixated on an idea and have a hard time letting it go, even when they see it is not working. [Vietnam]*

During our observations, other challenges were surfaced. For example, in two out of the three South African clubs and three out of the four of the US clubs, we observed that the sessions were not long enough to complete the planned

activities because, in most, cases the leaders spent significantly more time introducing activities than the Guide recommended.

One club we observed in the US was part of a class. The classroom teacher only allotted half of the class time each week to DSG with 28 students. This translated to a session that lasted only 40 minutes. So, during our observation, the children only had time to learn about the challenge (Helping Hand) and to work on their designs. They did not have time to test their designs or discuss them.

Conversely, in one of the South African observations, we noted that the session started with building of the Helping Hands. The children had worked on the designs in the previous session. The club leader noted that they don't usually have enough time to get through a full activity in a single one-hour block of time.

Another problem related to time, but not within the control of WGBH, is that in afterschool programs, children may come and go throughout the sessions. For example, during our observation of a club in the US, the session began with eight children, but within 30 minutes, there were only three children left because children were being picked up by parents early. The session ended with one child in a group alone, and two children in the other due to the early pickup times.

Observation Case Studies

In this chapter, we provide a summary of our observations from each of the site visits. These case studies include outcomes we observed and they also provide important context for the quantitative findings related to the impacts.

Summary of Findings across Case Studies

While each of the clubs we observed is unique in its own ways, there were many commonalities across clubs that we observed. For example, in all clubs, we observed that the club leaders consistently:

- Explained how the day's session was related to everyday life,
- Asked the children open-ended questions, and
- Made the engineering design process steps accessible at all times, either by using posters on the wall or displaying the design process on a blackboard or whiteboard.

As a result, we observed that most children in all the clubs seemed to understand how the hands-on activities related to real world problems and we heard them talk in empathetic ways about problems that people are facing in the world.

We also noted that most children seemed to grasp the steps of the engineering design process.

In most, but not all, clubs, we observed that club leaders:

- Let children try and fail as many times as needed,
- Started each session with a reminder of what they did in the previous session, and
- Ended each session with a preview of what they would be doing in the following session.

Time constraints seemed to play a role as to whether club leaders were able to let the children try and fail as many times as needed and whether the club leader spent time reviewing and previewing.

One of the significant differences between clubs that we observed was that some club leaders took a deliberately passive role, allowing the children to take the lead on the activities, while in other clubs, the leaders were far more directive, even lecturing the children and providing very explicit instructions and suggestions for addressing the engineering challenges.

In child-driven clubs, we observed that the children were more willing to innovate and that they came up with unique designs and collaborated in a very purposeful way. In leader-driven clubs, we observed that the children were less willing to innovate, needed guidance, and looked to their club leaders to help them.

We did not observe any communication between clubs during our visits, but we did have an opportunity to observe one club during a session when the children were recording videos to send to their partner club (US: Club 4). The children were significantly engaged in this task and were excited to exchange information with their partner club.

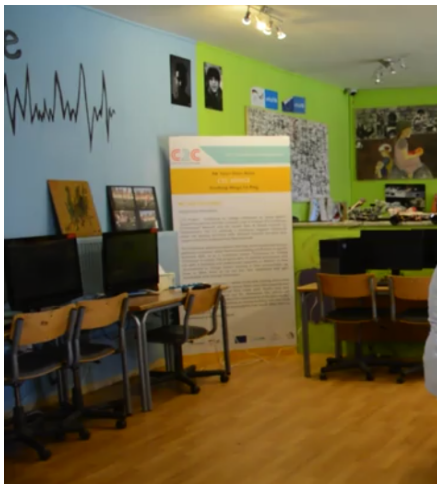
Jordan: Club 1

When did the observation take place?

Our observation took place in early July 2017.

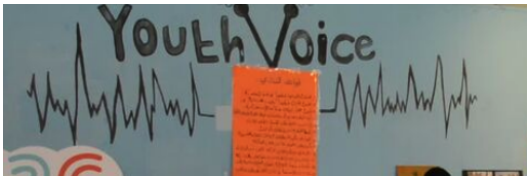
What is the environment like?

The room in which the club takes place is painted with very bright colors -- lime green, yellow, and blue. The walls are covered with posters and pictures. Notably, most of the posters are written in English, not Arabic. All the walls are lined with computers. It's a very cheerful place. There is a large table in the center of the room, with chairs surrounding it.



During our observation, there are other people in the room, but not at the table, so there is some background noise and people walking around, which is a little distracting to the children who occasionally focus on the action elsewhere in the room rather than on the discussion at the table. On the table in front of them are the materials that will be needed for today's challenge as well as a sheet of paper outlining the engineering design process steps. They are all seated around the table and the session begins with the leader explaining what they will be doing today.

How is the club structured?



This club is run by one DSG club leader who has some experience leading STEM activities before with youth. She speaks Arabic as her first language and English as a second language. She runs the DSG club as part of an after school program with middle school aged students. There are eight children in the club session--four boys and four girls. They are between 10-12 years of age. The program is open to all students who are interested in participating.

Is there a partner club?

Despite having been assigned a partner club in the United States, there was no mention of a partner club during our observation. The leader explains that they have been unable to communicate.

Which session did we observe?

We observed Safe Landing.

How did the children work during the session?

After a few minutes of explanation about the challenge by the group leader, the children break off into smaller groups of two and start working. Group 1 contains two girls, Group 2 contains two boys, and Groups 3 and 4 contain one boy and one girl each.

With the exception of one boy who is fairly quiet (and the leader later tells us is usually quite “mischievous”) the rest of the children are highly engaged with one another, talking animatedly and immediately jumping right into using materials. It does not appear that any of the groups, except the first one ever spent time drawing a design to start.

As the children work, the leader hands out materials and answers questions for the first few minutes. She then approaches one of the groups that seems to be having difficulty coming up with ideas and she gives them an idea of how to use the straws. She asks the children open-ended questions, such as, “What are the things that you invented? What are the things that you modified? What if we do that? What is the benefit of the umbrella? What

is the benefit of the shock absorbers and the types you used?" The children responded to her open-ended questions with ideas, but they seemed to be focused on wanting to know what the "right answer" was.

What were some of the outcomes observed?

The groups seem to rely very heavily on instructions and guidance from the club leader and each other for their designs. As a result, three of the groups initially end up with the same exact designs. They tie strings to the cups and attach a piece of blue plastic bag for a parachute. They attach beds of straws and popsicle sticks to the bottom of the cups to provide cushion. One group of girls (the ones who sketched their design) adds some folded paper at the bottom of the straws to provide a little additional shock absorption. The group with a slightly different design uses straws to hold the parachute instead of string. The children explain to us that the leader told them her methods and the children "took her idea and designed one like it."

The groups enjoy competing with each other. After about 20 minutes of working on their designs, the children start to test them out. They first test them out group by group, but soon they start testing them simultaneously, as if in a race with each other. They test them repeatedly for several minutes, trying to hold them higher and higher in the air. The first three groups land them successfully, cheering each time.

The children provide input and support to each other. The group with the slightly different design does not land the ball safely, so they go back to the table and work with the teacher and one additional boy student (the quiet one, who is now showing his mischievous side) on redesigning the parachute. After a couple minutes, however, the girl in the group is the only one revising the design. Her male partner is now playing with some other children in the group as they compete with their designs again. In the end, with feedback from the leader and a couple of the other children, the girl is able to land the ball and cup without the ball falling out. The rest of the children in the club clap when she is successful.

What did the children say about the experience?

One 12-year old girl explains her design, "Today we made this parachute. It shows how we can learn, as the teacher taught us, there are a lot of people who need this parachute to receive food in their area. So we tried to mimic this. In here, we create a base because we learned that every time pressure increases, the food goes downwards, and every time pressure decreases, it goes upwards. So here we have a parachute, we used bags, cups and a base. We added a ball inside the cup so that when we lift it upwards, what will happen is that when it goes downwards, the ball inside wouldn't fall."

Another 12-year old girl explained why the challenge is relevant, “First thing regarding the parachute, it helps people, of course the real parachute, it helps people in the sense that they receive food through it during wars or disasters or situations where it’s not possible to receive food through means of flying or cars. So it’s possible to send food through the parachute during wars.”

One 12-year old girl told us that she enjoyed the DSG club, “because they gave us new ideas, and also there is entertainment. We had fun...I learned that person must have new ideas. One shouldn’t stick to fixed ideas and should try different ideas, and to show innovation and have fun in life.”

She also reported, “they gave us new ideas and we became cooperative. They taught us how one can cooperate. And aside from cooperation, we learned to have self-confidence so when one gives new idea, he shows self-confidence...Because before they gave us the rules, they talked to us about cooperation and that everyone should be cooperative to hear opinion of another person, to have a dialogue and accept others and to have cooperation among people and respect each other’s points of view.”

Another 12-year old girl echoed this sentiment, “we were very cooperative together and she made teams so that people who didn’t know each other would get to know each other and there wouldn’t be troubles and we cooperated in cleaning once we finished and we cooperated in things because we had to.”

One 12-year old boy reported, “Entertainment. I had fun with DSG. There was no stress or anything. It makes you happy and doesn’t make you gloomy and the teacher makes us happy, such as in school, we don’t have to feel gloomy, we must be happy and interact with it. I mostly enjoyed the cooperation and group work.”

What did the club leader say about the experience?

Based on reports from the club leader and observations, the club leader’s approach includes the following elements:

- Starting each session with a reminder of what they did in the previous session.
- Explaining how today’s session is related to everyday life.
- Asking open-ended questions.
- Directing the children, rather than allowing them to take the lead.
- Making the engineering design process steps accessible at all times.
- Ending each session with a preview of what they will be doing next week.

She summarizes her approach like this: “At the beginning, we tackle the thing we’re doing and we bring it closer to something in real life, something in our life, then we start viewing solutions they created in reality, then we start talking about ideas and what we can do and things we can come up with. In the end, we brainstorm, then start building an experience and repeat the experience until we reach the main objective that we are seeking from this session.”

Over time, the club leader has noticed that the children are getting better at problem-solving. She reported, “From the last session, they were a little lost and didn’t know what to do. This session, they were better, they held objects and started thinking and started drawing as well. Some of them drew and showed us what they were going to do.” We should note, however, that we only observed one child drawing a design.

Jordan: Club 2

When did the observation take place?

Our observation took place in early July 2017. Because our observation happened during Session 1, we did not get a chance to observe the children designing or building anything. Thus, we also interviewed the club leaders a couple weeks later to gather their impressions of outcomes.

What is the environment like?

The room in which the club took place is quiet, bright, and colorful, with lime green benches placed in a semicircle in the center of the room, a woven rug on the floor in front of the benches, and bright, colorful seat cushions on the rug. At several spots around the room there are desks and benches, as well as drawing and building supplies, including pencils, rulers, cardboard, glue guns, and other materials. The two club leaders stand at the front the room next to a white board and the children sit on the benches.

How is the club structured?

The club is run by two club leaders, one male and one female. They both have prior experience leading STEM activities with children. The club includes eight students, only one of whom is a girl. The children range in age from middle school to high school. The club runs on Saturdays and is open to all who are interested.

Is there a partner club?

The club did have a partner club in the US. One of the leaders told us, “Sometimes we communicated through email and sometimes through Whatsapp. We exchanged photos and questions at times. They send the latest updates in sessions. But time zone difference was one of the challenges as well between us and the partner club.”

Which session did we observe?

We observed the first session of the DSG club.

How did the children work during the session?

For the first few minutes, the leaders stand and explain the DSG program and what the goals are. Some children ask questions, but mostly the children sit on the benches and listen quietly and intently.

After about 5 minutes of explanation, the leaders hand out paper and pencils. The papers contain questions for the children about their knowledge of engineering. One boy claims that he can't answer the questions yet because he doesn't know anything about engineering. The leaders remind him that he expressed an interest in engineering in order to join the club and encourage him to try to respond. The leaders let the children know that they will answer the same questions at the end of the six-week session and they will be able to compare their answers.

The children work quietly and individually while the leaders walk around and look at the student work, but do not interrupt them. As the children finish responding, they hand them to one of the leaders and he reviews them.

Following this, the leaders spend another five minutes engaging the children in a discussion of what engineering means to them. They discussed the idea that engineers are problem solvers and then the children provided several examples of real-life problems that could be solved with engineering, including a water-resistant bathroom chair for a disabled person that can move them around the house.

Next, the group watches the DSG introductory video. The children are very attentive during the video, despite the fact that it's in English and all the children' first language is Arabic.

After the video, the leaders engage the children in more discussion. Despite the lack of translation, the children demonstrated that they were able to understand the video by explaining the main points in the video. Finally, the children make name cards.

What were some of the outcomes observed?

The children are excited about engineering. Because children signed up for the club, they all had an interest in engineering, even if they didn't all understand completely yet what engineering was.

The children are interested in working together with other children. Despite the fact that the children did not know each other, they all expressed an interest in getting a chance to work together with others during the club.

According to club leaders during a follow-up interview a couple weeks later, the children are not as willing to innovate as the leaders hoped. One challenge the leaders faced was that the children often imitated the examples presented by the leaders, so they saw very little creativity or new ideas from the children from week to week. "Challenges were that sometimes the way of thinking was the same. They work in teams. So in a team someone thinks in a certain way, he could talk about it with his friends, so his friends start thinking the same way. So this was one of the challenges I faced as I like everyone to think differently and together they could create something totally different."

What did the children say about the experience?

One 13-year old girl commented that she has loved engineering for a very long time because her father is an engineer. She is looking forward to "working cooperatively with the group to design solutions to problems that affect people."

One 13-year old boy explained that engineering makes him happy. He signed up for the club because he likes how engineering lets "young people take an idea from their minds and physically execute it." Engineering is appealing to him because engineers fix problems, and he's excited to learn about how engineering can be global. He found the group of children to be cooperative and nice, so he is looking forward to the club.

What did the club leader say about the experience?

According to the club leader, their approach includes the following elements:

- Explaining how today's session is related to everyday life.
- Asking open-ended questions.
- Directing the children, rather than allowing them to take the lead.
- Making the engineering design process steps accessible at all times.
- Letting children try and fail as many times as needed.
- Ending each session with a preview of what they will be doing next week.

The club leader explained that it was important to her that the children not just see the sessions as “projects” but as problem-solving challenges.

South Africa: Club 1

When did the observation take place?

Our observation took place in early August 2017.

What is the environment like?

The club takes place in a classroom with a chalkboard at the front of the room, several windows on one wall, and colorful drawings and posters on the opposite wall. Notably, some of the language on the wall is English. The room is darkly lit -- there do not appear to be any lights on. In the middle of the room are two large tables surrounded by chairs. In the center of the tables, there are piles of materials, including paper, sticks (wooden skewers), Styrofoam balls, clay, tape, popsicle sticks, rubber bands, rulers, and binder clips.

How is the club structured?

The club is led by a female club leader, who has experience leading STEM activities like these. She speaks South Sotho and English. There are 16 children in the club, half boys and half girls. The club is offered afterschool to disadvantaged children.

Is there a partner club?

The South African club had a partner club in the US. When the leader was asked about the partner club, she said, “We did enjoy it but our challenge was the computers and the internet. But she did send me some pictures and I did send her some pictures. So it was fun.”

Which session did we observe?

We observed Seismic Shake Up.

How did the children work during the session?

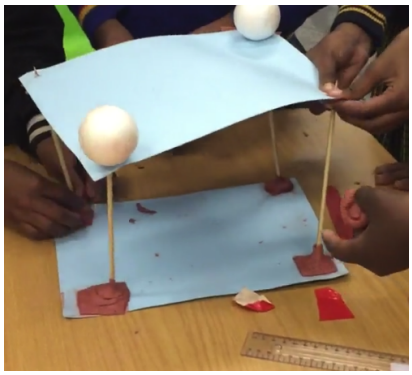
The leader starts with the children standing in a circle at the front of the room while she explains what they are going to do today. She tells them that some of

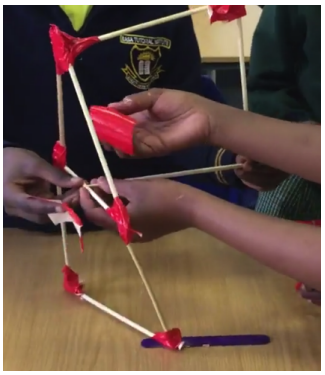
them have been naughty and so she randomly assigns them into two groups. The two groups sit at the tables and wait for instructions. Children begin by designing houses/shelters on graph paper in their notebooks. At the tables, a couple of children draw and the other children make comments and suggestions as they draw. The children are all very attentive, even those who are not drawing or commenting.

The children spend a couple minutes drawing and discussing their designs with their teams before beginning to build together. The teams build a single design, but everyone comments on it and/or tries to do different parts of the building process. In fact, I have never seen such cooperation.

The children spend a long time building, testing, and redesigning. They work together so nicely and collaboratively.

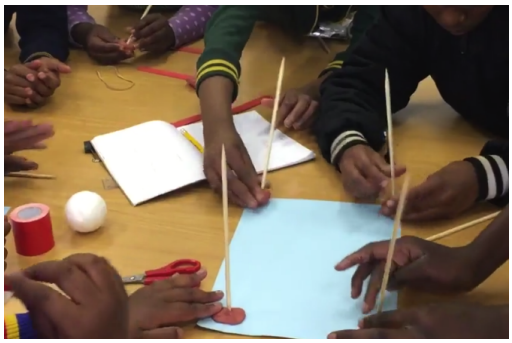
The structures look nothing alike. See the images below. One group tests their design and it withstands the earthquake simulation. The children cheer and jump up and down. The second group tests their structure, but it falls over as it is too top heavy. They redesign it, rebuild it, and test again. This time it stays standing and the children cheer.





What were some of the outcomes observed?

The children take collaboration to a new level. At any one time, there might be six children working on the same building, all with their hands in the mix and not disturbing or interfering with one another. I have never seen such levels of true collaboration when observing groups of children.



The children are willing to innovate. Neither of the designs looked like the other and the leader did not tell the

children how to design their structures.

The children are comfortable taking the lead. We observed the children comfortably working together and never relying on the leader for anything, except to answer an occasional question.

What did the children say about the experience?

When asked what they learned one kid says, “We learned that designing is not something that people can go without and that we can also be engineers one day.”

When asked about whether it’s better to work alone or in teams, the children reply that it’s always better to work in teams because they can “tell each other their ideas.”

“You must not give up. You must. We must try our best to do it.”

“I enjoyed this session because, it was easy and we did it as a team.”

“I learned that, you must not give up on something that you did, you need to do it more and more.”

What did the club leader say about the experience?

According to the club leader and our observations, her approach includes the following elements:

- Explaining how today’s session is related to everyday life.
- Asking open-ended questions.
- Remaining hands-off and allowing the children to completely take the lead.
- Making the engineering design process steps accessible at all times.
- Letting children try and fail as many times as needed.

South Africa: Club 2

When did the observation take place?

Our observation took place in early August 2017.

What is the environment like?

The room that houses the club is a bright blue with lots of computers and boxes of materials stored around the room. The club is held at one end of the room, while other groups participate in other non-club activities in other parts of the room. Thus, the room is filled with lots of talking and movement.

How is the club structured?

The club leader is a woman with experience leading STEM activities like DSG. She speaks Zulu and English. The club includes 12 children, four of whom are girls.

There are three older children (2 boys and 1 girl) who are helping the club leaders and the groups. These are students who participated in DSG clubs previously, both the 12-week and the 6-week clubs and they have an interest in design, so they volunteered to be mentors for subsequent sessions of the DSG Club. The female mentor stated, “It means that I can I can teach other younger children, everything that I was taught. I enjoy the part where I teach them, how to do things, and I love it.”

Is there a partner club?

The club has a US partner. About working with a partner club, the leader says, “Whatever means of communication that you have, definitely you have to establish it. Introduce each other to the kind of environment that you are in...Because it is far more rich and useful to experience something that children don’t know. They look forward to communication with other clubs. They look forward to sharing videos, they look forward to showing other children the environment that they live in.”

The leader reports that it has been daunting to communicate with US clubs that seem so well prepared and make it seem effortless to communicate using tools like YouTube when, in fact, she has to do a lot of preparation work to be ready to share with the partner club and does not work with YouTube. She just tries to explain their limitations up front:

“I have experienced that so far, we have had understanding people and partners and there are times where we didn’t. Where we didn’t have understanding people. Where if they threw communication away and we took a little bit of a while to answer and it was just. End of communication. Like oh, they are not interested. But mostly I have had people who understood where we come from, because we kind of do the introduction, where we make it easy for them to understand where we come from. And sometimes we give them an environmental take on it. This is where we come from. These are the issues that we are facing but we would like to be in communication.”

Which session did we observe?

We observed Emergency Shelter.

How did the children work during the session?

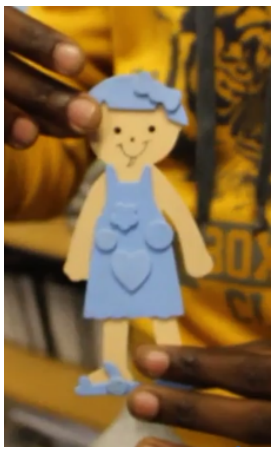
The Club leader starts the session (Emergency Shelter) by pointing to the engineering design process, written on the white board at the head of the room. The children are standing around a table, reciting the steps of the process as she points to them (in English, notably).

Next, she calls on an assistant to help her demonstrate to the children some examples of shelters from a book. The children break up into small groups of 3-5 and move to separate tables. At each table are copies of the activity sheet and some materials in the center. There are also materials available in a box, including cardboard, recycled boxes from cases of soda, tape, rulers, straws, dowels and others. These materials were provided by FHI 360 as a kit.

The children work on their designs in groups. In some groups, a single person draws the design while other group members watch intensely. In some groups, a single person draws the design while some other children look a bit bored. In other groups, all the children drew designs.

At some point, cheerful music begins to play in the background as the groups work on their designs.

After working on their designs for a few minutes, the groups begin to build with the materials. The groups become animated at this point, with most children participating in the building process. While the children seem to really enjoy building their shelters, it is clear after interviewing several children that they did not understand what a prototype was and the purpose of building such a small shelter to begin with. Many just report they were building it because that's what they were told to do. After the building was completed, the leader explained the idea of a prototype and the children seemed to then grasp the purpose of the task.



After completing their prototypes, the groups meet outside to test the three different designs. The children place small paper dolls inside each shelter to see which "person" would survive. One of the club leaders sprinkles water on it to mimic rain showers. Then he pours water on it. The "baby survives" and was dry. The four children in the group jump up and down with excitement.

The second and third groups have similar success and scream and jump with excitement at their outcomes.

What were some of the outcomes observed?

Some children work collaboratively while others do not participate. There are some children working independently and while most contribute to some aspect of the project, there are some children looking bored and uninvolved.

The designs are all similar. The structures all look alike and follow very closely with one of the examples given in the DSG handbook.

The club leader and mentors take the lead. The adults are very involved in the groups' work at every step. The children rely heavily on input from the adults.

What did the children say about the experience?

Due to language barriers, we were unable to conduct extensive interviews with children including data about their experience beyond what we reported above.

What did the club leader say about the experience?

According to the club leader and our observations, her approach includes the following elements:

- Explaining how today's session is related to everyday life.
- Asking open-ended questions.
- Directing children, rather than allowing them to take the lead.
- Making the engineering design process steps accessible at all times.
- Letting children try and fail as many times as needed.

The club leader reports that the children who enroll are interested in engineering to begin with. But, they do struggle somewhat with the fact that the materials are only provided in English. Some of the words are sophisticated and challenging, like, for example, "evaluate." She reports, "I have to make an example instead of just substituting it, I have say that, evaluate is when you actually have to see if works. So, it's a bit longer and it kind of takes, why is one word yet she kind of takes many sentences to explain it."

The leader reports learning about science herself, too, "It was a learning process that I was excited about. Now I am learning mathematics and science and technology. It has been fun. It has been something that I wouldn't trade for anything."

She also notes that the way to become comfortable leading DSG is by doing, not by just reading, "Not by reading the book, but by actually facilitating and going through it and actually exchanging ideas with the children as well."

Finally, she notes that, "I try to teach them that failure is ok. It helps them to build the momentum for success."

South Africa: Club 3

When did the observation take place?

Our observation took place in early August 2017.

What is the environment like?

The club takes place outside of a brick building, in what appears to be a dirt patch fenced in with metal fencing and surrounded by smaller structures made with corrugated metal roofs and siding. Inside the fence are several long, wooden benches and a thin, large piece of green material is hung over the area to provide sun protection. Birds are chirping loudly in the background.

How is the club structured?

The club has a male club leader, who has experience leading STEM activities. He is assisted by another male, who does not have experience. The club includes 11 children, 6 of whom are male. The club serves disadvantaged children and there are many languages spoken here, including Zulu, Sotho, Tsonga, and Venda. Some of the participants also speak English.

Is there a partner club?

The leader explains that they have had two partner clubs since starting. “The first one was quite active and then as DSG went on. About in session five, they were no longer that active. We tried to write emails to them but they don’t respond. Even on whatsapp. Some of them have whatsapp but they don’t utilize it. Those are the means of communication that we normally use to communicate with them. So, we struggle to get things from their side.

We did write a letter requesting another partner. So, have gotten another partner….It was kind of frustrating not only for us but for these guys (the children), too. Because they were happy about sharing solutions, sharing ideas, seeing what their partner clubs have come up with and then they match their strength of theirs….It doesn’t only build confidence in them but it also teaches them to be competent in terms of going internationally. So, it is quite helpful. If you can work with other South African clubs. I think that it can work. It will make it easier for us, even sometimes to meet as well. Face to face if it is possible. From

here we can go to Joburg if it's easier for us. When you see, locally you see the environment change. The more you become exposed to other opportunities. The more your mind will be open as well."

Which session did we observe?

We observed Helping Hand.

How did the children work during the session?

The observation starts with 11 middle school aged students seated on a long bench outside next to a building, including 6 boys and 5 girls. The leader stands in front of the children and asks questions. The children are very shy in front of the observer and only a couple of them quietly answer the leader's questions.

The leader explains the day's activities and the children take out their designs, which they have drawn in the previous session (the day prior) in notebooks. The objective for the day is to begin building. The leader distributes materials, which include colorful paint stirrers (popsicle sticks), colorful tape, scissors, metal fasteners, and rope.

The children work in two groups -- one with all the boys and one with all the girls (we believe that the children chose their own groups). When the leader needs to remind the children about the design process, he props a small white board against one of the benches and writes the steps on it.

During the building activity, a second leader arrives. He explains that he previously led a DSG club and this is his second time leading one. He does not have a background in STEM, but he says he has developed a passion for building and that he has learned a lot from his experience leading DSG. He applies the design process to all aspects of his life, including designing his own daily schedule.

The children begin to try out their designs. The girls are able to successfully hang a bag of cups on a wire high overhead and eventually take it back down again. It takes them several minutes to have success, but

when they do, they cheer happily.

The boys try to lift a single paper cup with their design, but they do not have success. So, the leader points out the steps of the design process and encourages them to redesign and rebuild and test again. So, the boys go back to their bench and begin to come up with a new design.

What were some of the outcomes observed?

The children are completely engaged while they work. If one or two children are taping the sticks or cutting or trying something, the others are leaned over, closely watching every move. Everyone participates and not one child appears to be left without a job. The children are literally huddled together while they work. None of the children is distracted or leaves the group to do anything else. The level of engagement is really quite impressive, given the age of these children.

The children enjoy the collaboration and teamwork. When asked if they liked working alone or as a team, the children respond that they like working as a team, "...because we can help each other."

The children demonstrate that they understand that failing is part of the process. When asked about challenges, one child describes how his team first tried to make the Hand with a wire hanger, but it didn't work, so they had to redesign it. "We learned that together, we can do anything." His teammate said, "We learned that you can do anything if you put your mind to it."

The children decide, on their own, that each group should have a team leader. According to the club leader, "Each and every team has a team leader, so they will represent on what they have done and what are their challenges that they had faced." This is not an explicit component of the DSG guide. The children came up with this approach on their own.

The children are willing to innovate. The two designs were completely different from one another. There was no evidence that children tried to copy each other's idea. They seem to be confident that they have a good design.

What did the children say about the experience?

The children in this club specifically asked for a DSG club to be run there because they heard of it from other children (the leader ran a club previously at

one of the schools where some of these children attend). Now, other children in other schools are hearing about DSG and have asked for clubs, too.

What did the club leader say about the experience?

According to the club leader and our observations, the club leader's approach includes the following elements:

- Explaining how today's session is related to everyday life.
- Asking open-ended questions.
- Remaining hands-off and allowing the children to completely take the lead.
- Making the engineering design process steps accessible at all times.
- Letting children try and fail as many times as needed.

The leader explains that they typically need 90 minutes to get through a session. He also emphasizes that while the children are working, he only supervises. He makes it a point not to help the children or to tell them how to do whatever they are doing. "For them to make good designs. I can't give them information. I have to allow them so that they can be challenged. So, I allow them to do it and to make mistakes."

The leader explains that DSG has helped him to lead more effectively but, more importantly, allows the children "the power to lead themselves."

He plans to train another teacher (the technology teacher) at one of the schools to do DSG so they can offer clubs to more children.

United States: Club 1

When did the observation take place?

Our observation took place in February 2017.

What is the environment like?

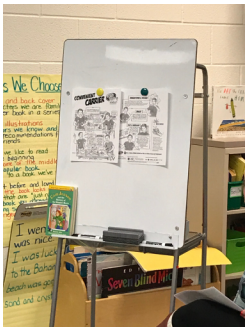
They meet in a second grade classroom in suburban Virginia. The classroom is bright and decorated with fun posters and information and the rug on which the children sit down is a colorful map of the US. There is a wheelchair and two sets of crutches (one for adults and one for children) in the room for today's session.

How is the club structured?

The club is led by a second grade teacher who has experience leading STEM activities. There are 10 children in the club, although during our observation there are only 4 girls and 4 boys.

Is there a partner club?

The club is partnered with a club in Malawi. There is no mention of the partner club during the session, until the very end, when the school administrator comes into the room and takes a group picture "to be sent to Africa."



Which session did we observe?

We observed Convenient Carrier.

How did the children work during the session?

The club leader spends a long time, more than 20 minutes, introducing the session. First, she explains the group will invent a way for someone to carry small personal items while using crutches or a wheelchair. She explains that they will brainstorm ideas first and she reads from a copied page about the materials they will use – cardboard, paper cups, string, tape.

The leader divides the group into two lines of four (boys & girls) and each child tries walking with the children's size crutches. The children are encouraging each other, watching as each takes a turn. She then reads a story about a teenage gymnast who had been in a car accident and was paralyzed as a result. She tells the group that she wants them to be thinking while she speaks … think about what their hands are doing.

The club leader asks the group to brainstorm … what kind of stuff do people carry? She then talks about different types of holders, like pencil holders. She asks for brainstorming ideas about holders.

The leader instructs the children to look at materials and think of different carrier designs. She then divides the group into two teams – she's thoughtful in deciding who will be working together. She explains her rationale to the observer, which includes an assessment of the children's strengths. One group is asked to design a carrier for a person in a wheelchair and the other group will design a carrier for someone on crutches. The leader shows the children the materials to work with (paper, duct tape, cups, string, rubber bands) and also some "personal items" including glasses and plastic cell phone replicas.

The two groups of four get together and the leader encourages them to brainstorm ideas. One boy says that they can get paper and sketch it out. One girl in the crutches group finds paper and a pencil and starts to sketch something, but quickly the children start taping cups to the crutches. The crutches group notices that they cannot tape the cups on the handles since "you can't put the cups here because you need to put your hands here."

Throughout the activity, the leader is watching the children but not saying anything. At one point, she encourages them to focus. The children in the two groups are also watching each other, seeing what the other group is doing. The children are talking to each other, working together. The leader reminds the children to be "an active member of your team."

The leader tells the children that they need to clean up. Neither group has finished a successful design and have not tested or redesigned but they were able to share what they had done so far. The crutches group includes a boy who predicts that "it doesn't really work well" recognizing that the cups are still open and things could fall out, even though he hadn't tested it yet.

What were some of the outcomes observed?

The children demonstrate mixed success working as groups. Some of the children are engaged, while roughly half are working independently and not engaging with their groups.

The children do not have sufficient time to test and retest their designs. The session feels rushed and children don't seem to have the time they need to try out their designs, learn from the failures, and try again. The club leader spent

a significant amount of time on the introduction, rather than following the suggestion to keep it to between 5 and 10 minutes.

The children demonstrate empathy. The stories at the start of the session and the exercise of trying out the crutches and wheelchair seem to have made a significant impression on the children. They seem to really grasp the importance and relevance of the challenge as evidenced by the comments they made during the session and during interviews.

What did the children say about the experience?

When the children are asked if this activity was fun, the group says enthusiastically, "Yes!"

We then ask what the children learned today. One girl said that it's "kind of hard using a wheelchair" and one boy says "it's hard for people to go around when they are injured and need to carry stuff." And someone adds that it's hard to make holders that won't allow things to fall out. One boy notices that when you put duct tape on something, you can take it off and re-stick it to something else.

When the leader says to the children that next week is their last week, all say "Noooo!" and one of the children says that you can sign up in the spring for another session.

What did the club leader say about the experience?

According to the club leader and our observations, her approach includes the following elements:

- Explaining how today's session is related to everyday life.
- Asking open-ended questions.
- Remaining hands-off and allowing the children to completely take the lead.
- Making the engineering design process steps accessible at all times.

The club leader says that this session and the last one were more difficult than the earlier ones and muses that maybe these two were too advanced for second graders.[9] She also shares that she was frustrated because she reminded the

[9] It's important to note that this is not one of the DSG activities in the Club Guide. This was an activity pulled off the website out of context. It's unclear why they didn't follow the Club Guide and chose this activity.

children that materials could fall out of the cups but they didn't alter their designs. The children felt the cups were really strong and that was enough.

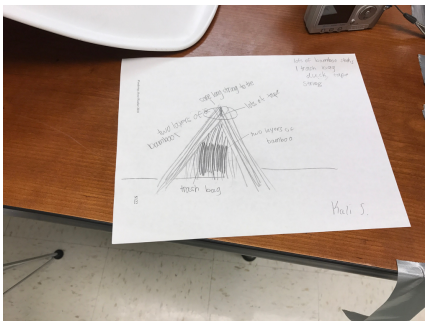
United States: Club 2

When did the observation take place?

Our observation took place in February 2017.

What is the environment like?

The club takes place before the school day in an elementary school classroom in suburban Virginia. There are a number of STEAM related posters and displays around the room and there is a 3D printer in one corner of the room.

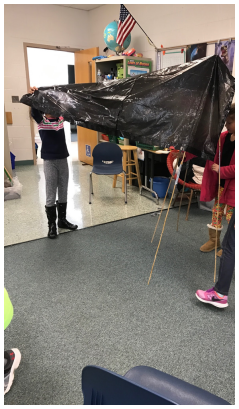


How is the club structured?

The club is led by a female teacher who has experience teaching STEM. She is assisted by a female school counselor, who has no science background but is enthusiastic about working with the children in this environment.

There are 11 children in the club. Five of the members are 3rd grade girls, six are 5th grade boys, and one is a sixth grade girl. The leader agreed at the beginning of the program to combine two clubs into one. She feels that the combination of the different ages has worked very well.

Is there a partner club?



The club is partnered with a club in California and Vietnam. Sharing videos and pictures with the other clubs has been challenging. There are privacy issues and challenges with the size of the uploads. The teachers' email accounts have size limits. The leader mentions she has sent some pictures through WhatsApp – the only way to send pictures because of their size.

They can email information but it's also been difficult to connect with partner clubs because of the time zone issues (despite the fact that the exchanges were not intended to happen in real-time, the leader was hoping to do so). Also, the club in CA is not starting for 2 more weeks. They mention that the Vietnam club is two weeks behind them and it's been "cool to get pictures from them."

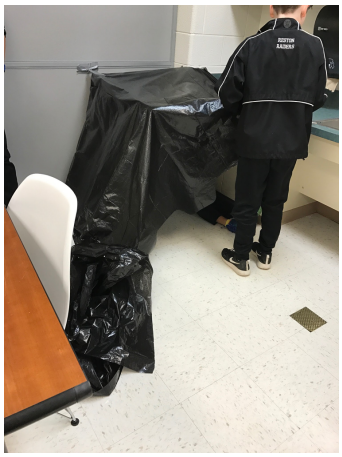
Which session did we observe?

We observed Emergency Shelter.

How did the children work during the session?

Before the leader introduces the lesson, she notes that she will be shortening the first activity in the interest of time. Despite saying this, she ends up spending 30 minutes introducing the activity and providing background information about structures. This, again, is significantly more time than the DSG guide recommends. Eventually, she explains that the children are going to be tasked with making a shelter. She divides the group into four teams. She asks them to "tell me what success would be?" One student says it won't fall down and a boy asks for clarification about the tent fitting one person or more than one person.

The leader talks about designing the tent. The co-leader reminds them all that last week they ran out of time looking at materials and reminds them they have a half hour so they shouldn't waste a lot of time looking at materials. She suggests that they all sit down and sketch out their design, as quickly as possible. She reminds them it's okay to start building a structure and then change their design.



The materials are bamboo sticks and duct tape (pre-torn by teachers), huge garbage bags, and string. The leader says to think carefully before they cut because it compromises the integrity of the garbage bag. She also reminds the children that the tent needs to be anchored or attached to something, and it must be self-supporting because it has to still stay up when they let go and someone gets in. She explains that self-supporting means it has to stand on its own.

One of the boys brings his drawing to the leader and she asks him to "describe" what he has drawn. He does and she asks clarifying questions. The assistant leader is also circulating from table to table talking with the children about how they're going to implement their drawings.

Group 1 builds a small shelter and then realizes it's too small when one girl climbs into it. They take it apart and rebuild it bigger by taping two sticks together before attaching them to one another. The older boys check out the shelter being built by the 3rd grade girls, observing how they did theirs. One boy asks if the girls' shelter is sturdy and then blows on it to test its strength. There's a lot of chatting within groups.

One of the third-grade girls tells the older boys that “you can’t copy us” and one of the boys says “yes we can.” One of the boys in Team 4 says to his teammate … “help” because the second boy is distracted and would rather build something else. [The club leaders later tell us that this boy has trouble being part of a team.] She reminds this boy that every week, teamwork is an issue for him.

After each team has worked on their shelters, the four groups come together in the hall. Each of the shelters is slightly different. The two groups that had built their tents in the classroom (on a rug) need to modify their models based on the environment (slippery floor).

It’s now time to disassemble their shelters. The children seem to have enjoyed the activity and are proud of their structures. One is attached to a wall (sturdy), one is a triangle with the point up high in the middle. One is a longer shorter tent and one did not really come together at all. They do not have time to discuss each model or have the children present their structures because of the time the leader spent introducing the session.

What were some of the outcomes observed?

The children enjoy the hands-on portion of the club. The children become animated and active when they start designing and building.

The children compete with other groups. The children are competitive with the other groups and appear not to be interested in sharing ideas with each other. They try to prevent the other children from seeing what they are doing.

What did the children say about the experience?

Due to time constraints, we could not interview the children.

What did the club leader say about the experience?

According to the club leader and our observations, the club leader’s approach includes the following elements:

- Explaining how today’s session is related to everyday life.
- Asking open-ended questions.
- Directing and lecturing, rather than allowing the children to take the lead.
- Making the engineering design process steps accessible at all times.

She notes that the sessions fit well with STEAM and the school’s interest in inventing and engineering. The leader explains that one hour is not enough for a

session. But, again, this was due to her deviating from the guide recommendations.

United States: Club 3

When did the observation take place?

Our observation took place in March 2017.

What is the environment like?

The afterschool program is located in an old Victorian house in an urban location in Massachusetts. The room where the club takes place has high ceilings and windows and is painted blue, with cubbies covering most of one wall. On the other walls are posters that include “Bully-Free Zone” and “No Phone Zone” in addition to other positive and affirming messages. The hardwood floor is scuffed and a bit worn from years of use. The lights are off – all the light is coming from outside through the windows. Because this is an afterschool program, there is another group of children meeting in the next room and for the first few minutes they are quite loud … almost hard to hear the club leader speaking to the children and difficult to hear some of the children in the club talking. All the children and adults are seated around a table. There are scissors and tongs in the center of the table.

How is the club structured?

The club is led by a male who works for the afterschool organization and has several years of experience leading STEM activities. The club includes eight children (4 boys and 4 girls) ranging in age from fourth grade through seventh. The club primarily serves urban, low income families. The leader is assisted by a young woman volunteer through AmeriCorps (Corporation for National and Community Service) and a male volunteer.

Is there a partner club?

Despite having been assigned a partner club, there was no mention of a partner club during our observation. The leader explains that they were unable to communicate because their partner never got started and they didn’t request another partner.

Which session did we observe?

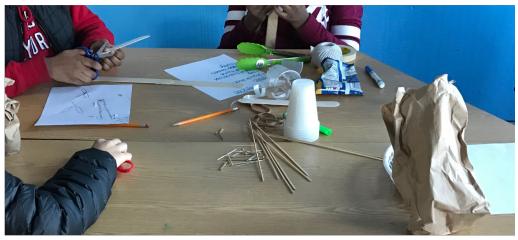
We observed Helping Hand.

How did the children work during the session?

The club leader starts by asking the children what helps move the arms of the tongs. They discuss the springs and the pressure. All the children raise their hands to answer and share their ideas. The leader explains that their project today is to create a device to grab a bag from a high place – someplace taller than they are.

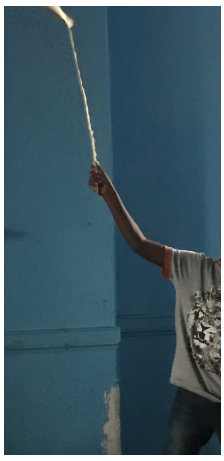
About 10 minutes into the session, one of the boys needs to leave.

The class divides itself into two groups for the project – girls in one group and boys in the other. They begin to brainstorm ideas and different ways to make their device. Each group gets paper (one piece of paper per child) and pencils and tongs and a pair of scissors on each table. The AmeriCorps volunteer sits with the girls and the male volunteer sits with the boys. In both cases, the adults are asking questions to coach the children through the process. The leader moves from one table to the other asking questions and providing feedback. At one point, he leaves the room as the children are working and comes back with a brown paper bag for each kid – with a piece of fruit and some pretzels in each bag – their afternoon snacks.



One of the girls is called to leave, so the group of girls is now three.

Throughout, the leader keeps reminding them about teamwork … "come together" to create a device. The children are all engaged and interested and appear to be excited about the project.



The group of girls is now down to two sixth-grade girls.

The leader informs the children that they will have 15 minutes to build. Each of the boys is working on their own at this point, playing around with the materials.

Another boy leaves so the boys' group is now down to three. A few minutes later, another one of the girls leaves, so it's now just one girl left on the team with the AmeriCorps volunteer. Shortly, two more boys get called out of the classroom to leave. We now have two boys and one girl left in the class.

The children build for a few minutes, working independently. The leader now tells the children they're now going to "test" their helping hands … "make sure the arm goes through the loop." Both designs are successful.

The leader asks the children to consider if they would have done anything differently. One boy says he doesn't know. The leader asks questions … "what do you need to make your device?" The boy doesn't know. Next, the leader has both teams tell the group about their inventions. The one girl remaining describes the steps her team took to create this device and why the extra string was needed to add the extra support. She also shows how they cut the cup in half and put one half on the top of each arm. The two boys left in the boys' group explain the tape and elastics they used and the tape around the stirrers.

Finally, the leader then gives the group a preview of next week's session … they will be creating a shelter.

What were some of the outcomes observed?

Very few children are able to fully participate. The constant dismissal of children from the session meant that most of the children didn't build, test, or discuss the challenge. Most of the children end up missing most of the session.

The children who did stay are actively engaged, but not collaborating. The children are very focused on what they are doing, but most worked independently because very few children were left.
The adult volunteers are actively driving the activity. Rather than being there to answer questions or just prompt children when they needed it, the volunteers were actively driving the hands-on activity, making suggestions and telling children what they would do when the children asked them.

What did the children say about the experience?

Due to time constraints, we could not interview the children.

What did the club leader say about the experience?

According to the club leader and our observations, the club leader's approach includes the following elements:

- Explaining how today's session is related to everyday life.
- Asking open-ended questions.
- Directing and lecturing, rather than allowing the children to take the lead.
- Making the engineering design process steps accessible at all times.
- Ending each session with a preview of what they will be doing next week.

We were unable to connect with the leader for an interview.

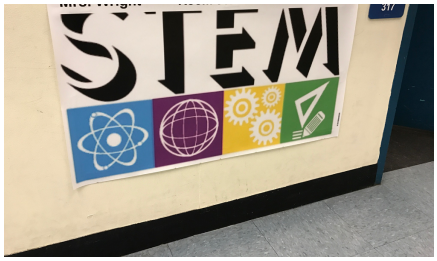
United States: Club 4

When did the observation take place?

Our observation took place in February 2017.

What is the environment like?

The club takes place in an elementary school STEM classroom in an urban Massachusetts location. The school appears to be an older building. The walls in the halls and in the stairwells are filled with signs and colorful posters made by the students, with messages about how to treat others, how to be respectful when going from one classroom to another, what makes someone a great friend, etc. The leader reports that this is one of the most popular schools and that the children in this class are very bright – a number of them will go to Boston Latin next year, which is an exam school. The wall space in the classroom is covered with colorful signs, posters and a calendar. There is a sign outside the door saying "STEM" and the topics of the posters inside the classroom are STEM related.



How is the club structured?

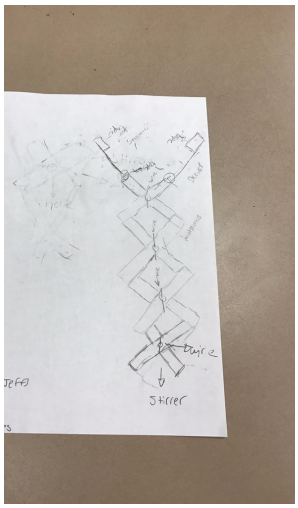
The club leader is a STEM teacher -- a woman with several years of experience leading activities like these. She is assisted by a young male who is currently enrolled in a teacher education program. There are 28 children in this sixth-grade class (16 of whom are girls) and they meet twice each week. Half of the time, the lesson is DSG – the other half is something else. The club is offered as an elective class for sixth graders.

Is there a partner club?

They are partnered with a club in Jordan, but they have had trouble communicating with their partner club. There is another DSG club at this school partnered with a club in Malawi. They have had more success communicating, so today, the leader is showing the Malawi video to this class. She has posted a shorter version of the video on her own DSG Twitter account – two girls raise their hand that they've looked at the video from Malawi on Twitter.

The leader mentions that they're having difficulty communicating with their partner club in Jordan so they will instead be partnering with a club in Vietnam.

Some children cheer when they hear this – there are several students in the class who are of Vietnamese descent. They will be allowed to talk in Vietnamese on the videos. The leader tells the class that if they can connect with Jordan, they will then have two partner clubs. She tells the class that, if there is time, they can start videos for Vietnam today. A few of the children clap when she says this.



Which session did we observe?

We observed Helping Hand.

How did the children work during the session?

First, the leader introduces the activity, referencing the instructions/information she has included on two pieces of flipchart paper. She talks about the materials available for today – paint stirrers, fasteners, tape, scissors, string, paper cups, elastics, coated wire (to use to fasten, but you won't be cut), paper towel rolls ("we don't need them but it would be nice to have options" as the children come up with designs). She asks the class to think about someone who might be injured or for some reason does not have full use of their arm or if someone can't reach something on the top shelf. She reminds the class that she always has them sketch out their ideas first. Today's session will be reserved for sketching and designing only.

One table of boys refers to their sketch as a "blueprint" but one of his teammates says that it won't work the way it's designed. They don't seem discouraged, but they recognize once they start to build they will need to revise and adjust their plans. One boy describes this lesson as "less brain hurty" than the last DSG one. Another boy says this device reminds him of something he used as a kid. Another group has multiple drawings on one piece of paper since each student drew their own design. When I ask one table if this is fun, they all say yes. One student describes to me how they'll build a hook at the end of the device. The room is very loud … a buzz of ideas and activity.

The children are not familiar with brass fasteners, so the leader and the assistant demonstrate how these work and how they can be used in their designs. As teams finish their drawings, they show the leader their drawings, answers any questions she has, and she then gives them an iPad to go out in the hall and record their message to the club in Vietnam.

We observe one group in the hall -- a group of 5 girls (3 Caucasian and 2 of Vietnamese descent) as they decide what they want to include in their introductory message to the children in this other club. One girl says … "you say

our names and I'll say that we're in 6th grade." [They want everyone included in this effort.]

One of the Caucasian girls asks one of the Vietnamese girls to "say hello in Vietnamese." Then together the five girls say the name of the school and that they're in sixth grade and then they go down the line saying their names and then they go down the line saying their age, then favorite subject in school and then again down the line with their favorite hobbies. At the end of the recording they ask together what the other children' favorite subjects are and what hobbies they have. After "take one", the girls decide they could do better, so they do a second take. They tell the children that they like skiing and sledding.

When the session is over, the leader has drawings from each of the teams and collects the iPads with a promise that she will edit the videos so they can be sent to the club in Vietnam.

What were some of the outcomes observed?

The children work collaboratively, sharing ideas and feedback with other members of their group. Most children seem to be very actively engaged and participating in the activity.

The children are even more excited about their partner club than the hands-on activity. The children were extremely excited to learn about having a new partner club in Vietnam. They ask lots of questions about the club and the videos they will create for them. They are also very excited about the other club's partner club in Malawi. They seem hungry for any information about children oversees, even the ones they are not partnered with.

The children are comfortable taking the lead on the activity. Perhaps because there are so many children, the leader and assistant could not work individually with each child, and so the children take the lead and seem quite happy doing so.

What did the children say about the experience?

Due to time constraints, we could not interview the children.

What did the club leader say about the experience?

According to the club leader and our observations, the club leader's approach includes the following elements:

- Explaining how today's session is related to everyday life.

- Asking open-ended questions.
- Remaining hands-off and allowing the children to completely take the lead.
- Making the engineering design process steps accessible at all times.
- Ending each session with a preview of what they will be doing next week.

The leader reports that this is the first STEM program in the Boston public schools and they hope others will be established based on the success of this one.

Summary

A summative evaluation of Design Squad Global (DSG), including a randomized control study and an observational study, found that the program had several positive and significant impacts on children in the US and internationally, as well as on their club leaders.

DSG successfully taught middle school-aged children in the US and abroad about engineering, including important science concepts related to structural integrity. DSG also had a positive impact on children's ability to design a solution to a real-world problem. Participating in DSG sparked children's interest in participating in more engineering activities in the future. In fact, during observations in South Africa, we noted two older youth who, it turned out, were DSG alumni who volunteered to return to the DSG clubs as mentors to the younger children because of the positive experience they had as DSG club members.

DSG encouraged children who were exposed to the process of problem solving with children from other countries to help people in other countries solve problems in their communities. Moreover, we found that children in the treatment group were able to relate to children in other countries significantly better than children in the control group. In fact, children in clubs with a partner club in another country were significantly less likely to use stereotypes when they described children from other countries than children from clubs that did not have a partner. DSG also helped children gain greater confidence with respect to helping their peers and respecting their peers' ideas.

With respect to DSG club leaders, the study found strong evidence that the DSG club leader training and Guide helped treatment group leaders feel comfortable leading engineering activities. Even though 75% of DSG club leaders had no prior experience leading STEM activities, all of them (100%) reported feeling comfortable or very comfortable after participating in DSG.

DSG club leaders were more comfortable than control group leaders collaborating with leaders from other countries and their creative ways of solving communication challenges and making the DSG club experience a significant one for children demonstrated their levels of ownership and commitment.

This evaluation study demonstrated the positive promise of DSG on children and educators globally and identifies several challenges inherent to programs like DSG. These challenges, however, such as communicating with partners across the globe, working with partner clubs operating on different schedules, or the logistical struggle of sharing video in locations where Internet access is

unreliable, were not insurmountable. This evaluation demonstrated that club leaders who are committed to the goal of providing real-world engineering projects that are meaningful and socially relevant to communities around the world, and the goal of helping children begin to see themselves as young engineers with the power to make a difference, can find innovative and effective ways to overcome such challenges and reap significant benefits for the children they serve.

Appendix A: Youth Survey

United States
Treatment Group Survey

We are doing a survey of kids around the world to learn about their interests. Please answer the following questions as honestly as you can. Thank you!

1. What is your Club Leader's name?
2. In which city or town does your Club meet?
3. How old are you?
4. Are you a: ⚪ Boy ⚪ Girl *(Choose one)*
5. What languages do you speak at home?
6. Are you Latino/a? ⚪ Yes ⚪ No (*Choose one)*
4. Are you… *(Choose all that apply)*

- ❑ White or Caucasian
- ❑ Asian
- ❑ Black or African American
- ❑ Indian or Middle Eastern
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ American Indian or Alaskan Native

The following statements are about ENGINEERING. *Check the box that shows how you feel about the statement.*

	Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**
6. I know what engineering is.	⚪	⚪	⚪	⚪
7. I know what engineers do.	⚪	⚪	⚪	⚪
8. Engineers do work that helps their community.	⚪	⚪	⚪	⚪
9. Inventors solve problems that help people.	⚪	⚪	⚪	⚪

10. Imagine you need to design a shoe that you can wear AND can hold objects, like keys or money. What would that look like? You may draw or write in any language.

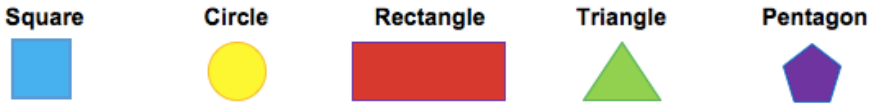
11. How do you feel about your design idea? (*Choose one)*

- ❑ Great
- ❑ Good
- ❑ OK
- ❑ Bad

12. How much would it have helped your idea to design with a team of people? (*Choose one)*

- ❑ A lot
- ❑ Somewhat
- ❑ A little
- ❑ Not at all

13. When you are building something, what shape do you think helps make the strongest structure? (*Circle one)*



The following statements are about YOUR INTERESTS AND WHAT YOU ARE GOOD AT. *Check the box that shows how you feel about the statement.*

	Strongly Disagree	Disagree	Agree	Strongly Agree	I Don't Know
14. I am interested in designing things.	❑	❑	❑	❑	❑
15. I am interested in creating or building things.	❑	❑	❑	❑	❑
16. I would like to be part of a group of kids that builds or creates something new.	❑	❑	❑	❑	❑
17. I can solve problems in my community.	❑	❑	❑	❑	❑
18. I would like to travel outside my country someday.	❑	❑	❑	❑	❑
19. I would like to meet children from	❑	❑	❑	❑	❑

other countries someday.					
	Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**	**I Don't Know**
20. I would like to know more about the lives of children from other countries.	⬭	⬭	⬭	⬭	⬭
21. I would like to help people in other countries to solve problems in their communities.	⬭	⬭	⬭	⬭	⬭
22. I like working in groups.	⬭	⬭	⬭	⬭	⬭
23. I am confident I can help my peers.	⬭	⬭	⬭	⬭	⬭
24. I am confident I can respect my peers' ideas.	⬭	⬭	⬭	⬭	⬭
25. If I learn engineering, then I can improve things that people use every day.	⬭	⬭	⬭	⬭	⬭
26. I am interested in solving problems in my community.	⬭	⬭	⬭	⬭	⬭

27. What do you think kids in South Africa and their homes look like? You may draw or write in any language.

28. Did you enjoy the DSG Club? ⬭ Yes ⬭ No (*Choose one)*

29. What did you like best about the DSG Club?

30. Would you join a DSG Club again, if you could? ⬭ Yes ⬭ No (*Choose one)*

31. Do you think your friends would enjoy DSG? ⬭ Yes ⬭ No (*Choose one)*

Thank you! Please return this survey to your Club Leader.

Appendix B: Club Leader Survey

US Club Leader Survey
Treatment Group

Thank you for taking the time to respond to our survey. Your responses will help us develop engineering programming that meets the needs of club leaders and children around the world.

Please check the box that best matches how much you agree or disagree with each statement below:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I Don't Know
1. I am comfortable leading hands-on activities with kids (where they do things with real materials rather than just reading or writing about them).					
2. I am comfortable leading open-ended activities with kids (i.e. activities that have many possible solutions or answers.					
3. I am comfortable talking with kids about engineering and inventing.					
4. I am comfortable using a problem-solving process with kids (for example: identifying a problem, brainstorming, designing, building, testing & evaluating, sharing solutions).					
5. I am comfortable helping kids recognize their own perspectives.					
6. I am comfortable helping kids recognize other's perspectives.					

	Strongly Disagree	Disagree	Agree	Strongly Agree	I Don't Know
7. I am comfortable helping kids learn about what life is like for kids in other places in the world.					
8. I am comfortable helping kids learn to communicate and collaborate effectively with people from different places and perspectives.					
9. I am comfortable helping kids learn how to work in teams to solve problems.					
11. I am comfortable using web-based communication tools (such as Skype) to communicate with other educators.					
12. I am comfortable with the idea of partnering with an educator from another country to lead an education program.					
13. I know how to communicate ideas to others so that they are clear to people from different backgrounds and who speak different languages.					
14. I feel confident that I could approach educators from other countries to collaborate on student programs.					

15. As an educator, how have you encouraged kids to develop an interest in people and places around the globe, if at all? Please give an example of an activity that you have led in your school or after-school program. If you haven't done this, how might you? Please give as many details as possible. If you are not sure, please write "I don't know.

16. Please list any specific examples of successful collaborations that you have had with educators from other countries, if any. What made those collaborations successful? If you have not had any experiences like this, please write "Not applicable."

17. For DSG, did you encourage kids to learn basic engineering skills and concepts, including the design process? If yes, please describe what you did.

18. Did participating in DSG affect your level of comfort in leading engineering activities? Please explain.

19. For DSG, did you encourage kids to develop an interest in people and places around the globe? If yes, please describe what you did.

20. For DSG, did you encourage kids to work in teams, recognize their own and others' perspectives**,** and appreciate that different people have different perspectives? If yes, please describe what you did?

21. Overall, what, if anything, do you think you learned about global competence and how to nurture it in kids as a result of participating in DSG?

22. Did participating in DSG affect your level of comfort collaborating with educators from other cultures/countries? If so, how? If not, why do you think it didn't?

23. For DSG, you were asked to collaborate with a Club Leader from a partner club in another country. How did you communicate with you partner Club Leader? How often did you communicate, and what did you discuss or share? Were there any challenges? How did you address those challenges?

24. What, if anything, did you learn from this experience about cross-cultural collaboration?

25. Please tell us about a special moment you experienced while leading DSG.

26. Please tell us about any problems you experienced while leading DSG. If you could do anything to improve DSG, what are the changes that you would make?

27. Would you recommend DSG to other programs (afterschool, in-school, etc.)? Why or why not?

Thank you!

Appendix C: Observational Protocol

Observation Protocol

Below is a list of things we are hoping to learn from the videos about each club.

Demographics of the Group

1. Number of kids participating
2. Approximate age/grade of kids
3. Number of boys/number of girls
4. Environment (where is the club held, what are the features of the space)
5. Number of club leaders

Observations of Club Leader

- Seem comfortable leading the hands-on activities?
- Using a problem-solving process with the kids (identifying a problem, brainstorming, designing, building, testing & evaluating, sharing solutions)?
- Letting the kids come up with their own solutions?
- Asking open ended questions?
- Reminding kids about the steps of the design process?
- Allowing the kids to fail?
- Supporting kids while they design and build?
- Asking probing questions?
- Encouraging the kids to work in teams to solve problems?
- Encouraging the kids to learn basic engineering skills and concepts, including the design process?
- How was the collaboration with people in other countries (if observed)?
- Were there any challenges?
- Did the club leader make any modifications to the activity?

Observations of the kids

- Interested and engaged in the activity?
- Enjoying the activity?
- Working together as a team?
- Understanding the engineering design process?
    - Do they understand the design process? (do they understand the steps when the club leader discusses them?)
    - Do they take their understanding of the design process to the next level and use it on their own without the club leader's prompting to progress through the activities?
- Show interest in people and places around the globe (if relevant)?
- Being respectful of others' perspectives if different from their own?

- Were there any challenges as the kids did the activity?

Prompts/Questions for Kids

If you have an opportunity to talk with the kids as you walk around, below are some suggested questions or prompts you may want to use. Feel free to use your own, too.

- Tell me about your project.
- What do you think of the activity and DSG?
- What steps did you take? Can you show me?
- [If something didn't work] What would you do differently next time?
- Did you have fun? If so, what made it fun? If not, how could it be better?
- What's one thing that you learned today in DSG Club?
- Have you been able to learn about the kids in [partner club location]?
- If so, have you learned anything new from them? What surprised you about them?
- What interesting things did you learn about your partner club or their country that you didn't know before?
- Others, as needed

Prompts/Questions for Club Leaders

It is doubtful that you will have a chance to ask many questions of the club leaders, as they will likely be very busy. If you *do*, below are some suggested questions. You do NOT have to ask all of these. These are just ideas.

If you *do not* get a chance to ask any questions of the club leader, that's perfectly OK! Please ask if they would be willing to complete a brief survey online and we will send you the link.

- Did you operate the DSG club as a class, a club or both?
- If you did DSG in a class, which class was it and how did DSG fit into the class objectives?
- For DSG, did you encourage kids to learn basic engineering skills and concepts, including the design process?
- Did participating in DSG affect your level of comfort in leading engineering activities? Please explain.
- For DSG, did you encourage kids to develop an interest in people and places around the globe? If yes, please describe what you did.
- For DSG, did you encourage kids to work in teams, recognize their own and others' perspectives, and appreciate that different people have different perspectives? If yes, please describe what you did?
- Overall, what, if anything, do you think you learned about global competence and how to nurture it in kids as a result of participating in

DSG?

- Did participating in DSG affect your level of comfort collaborating with educators from other cultures/countries? If so, how? If not, why do you think it didn't?
- For DSG, you were asked to collaborate with a Club Leader from a partner club in another country. How did you communicate with you partner Club Leader? How often did you communicate, and what did you discuss or share? Were there any challenges? How did you address those challenges?
- What, if anything, did you learn from this experience about cross-cultural collaboration?
- Please tell us about a special moment you experienced while leading DSG.
- Please tell us about any problems you experienced while leading DSG. If you could do anything to improve DSG, what are the changes that you would make?
- Would you recommend DSG to other programs (afterschool, in-school, etc.)? Why or why not?