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From Kickoff to Handoff: Coaching Teens to Tackle STEM Literacy

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From Kickoff to Handoff: Coaching Teens to Tackle STEM Literacy

Abstract

This article discusses how intensive, content-rich, multiple-day conferences for teams of youth and their adult coaches can be used to initiate the training and planning needed for teens to successfully serve as STEM teachers. The concepts are based on three 4-H "teens as teachers" projects that included 29-36.5 hour initial training conferences. Teenagers (173) completed pre/post surveys on STEM knowledge, skills, careers, resources, and teaching ability. The teenagers exhibited increases in these areas for all three conferences. The authors discuss the common elements of these conferences, provide implementation examples and suggest resources that support this type of training.

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Introduction

The purpose of this article is to demonstrate how a conference-based training design was used to prepare teens to teach younger youth STEM education activities in their local communities. The training design was based upon principles outlined in *Staffing with Teenagers and Teens as Cross-Age Teachers Promising Practices* (Ripberger & Blalock, revised 2013). While the conferences discussed in this article were implemented at a national level, these ideas could be easily replicated at state and even local levels.

Teens as Teachers

Since 1986, 4-H Youth Development Programs have been systematically training teenagers (Groff, 1992) to deliver a wide variety of programs (healthy living, job readiness, science, etc.) to younger youth (Bird & Subramaniam, 2011; Ripberger, Bovitz, Cole, & Lyons, 2008; Ripberger, Devitt, & Gore, 2009; Smith, Meehan, Enfeld, George, & Young, 2004; Strong, Christensen, & Carter, 2008; Utah State University Cooperative Extension, 2011). Lee, Murdock, and Paterson (2002) studied 14 teens as teachers programs and identified 12 essential elements of programs that lead to positive outcomes for the teen teachers and those they teach. The essential elements relevant to this article include: (a) curriculum, (b) initial training, and (c) preparing teens for success.

Several resources have been created from their work to support 4-H professionals as they develop

teens as teachers programs. These resources include a 4-H Afterschool resource guide to help practitioners recruit and train teenagers to work with younger youth in afterschool settings (Junge, 2005) and a more concise 4-H Science fact sheet, *Engaging Teens as Teachers through Youth-Adult Partnerships in 4-H Science* (Schmitt-McQuitty, 2012).

Project Description

This article discusses three STEM teens as teachers kickoff/training events, Teens Teaching Youth Biotechnology (January 2012), the National Youth Summit on Geospatial Technologies (September 2013), and the National Youth Agriscience Summit (January 2014). Conference content emphasized understanding of the STEM area, career awareness, community resource awareness, and teaching confidence. All training conferences included intensive programming with full immersion in varied perspectives or applications (e.g., public interest, commercial, governmental, etc.) of the STEM field under consideration. In addition to presentations and tours from training partners, teen/adult teams also experienced several activities from suggested curricula and practiced teaching these activities on the last day. The conferences included time to brainstorm ideas for teen recruitment, training, and program implementation.

Teens Teaching Youth Biotechnology

This was a 4-day program held in Indianapolis, Indiana designed to prepare teens and their adult partners to conduct biotechnology and agriscience literacy activities for youth in afterschool, club, and summer/camp programs in their home communities. Teen/adult teams were provided opportunities to: learn more about new and emerging areas of biotechnology, understand issues surrounding development of biotechnology products, interact with corporate biotechnology personnel as well as college students in biotech programs, explore industry facilities, increase skills in 4-H Science program design, and improve teaching and facilitation skills.

National Youth Summit on Geospatial Technologies

This was a 5-day training held in suburban Washington, D.C. for high school teens interested in Global Positioning System (GPS), Geographic Information Systems (GIS), and Remote Sensing (RS) technologies. The ultimate goal of the summit was to prepare teens and their adult partners to facilitate the Maps and Apps National Youth Science Day and other GIS activities. Teams learned several applications of geospatial technologies in agriculture, climate, defense, emergency preparedness, natural resources, navigation, parks and recreation, planning, and transportation. In addition, they had opportunities to interact with leaders in geospatial technologies, and to visit geospatial organizations and exhibits in the Washington D.C. area.

National Youth Agriscience Summit

High school youth and their adult partners interested in becoming Champions for Agriculture in their communities attended the 5-day summit held at the National 4-H Youth Conference Center in Chevy Chase, Maryland. At the conclusion of the summit, teams were to return to their home communities prepared to help increase the agricultural literacy of the general public as well as key local

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stakeholder groups. The teams learned about issues related to production of food, feed, fuel, and fiber, with an emphasis on the rapidly emerging areas of animal and plant sciences and technologies. Participants were introduced to various challenges facing agriculture, including global food security and sustainability, and teens learned how they could begin to address those challenges today and in the future. The summit provided multiple opportunities for participants to interact with agricultural scientists, researchers, leaders, politicians, and advocates, and allowed them to visit agricultural organizations in the Washington, D.C. area (e.g., U.S. Department of Agriculture, University of Maryland College of Agriculture and Natural Resources).

Conference-Based Training Design

The trainings described above were developed using practices outlined in the *Staffing with Teenagers and Teens as Cross-Age Teachers* chapter in *4-H Science in Urban Communities Promising Practices Guide* (Ripberger & Blalock, revised 2013). While the referenced publication identified promising practices in four areas: (a) program planning and evaluation, (b) recruitment, (c) training, and (d) resources and support, the focus of this article is on training and resources and support (Table 1).

Table 1.

Components of Conference-Based Training Design (Ripberger & Blalock, revised 2013)

Item	Details
1. Provide quality training for teens and their adult partners (training).	Ensure enough time is planned for training teens *and* the adults who will be supporting them. Provide enough training to ensure the outcome desired, but not so much that it overwhelms the teens. Plan trainings according to the developmental state of the teens. Teens respond better when they are part of developing the plan and implementing the solution. • Require adult partners to attend trainings. • Allow time for teens to plan program delivery. • Include teambuilding initiatives for teens *and* adult partners. • Model skills and behaviors you want participants to emulate. • Use experienced teens as co-trainers.
2. Supportive adult partners are a critical factor in great teen	They should understand the program goals and philosophy. A supportive adult should be present when a teen is teaching, to provide moral support and to assist should something unexpected happen. Look

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teaching (resources and support).	for adults who: • Have a strong rapport with teens, • Can gently pose ideas to consider, • Are good listeners, and • Enjoy teenagers.
3. Provide research-based curricula and materials (resources and support).	Materials should be teen-friendly, easy to follow, and suitable for teens working in pairs or teams to present in a variety of settings.
4. Ask youth to visualize the teaching process (training).	Help them think through the lesson, including what they might need and how they will present the activity. Ask teens to brainstorm about the kinds of unexpected occurrences they might encounter and how they would handle them. Problem-solving ahead of time increases teens' ability to deal with problems when they occur, but avoid simply presenting them with solutions.
5. Group youth into teaching teams (training).	Assigning teens into teaching teams creates greater comfort for them as they plan and implement lessons. It also builds a sense of accountability – to each other. Allow teens to work with whomever they choose. • Create teams with 2-4 teens and 1 adult coach/partner. • Pair a more experienced teen teacher with an inexperienced teen. The experienced teen can mentor the new teen. It is the experienced teen's responsibility to move the new teen through the process (counselor-in-training concept).
6. Create opportunities to practice (training).	Practice takes extra time but is a vital component of a successful teaching experience. Make suggestions and offer resources that strengthen what and how they are teaching. If there are multiple teens teaching multiple workshops, have them present lessons to

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	each other, and guide a constructive discussion after each presentation. This creates a learning community as well as a teaching support system for them to access before, during, and after their teaching experience.
7. Assist teens in reflecting on their teaching [teachback] experience (resources and support).	When teens reflect on their teaching responsibility, they identify their strengths as teachers and areas upon which they need to improve.

Quality Training for Teens and Their Adult Partners

Based on previous work by Lee, Murdock, and Paterson (2002) and Ripberger and Blalock (revised 2013), quality, high-context trainings include immersion programming in order to provide teens with a deeper understanding of STEM content. With that in mind, the training conferences described above included from 29 – 36.5 hours dedicated to enrichment and skill-building activities.

The training conferences featured keynote speakers, workshops, field trips, and panel discussions. Invited keynote speakers included leaders and/or policymakers in their content areas from STEM corporations and government agencies. Experiential workshops were planned to show the full scope of the content area and were often tied to the upcoming teachbacks. Field trips were planned to bolster career awareness, highlight cutting-edge research and technologies, and demonstrate real-world applications. Visits were made to laboratories, STEM corporations, museums, government agencies, and universities. Panel discussions provided opportunities for youth to learn about and discuss current STEM issues and career pathways. Panelists included corporate and university scientists and college students in STEM fields.

Throughout these program components, STEM professionals demonstrated enthusiasm and passion for their fields. In addition, teen/adult teams were exposed to high quality, engaging teaching methods that the teens could easily replicate in their own STEM literacy education programs.

Teambuilding was a critical part of the conference trainings. Teambuilding activities were designed to foster reliance between peer and adult partners. Activities included ice breakers and group challenge initiatives, and all workshops required partners or small group teams to meet the objectives.

High-quality training conferences include opportunities for teen and adult teams to begin planning their community-based STEM events. Examples of these events include round robins, science activity stations, afterschool programs, Science Saturdays, etc. The teams were asked to think about what their event would look like, the who, what, when, where, and how of the STEM educational program. A brainstorming session about available community resources (supplies,

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funding, expertise, volunteers, etc.) was an important component of the planning process. The University of California 4-H Youth Development Program has a Youth Service Learning Project Planning Guidebook (2012) that is an excellent resource to facilitate the planning process.

Supportive Adult Partners

The importance of having supportive adult partners in attendance at the trainings cannot be overemphasized. The adults functioned as coaches, managing expectations, instilling self-confidence, providing feedback, and guiding the teens to successful outcomes. Where possible one or more STEM area partners should attend as well. These content rich partners can lend expertise on curricula, help identify resources, and even provide facilities for activities. The Biotechnology training specifically required teen/adult teams to include content rich-partners in addition to the 4-H professional.

Research-based Curricula and Materials

It is important to identify suitable curricular resources before the conference. Activities should include easy-to-understand (and complete) documentation, should be easy to implement by teen teachers, and should be age-appropriate for the youth they will be teaching. The use of 4-H curricula is encouraged.

Curricula that would/could be used for community-based STEM literacy activities were introduced and practiced at the training conferences. Either a materials kit or a comprehensive list of materials needed for each activity was provided to each team. Curricula training was implemented a bit differently at each conference, but a major commonality was the introduction and implementation of as many lessons/activities from the curricula as possible. This allowed teens to experience the activities, and promoted a level of confidence in their ability to replicate the activities with younger youth.

Teens Visualize the Teaching Process

Visualization can be a powerful tool for success. Teen/adult teams were asked to visualize their community STEM literacy programs and record the results on flipchart paper. They were asked to brainstorm answers to the following questions:

1. What does it (successful programming) look like?
2. What do you (teens) do?
3. What do you (teens) need?
4. How would you know it was excellent STEM learning?

The resulting teen-generated list provided teens with a guide to review prior to teaching and a tool to reflect upon performance after teaching. Table 2 provides an example of this technique (answers

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were not edited by the authors).

Table 2.

Teen Generated Checklist for Successful Out-of-School Time Science Programming (4-H Science Ambassadors, 2013)

What does it (successful programing) look like?	
• Simple, fun, and interesting activity • Informative • Well-organized • Creative and original • Age appropriate • Different techniques used for learning • Safe • Excitement in room	• Participant involvement/engagement • Teamwork • Connected • Focused • Participants helping each other • Teens walking around and helping • Active communication • No one is sleeping
What do you (teens) do?	
• Ensure student activity will be fun as long as they follow directions and behave • Teach in a fun and educational manner • Make it interesting • Not be shy • Project your voice but don't scream • Speak their language • Eye contact when speaking • Set a good example	• Provide explanations • Give tips • Don't give too much help • Engage the children • Get everyone working together • Get the kids to ask questions • Let students voice their opinions

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• Act appropriately • Be disciplined and responsible • Must be prepared and organized • Know information ahead of time • Facilitate • Well given instructions • Break it down into small steps • Connect the ideas	• Allow students to use creativity • Show respect toward the students • Listen to the students' ideas • Let them figure out the science • Include scientific vocabulary • Be sensitive • Use humor • Attentive • Friendly
What do you (teens) need?	
• Knowledge of the subject • Organization • Be prepared • Lesson plans • Budget • Supplies • Space • To know how many children you are teaching • Ages of children • Light refreshments	• Interaction with the students • Respectful students • Willing learners • Kids participation • Public speaking skills • Time management • Loud voice • Sense of humor • Enthusiasm • Patience

• Communication	• Big smiles
How would you know it is* excellent STEM learning*?	
• The students' make connections with the lesson and daily life • The students had fun, but still learned something from your lesson • By how much new vocabulary is learned • How well the students answer the questions • Being able to properly teach the information back	• Completion of project/the physical product • Thinking about/solving problems • They remember it • Recommendation • Asks you to return • Out of class curiosity • Activities are hands on

Group Youth into Teaching Teams

In each of the three conferences the teen participants paired up or broke into small groups to form teaching teams. They were asked to include less experienced or less knowledgeable teens with teens who had more experience and/or content knowledge. Paired and small group teams allow teens to support each other and reduces some of the anxiety associated with public speaking. In addition, the more experienced teens serve as role models for the newer teens.

Opportunities to Practice—Teachbacks

The culminating component of each of the three training conferences was the teachback session. Each teaching team implemented an activity from the previously demonstrated curriculum. Teaching pairs were assigned to rooms in a way to allow multiple activities/lessons in each room. This strategy not only allowed teens to practice teaching, it also provided a practical review of several lessons (or all) from the curriculum. The teen teachers taught the activities to the other teens and adults in the room as if the lesson was new to the audience.

Teens Reflect on Teaching (Teachback) Experience

After the teachback, adults facilitated feedback from the group. Teens and adults at two of the training conferences used the previously generated visualization checklist as a guide to assess performance. Positive comments were requested first, followed by constructive feedback.

Methods

While the emphasis of the trainings was on helping teens transition from conference participants to STEM educators, it was recognized the transition would be easier if teens felt more confident in their subject matter knowledge and skills (teens self-selected into the program, so interest levels were already high), as well as their ability to teach. Participants completed anonymous paper and pencil pre- and post-training questionnaires developed by the authors that included items on understanding the STEM area, career awareness, community resource awareness, and teaching confidence.

The Agriscience and Geospatial surveys used Likert type questions (1=strongly disagree, 5=strongly agree) to assess the items, while the Biotechnology training used a four-point scale (1=strongly disagree, 4=strongly agree). Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Statistical significance was computed using paired *t*-test analyses.

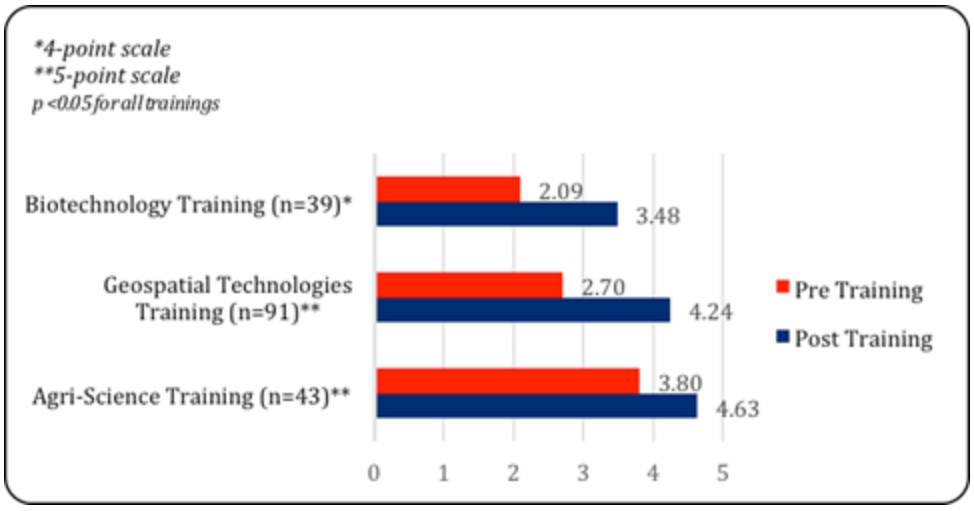
Results

In all, 173 youth from the Agriscience (n=43), Geospatial Technologies (n=91) and Biotechnology (n=39) trainings completed both the pre- and post-training surveys. Results reported here are for the four individual items relevant to this article: understanding of the specific STEM area, career awareness, community resource awareness, and teaching confidence. The difference between the pre -and post- questionnaires for the four items were significant at the $p < 0.05$ level.

Teens were asked to rate how strongly they agreed or disagreed with the statement "I understand [the science or technology of the STEM Area]." For each of the three conference trainings, teen participants exhibited increases in level of understanding of their specific STEM content areas (see Figure 1).

Figure 1.

I Understand This STEM Area *(1=strongly disagree, 5=strongly agree)*

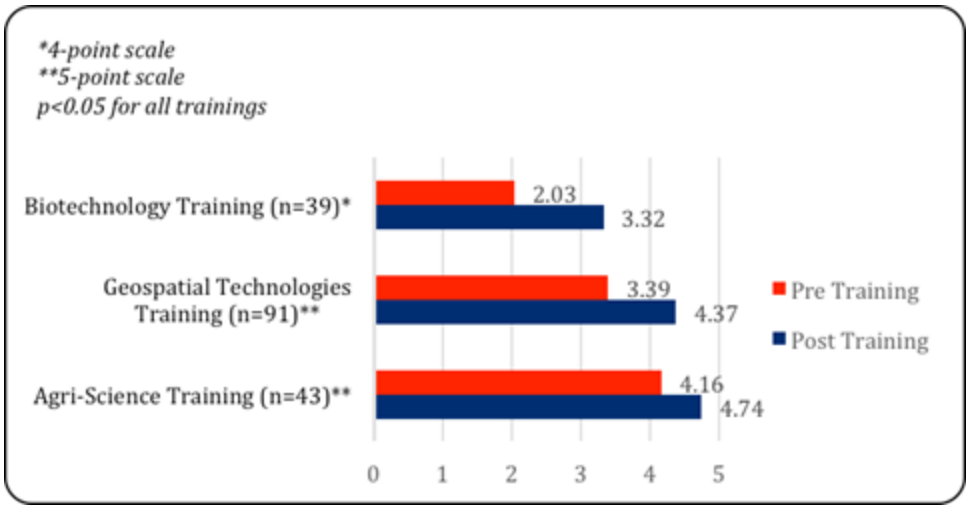


Teen participants from all three conference trainings were also asked to rate how strongly they

agreed or disagreed with the statement "I am aware of careers [in the STEM Area]." Response rates indicate the teens exhibited gains in awareness of career pathways for their specific STEM area (see Figure 2).

Figure 2.

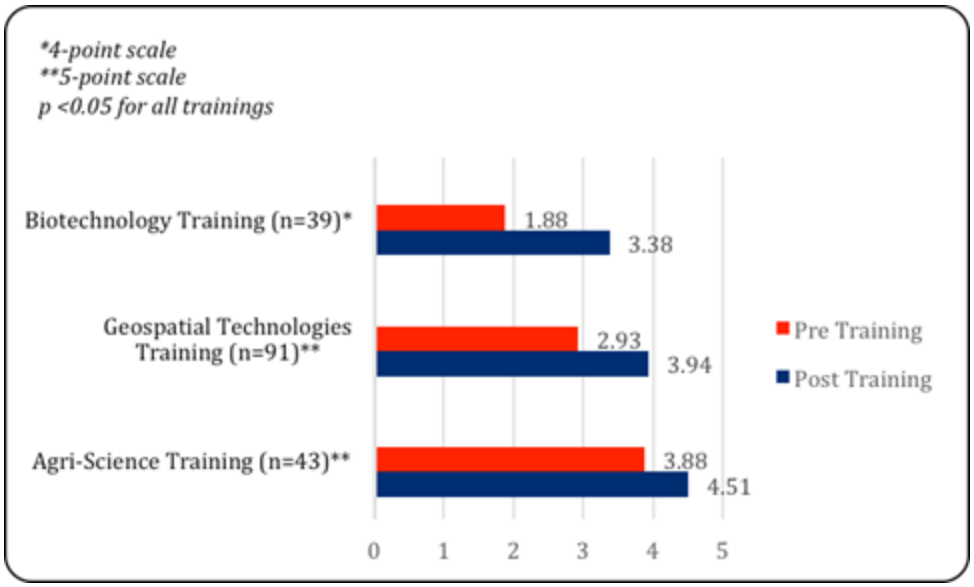
I am Aware of Careers in This STEM Area *(1=strongly disagree, 5=strongly agree)*



The ability to identify community STEM experts was an important outcome of these trainings. Teens were asked how strongly they agreed or disagreed with the statement "I know where to find people in my community who can help me with projects [in this STEM area]." For each of the three conference trainings, teen participants demonstrated they felt more confident about locating experts in their content areas (see Figure 3).

Figure 3.

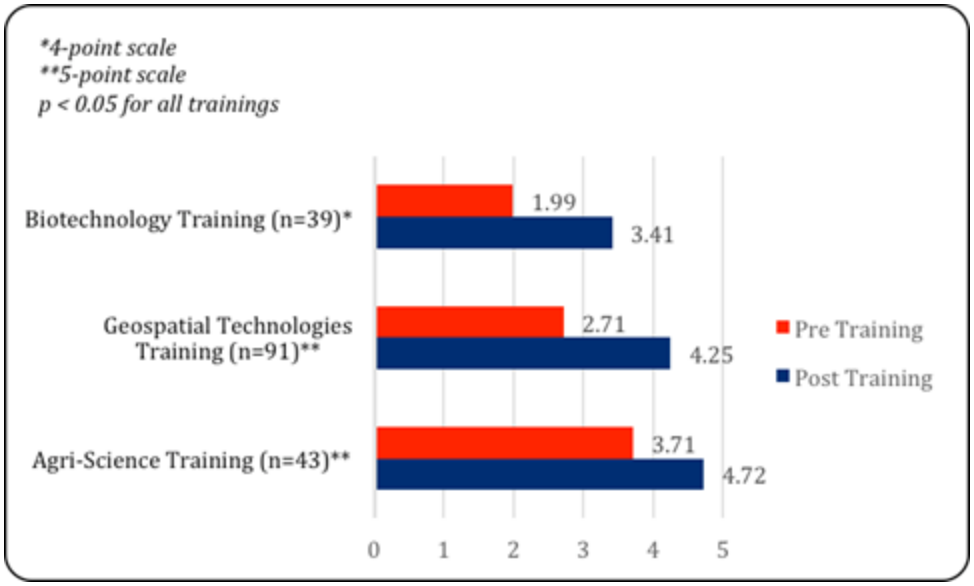
I Know Where to Find People in My Community who Can Help Me with Projects in This STEM Area *(1=strongly disagree, 5=strongly agree)*



The overall purpose of the conference trainings was to provide teens with the tools and confidence needed to implement STEM literacy projects in their home communities. Teen participants from all three conference trainings were asked to rate how strongly they agreed or disagreed with the statement "I am confident I can teach others about [the STEM Area]." Response rates indicate gains in confidence to teach others about the STEM content areas (see Figure 4).

Figure 4.

I am Confident I Can Teach Others About This STEM Area *(1=strongly disagree, 5=strongly agree)*



Discussion

The goal of the Agriscience, Biotechnology, and Geospatial Technologies conferences was to prepare teens to teach younger youth STEM education activities in their local communities. The trainings provided STEM-immersive experiences designed to deepen and broaden teens' understanding of the content areas as well as instill confidence in their teaching/facilitation abilities.

Understanding the STEM Content Area

STEM programming is designed to serve as enrichment to (not remediation of) classroom learning. Teens must have a deeper understanding of the content area than the youth they are teaching in order to feel competent (Lee, Murdock, & Paterson; 2002). Teens are better informed, confident teachers when they are able to fully appreciate and understand how the multi-faceted pieces (emerging technologies, career pathways, cutting edge research, etc.) of the STEM area come together to form a cohesive picture.

Achieving an appropriate depth and breadth of STEM content understanding through this kind of intensive, immersive programming requires resources: time (including a minimum of 30 hours of programming), money, content-rich partners, supplies, curriculum, etc. Unfortunately, there are no shortcuts. The payoff, however, for these efforts is priceless: (a) teens are competent, confident, and excited about their teaching/leadership roles and, equally important, (b) 4-H professionals have

an increased capacity to deliver high-quality STEM literacy programs (Groff, 1992). Fully trained teens are not only able to help meet program delivery goals, but they become an additional resource for future trainings in the STEM area.

Where to Find Help

Another benefit of intensive programming with multiple types of activities (keynote speakers, panels, workshops, field trip) is that teens are better equipped to broadly imagine or brainstorm where to find content-rich partners and resources in their home communities. This helps to lessen (or even eliminate) anxiety when planning their own STEM educational events.

Career Awareness

The importance of the variety of exposures to STEM experts, organizations, research, and technologies cannot be overemphasized. The teens were able to speak with multiple STEM professionals and see where they worked, which gave them a broader knowledge of possible career pathways. Not only will this exposure help teens clarify future directions and career choices, it also provided additional perspectives with which to develop a complete picture of the STEM field. Again, this depth and breadth of knowledge means they are more likely to understand individual activities in terms of the bigger picture. This in turn helps them become better teachers, as they are better able to point to the real world relevance of the activities.

I Am Confident I Can Teach Others

The discussion thus far has repeatedly emphasized the importance of developing teens' confidence in the subject matter and their teaching abilities. That the teens reported increased confidence provides justification that the intensive, immersive programming was effective.

While understanding the context of an activity is just as important as knowing how to deliver the activity, providing the teens with opportunities to practice teaching (teachbacks) is also critical. It is a disservice to teens to demonstrate one or two activities and then send them on with a materials list or kit to teach. Providing opportunities for them to teach while at the conference allows them to get positive feedback and constructive comments for improvement in a safe, supportive environment. The teens left the conference feeling confident in their knowledge and teaching abilities.

The idea of using conferences as kickoff/training events need not seem overwhelming. Conference trainings can be centralized, with state level personnel responsible for organizing and implementing the event. Utah State University 4-H has done just that with their TRY (Teens Reaching Youth) STEM trainings (Utah State University Cooperative Extension, 2011). Purdue developed core teen/adult training teams after the Biotechnology conference to assist with future trainings.

When the results—increased teen confidence coupled with increased capacity to deliver STEM literacy programs—are reviewed together, it is easy to justify the cost in time and resources given the outcomes/outputs.

Limitations

As discussed previously, the teen/adult teams were immersed in as many STEM experiences as possible during the 29-36 hours of the conferences. This was an intense schedule, and there were no dances or other traditional teen conference offerings to provide levity amidst the trainings. Even so, what was not systematically captured by the evaluation was the sheer excitement and enthusiasm the teams exhibited during and at the close of the conference. This article also does not address either the ongoing training and support needs required by teens, or how the teens as teachers model eventually moves the teen from teacher to leader.

Recommended Resource

4-H Extension professionals are on a constant quest to locate high quality training materials. One resource that the authors will use in future projects will be the Teens as Teachers website for teens and the adults who support them, developed by the University of Illinois Extension. This website includes short videos, presentations, worksheets, logs, and virtually everything conference planners need to provide high quality training (e.g., planning science activities, tips for teachbacks, visualizing the teaching process, teaching reflection log, etc.). The website is available at http://web.extension.illinois.edu/4hteenteachers/

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