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# Navigating The Obstacles In Science Education For School Outreach

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**Abstract** - This paper gives an overview of the education outreach initiatives that the authors have personally been involved with, their successes and shortcomings are discussed with ways to overcome the difficulties encountered. Recommendations are given on how to navigate the obstacles. Industry professionals, college professors and even church groups participate in education outreach initiatives. For a successful experience, one has to navigate through various phases of the process. The strategy is to convince stakeholders that there is value in doing the outreach activity, form a partnership with the school, circumnavigate the security and administrative procedures, and finally deliver the material to the students. Successful education outreach programs have well-defined objectives, roles and expectations. Success depends on the level of commitment of all parties involved. Taking a look at individual programs, focusing on their shortcomings and best practices, this paper serves as a compilation of useful ideas for effective science and math education outreach. Navigation techniques mentioned in this paper systematically address each obstacle encountered, making solid recommendations for the future. One of the biggest challenges is showing the direct benefits of the outreach activity to stakeholders, so they can see how they profit from sacrificing their workers as outreach mentors.

**Index Terms** - Education Outreach, Science, Technology, Engineering, Mathematics

## INTRODUCTION

Education outreach enhances the lives of everyone involved, students, teachers, administrators, and mentors. Targeting the sciences and mathematics extends these benefits to areas that are starved for intervention. The need for science and mathematics education outreach is becoming increasingly greater, and resources must be spent to ensure the continued support of these activities by reducing or eliminating the obstacles.

There are different types of education outreach activities. There are informal and formal types. Depending on the type, one can spend as little as 30 minutes to one hour and accomplish the goals, while other types may take longer, much longer. The more structured the program, the more time-consuming it will be; the greater the payoff however.

This paper takes into account all aspects of the education outreach process. The perspectives of all parties involved are represented here. However, the students' perspective is not emphasized as they are considered the recipient of the benefits. This is not to say that there is no benefit to others involved, but it can be argued that the benefits then would be secondary, they can be considered the rewards of giving. In this paper, the 'stakeholder' is defined as the person at the top of the process who normally owns the financial resources that are necessary to sponsor the outreach activity. The 'mentor' is defined as the person acting as the instructor who will eventually enter the classroom to deliver the lesson. The 'school administrator' is defined as the official in

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the receiving school who provides administrative help with the process. Each of the authors has served in at least one of these capacities and therefore brings representative and personal experiences from each instance.

Education outreach comes in a wide spectrum of types. These may take the form of small talks, organized competitions, short and long term teaching events, internet forums and one-on-one mentoring. These can be characterized by the level of effort required to arrange/organize them, the difficulty and ease of measuring the amount of expected return. Arguably, the most rewarding type requires the most effort and resources. These are usually more structured and long-term. It can also be said that these may require a bigger buy-in from the stakeholders. On the other end of the spectrum are the smaller, less formal types. They are quick and cost less. Stakeholders like these types. On the other hand, there is usually not enough time to make a big impact and even less chance to effectively measure the benefit. For sake of completeness, all the others in between deserve to be mentioned. These are events that may have lost their focus due to poor planning, but started out with the intention of being formal programs, or those spontaneous opportunities that no well-meaning educator can turn down. Table 1 below is a snapshot of some specific engineering education outreach programs with their corresponding types. A quick look at these outreach initiative, can give an idea of the impact of these outreach programs as it correlates to the type and level of effort required to administer the program.

TABLE I  
ENGINEERING EDUCATION OUTREACH PROGRAMS

Program	Web address	
Algebra Project	<a href="http://www.algebra.org">www.algebra.org</a>	long term
FIRST Robotics	<a href="http://www.usfirst.org">www.usfirst.org</a>	single event
Future City	<a href="http://www.futurecity.org">www.futurecity.org</a>	long term
GEAR UP	<a href="http://web.eng.fiu.edu/cedc">web.eng.fiu.edu/cedc</a>	long term
JETS	<a href="http://www.jets.org">www.jets.org</a>	long term
NASA Speakers	<a href="http://www.nasa.gov/">www.nasa.gov/</a>	single event
NAFP	<a href="http://www.uncfsp.org">www.uncfsp.org</a>	long term

## EDUCATION OUTREACH PROCESS

Regardless of the type of education outreach initiative, there is a gross outline of how they are done. It is a four-step process. These steps will be treated individually.

### *Step 1: Soliciting Approval*

Convincing the stakeholders that there are significant benefits to be realized, and getting their buy-in. They should walk away with a clear sense of gratification for being a part of the outreach effort. Take for an example a university doing school outreach to stimulate engineering interest in K-12 children. The department chairman and the college dean would be the stakeholders who the mentor (possibly an associate professor) has to convince that it is more profitable for the university to allow them to spend 6-8 hours per week at a middle school versus writing research proposals for grant money.

The goal is to get the point across that "enhanced engineering education in our K-12 classrooms can provide more students a more specific understanding at an earlier age of what a technical career entails" [1] Furthermore, those same students may be sitting in the corporate boardrooms waiting to award the grants for which the universities apply.

### *Step 2: Partnering*

Forming the partnership between the giving and receiving organization; assuming the engineering knowledge is what is being given. Of course, if this changes, so does the role of giver and receiver. This step can easily be taken for granted because its effect is so subtle. Having dialogue with the school may give the impression that a partnership is formed. On the contrary, there has to be somewhat of a contract between the two parties, defining roles, responsibilities and expectations. A critical step that many miss is outlining a contingency plan for times when things are not going as planned. Taking this step for granted can cause the outreach program to be more challenging than needed, and possibly fall through.

### *Step 3: Navigating*

This is the navigation step. Navigation began from step 1, however it is in step 3 that the traditional navigation, the effort of blocking and

circumnavigating tangible obstacles are realized, with immediate impact and immediate results. Some of the obstacles encountered seem necessary; while others are problematic and can be seen as a nuisance. Some necessary obstacles include money, administrative support and time. The obstacles that cause unnecessary strain include security checks, lack of communication, schedule conflicts and certain technical troubles. These obstacles, if not addressed add up to being a discouragement and hassle for persons involved.

#### *Step 4: The class*

The delivery of the material finalizes the process. Even at this point there is a high level of effort because the mentor has to develop material tailored to the needs of the students, they also have to acquire information (learning aids) that may be useful and not only deliver, but it has to be deemed appropriate for the audience.

As obvious as this may seem, taking material delivery into account has big benefits. In one experience, a parachute made of brightly colored nylon cloth stitched together by triangular wedges was being used to bring to life the meaning of angles and fractions when learning mathematics. The parachute was placed in the center of the room and the students formed a circle around the teaching aid (parachute)—a safety hazard was created instantly when one of the students stepped on the nylon parachute that was resting on the tiled floor, slipped and fell. On any given day, children fall and get hurt in the classroom. However, there is something worthy of report when the smallest accident occurs while there is a visitor in the classroom on that day; especially when the situation appeared to be created by the visitor. Extra care and thought is required in this step.

The four general steps in the process of delivering knowledge to students using non-conventional means can be applied to all outreach experiences, whether explicitly or without prior planning.

### **PERSPECTIVES**

The outreach process takes on a different meaning and presents different challenges depending on the perspective from which it is experienced. The stakeholder's perspective is the point of view that

can determine whether or not the program survives. The stakeholders hold the key to opening the doors to start, continue and stop the entire initiative. Due to this inherent excess authority, the causal observer may think the stakeholders have an unfair advantage. The fact is, the stakeholder is burdened with taking that delicate balance between his bottom-line and the rewards of participating in school outreach. If we assume for the sake of this discussion that the stakeholders truly want to be involved, then the issue becomes purely justifying the cost-benefit and return on investment—an undertaking that is not simple.

It gets more complex when the stakeholders' second thoughts lead them to have buyer's remorse about making the decision in the first place. Some programs take long-term commitments to be effective and the term can be as long as one to two years, as in the case of the NASA Administrators Fellowship Program; or five years, as in the case of the Gaining Early Awareness & Readiness of Undergraduate Programs (GEAR UP). During these time periods, much can change. The organization's goals may have changed from an education focus to one of say, operation; or in the case of academia, from instruction to research. When this occurs, the outreach programs are in jeopardy of losing stakeholder support. To get around this, the mentors have to stay abreast of, or even ahead of these changes and be sure to remind the stakeholder of the initial objective and emphasize the reason the initiative was taken on in the first place. Some programs, if not the vast majority, may not have binding contracts in place to prevent the effects of policy and agenda changes from affecting the program. However, it takes active feedback and communication between the stakeholder and the mentor to prevent the program from becoming a casualty of change.

From the stakeholder's perspective, it is a difficult decision to sacrifice talented employees for the sake of learning; especially when there seem to be many other programs doing similar things. Questions that come to mind are what good is it? What's in it for me? How will my employee grow by getting involved in this? These are obvious inquiries that remain unanswered, thus making the decision to approve the initiative a

tough one. The way to address these questions is to be specific. The responses should directly impact the company, the university, the sponsoring organization in general, and the department that is making the sacrifice in particular.

If the question were to be asked, who owns the outreach process? The most accurate response would be—the mentor. The mentor, the person who ultimately stands before the students has traditionally been the one to carry the banner for the program; and sees to its success. This is why the mentor is the one responsible for soliciting approval from the stakeholders. This philosophy is not flawless because there are stakeholders and administrators who are playing similar roles. Given this amendment, the owner of the process is the one who initialized the program, its brainchild; who wants nothing more than to see the program succeed.

The outreach process from the mentor's perspective is quite different from the others. It is pickled with effort and self gratification. The mentor, being the one responsible for delivering and sometimes preparing the material has to be prepared to be a sales person on both ends of the journey. From this point in the discussion, the assumption will be made that the outreach program is approved and there is no longer a need to convince the stakeholders of its merits. The task remaining is to take the message to the classroom. To do so, there are several hurdles to overcome. Coordination between the mentor and administrator, scheduling security checks and lesson planning are just a few. The classroom experience presents its own obstacles. There are events and encounters that occur in that environment that are less likely to occur elsewhere. For example, there are not too many places where you will be told to huddle silently in a corner with 30 or so other people, with the lights off, for four hours, without any prospect of going to the restroom if the need arises. This actually occurred when one of the outreach schools went into 'lockdown'. Lockdowns are enforced in schools to ensure the safety of the children when there is eminent danger in the vicinity of the school. In the case mentioned, there was a gunman trying to get away from police by running through the schoolyard.

Despite the praises given to mentors, there are cases where administrators and stakeholders have to do anything short of begging to get mentors to support outreach events. This is an experience expressed by stakeholders of some speakers bureaus, where faculty members and engineers are asked to set as little as one day aside to give a speech to school children, yet their heavy workload may not permit them the time to participate. In these cases, the organization may try making it a formal requirement that staff members participate in outreach activities. Possibly adding outreach to their job description may garner more support. As much as it would be nice to have volunteers for such a noble effort, the reality is that people sometimes have to be forced to contribute to things that they do not see as a direct benefit to themselves.

Another unique perspective is that of the school administrator. The administrator plays a key role in the upfront planning of the visit as well as serves as a host to the mentors while they are on the school property. They have the unattractive job of telling the teachers that there will be another interruption to their already-tight schedules, as they prepare for standardized tests such as Florida's Comprehensive Assessment Test (FCAT). During an interview with one particular school administrator, it was determined that there is a general consensus among school teachers that having an outreach mentor in the classroom serves as professional development for the teachers because they get to observe a different teaching style. However, he thought there was little to be gained from short-term programs, where the mentor only teaches one class. A more collaborative approach of planning and coaching to augment the observation would be better. In order to see any systemic change, such an approach would take time. Furthermore, he added that it is almost not worth the effort if there is not enough time for mentors and teachers to get together and plan the lesson ahead of time. He believes many teachers would embrace the idea because they need help.

From the administrator's perspective, the main obstacles are (1) cost of material if the school is required to provide them, (2) scheduling conflicts with the mentors, and (3) fitting the outreach sessions into the regular school schedules.

## BEST PRACTICES

Successful education outreach programs usually have the hallmark of well-defined objectives, roles and expectations. Programs that are designed well, are those designed to address the real needs of the target community. It is imperative to involve all participants at the planning and design stage, forcing everyone to work together from the onset. Objectives that are defined by all the participants are better supported, become more meaningful, prove more effective, and result in a bigger payoff. Being brought in the middle, or after the design and planning stage is not efficient and can be disruptive, if not detrimental to the program.

As mentioned earlier, not every outreach program is successful, and there are those that are eminently successful. Discussed in the section are the best practices and lessons learned from some of the most successful outreach activities of 21<sup>st</sup> century. The success measure here is closely tied to the percentage of obstacles that were surmounted.

Assessing the success of an outreach program is tricky. In addition, if the program is not elaborate enough, understanding the effect it has on the school and students may not be even possible. It was found through research that the American Institutes of Research (AIR) and a partnership called Building Engineering and Science Talent (BEST) found a way to rigorously assess Math and Science outreach programs. The programs were rated on a 4-tiered effectiveness scale depending on the number of research studies that were conducted on each program, and subsequent positive or negative results. The highest possible rating was labeled 'verified,' indicating five credible studies were conducted on the program and that they all returned positive results. The other ratings were labeled 'probable,' indicating two or more studies with positive results and no major negatives. The bottom tier was labeled 'further research investment'. BEST and the AIR did not find any outreach programs worthy of a 'verified' rating. Of the twenty programs they examined, the highest rating was the second-highest, 'notable' effectiveness. [2]

The seven programs deemed notable were compared and contrasted to determine any

common denominators that would correlate to their success. These were considered best practices that can be used to remove some of the obstacles that lie in the way:

- Distilling usable insights about the program to the following principles:
  - Defined outcomes
  - Persistence
  - Personalization
  - Challenging content
  - Engaged adults
- Deepening the knowledge base of the program
- Tightening the links between research, policy and practice
- Aligning system wide and targeted approaches

The best practices mentioned above came from the BEST research. One thing the programs had in common was consistent expectations between all the parties involved.

There are navigation techniques that are tried and true for any successful undertaking. One of the most important is communication. Although the positive impacts of taking the message of math education to the students is obvious, care must be taken to explicitly communicate them to the people who have the ability to sustain or end the project—the stakeholders and school administrators. The uniqueness of this situation however, is that the message has to match the recipient. That is to say, one has to take into consideration that the stakeholder has a need to hear something different from what the school administrator needs to hear. Hence, the navigation techniques discussed covered in this paper are those that have worked consistently in various programs and have realized some measure of success.

A good navigation technique is to get international attention for outreach programs. After all, there is a crisis in the making here. The world is getting more technologically advanced, and it takes math and science to keep up with the demands of technology. One way to accelerate the schools' efforts is to take the math message to the schools, using qualified engineers, mathematicians and scientists.

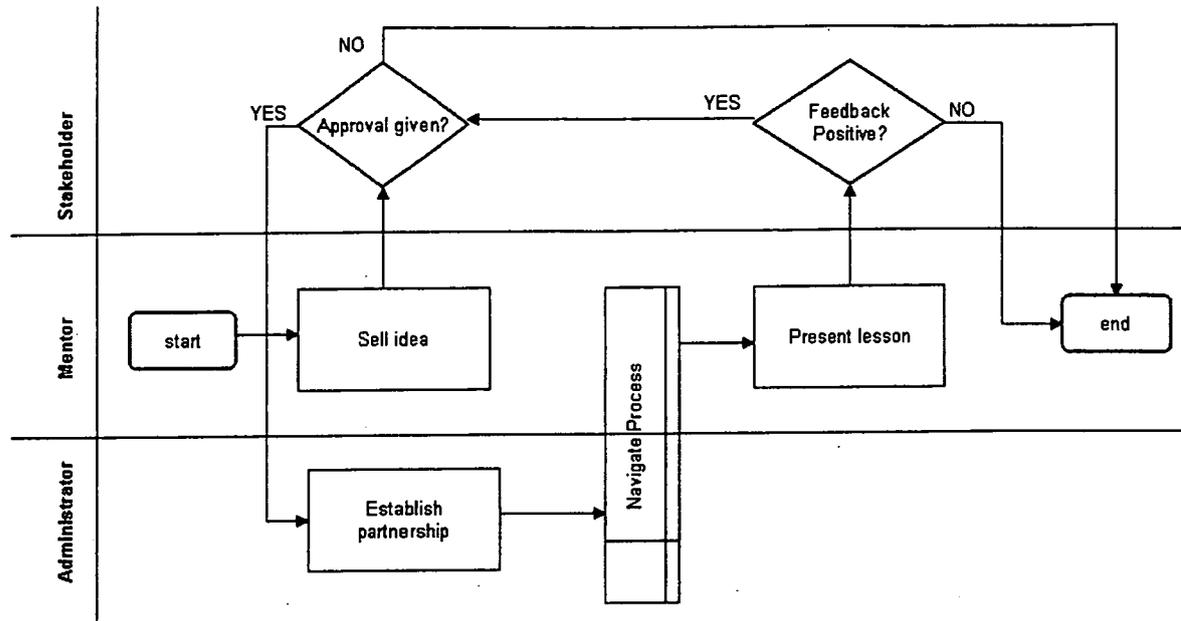


FIGURE 1  
SCHOOL OUTREACH PROCES FLOWCHART

#### ACKNOWLEDGMENT

The authors wish to thank school administrators who graciously opened their classrooms to accommodate the outreach mentors. For providing the resource and venue to compile this work, appreciation is extended to the US Air Force, the National Aeronautics and Space Administration, and the Florida International University College of Engineering.

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