

# **An Aviation-Themed STEPS Camp for Engaging 7th Grade Girls: Assessment Summary**

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## **Abstract**

The STEPS Camp for Girls at Grand Valley State University (GVSU) is a four day introduction to science, technology, and engineering. The main objective of the camp is to increase the number of females, particularly those who are members of additional under-represented groups, entering the engineering profession through building self-esteem, confidence, and self-efficacy; increasing content knowledge and interest in engineering, science, and technology; and nurturing teamwork in each camper.

A 10-year tracking study on the impact of the camp showed that 47% of camp participants claim an interest in a science related career versus 18% of a comparable peer group. Most of the participants responded that STEPS showed them aspects of science, technology, engineering and mathematics which increased their interest in those fields. Furthermore, participants responded that STEPS helped narrow their focus on career options or introduced new career options.

Pre and post-tests showed improvement in content knowledge in aerodynamics, airplane parts and their functions, and process plans. The post camp student impressions survey, conducted one month after graduation, revealed that 20% of the campers learned something new about themselves. A parent impressions survey provided validation evidence that camp goals were met.

Keywords: STEM, Conference Proceedings, K-12 Outreach, Assessment

## **Introduction**

Women and members of other under-represented groups such as African-Americans and Hispanics can have successful careers in engineering and technology. An under-represented group within a profession is distinguished by a characteristic such as gender, race, or national heritage and comprises a significant smaller percentage of the members of that profession than of the general population. However, while women comprise 47% of the labor force, only 14% of professional engineers are women (Bureau of Labor Statistics, 2011). This discrepancy is fostered by a lack of positive role models and support systems; a lack of knowledge of science, technology, engineering and mathematics (STEM) careers available; and a misunderstanding of the importance of good math and science education in pursuing a STEM career.

The Science Technology & Engineering Preview Summer (STEPS) enrichment program at Grand Valley State University (GVSU) is designed to address these issues (Maas, Standridge, and Plotkowski, 2013). The student services group within the Seymour and Esther Padnos College of Engineering and Computing (PCEC) operates the program which for seventh-grade girls through week-long day camps. About 40 girls attend each of two sessions. In the past 11 years, 945 girls have successfully graduated STEPS.

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An overview of an earlier version of the GVSU STEPS camp is provided by Plotkowski, Sheline, Dill, and Noble (2008). Kundrat and Choudhuri (2006) discuss a methods engineering improvement study for the airplane construction portion of the camp. In addition, Bennett (2012) describes a similar aviation themed STEPS camp at the University of St. Thomas. The original aviation themed STEP camp at the University of Wisconsin – Stout is described by Bee, Puck and Heimdahl (2003). A retrospective discussion and assessment of the first 10 years of the camp is provided by Bee, Puck and Heimdahl (2007). The first 16 years of the same camp are reviewed by Puck and Stary (2012).

An overview of the GVSU STEPS camp is provided. Assessment activities are described with summary statistics provided:

1. A 10-year longitudinal study of changes in camper perceptions about STEM as well as career choices
2. An evaluation of increase in student knowledge of the technical content of the camp
3. Post camp surveys of campers and their parents or guardians

### Camp Overview

GVSU offers several co-curricular and summer enrichment K-12 outreach activities (Plotkowski, 2010) including the STEPS camp. Many, such as the STEPS camp, are offered in partnership with the local community, such as the activities described by Pawloski, Maas, Meyers, Standridge, and Plotkowski (2011).

The STEPS camp uses radio controlled airplanes to help the girls learn about aviation, physics, aerodynamics, chemistry, manufacturing and assembly processes. During the camp, the girls are mentored by female students in a STEM track, taught by qualified faculty and are guided by community volunteers to assemble and modify their airplanes.

The program has three stated educational and student development goals:

1. Build self-esteem, confidence and self-efficacy. By instilling confidence in the girls, we hypothesize that they will thrive in their current educational environment and will be more willing to try new things in the future.
2. Increase interest in STEM and knowledge in these areas.
3. Nurture teamwork. STEPS campers are picked by lottery from a pool of applicants and then are randomly assigned to one of four teams. Throughout the week, the girls learn to rely on their teammates in both one-on-one and group settings.

The STEPS camp is designed to achieve a balance between technical, developmental and recreational activities for the campers. The campers are engaged with technical classes in computer aided design (CAD), computer numeric control (CNC) machining, aerodynamics, and webpage design. Airplane construction continues to improve each year.

The camp is supported widely by the local community. Alcoa Howmet in Whitehall, MI, provides tours, activities and the opportunity to interact with a significant number of female engineers. At Rapid Air at the Gerard R. Ford Airport in Grand Rapids, MI, the campers fly in a four-seat Cessna aircraft under the guidance of Blue Sun Air of Zeeland Charter Township, MI. The campers also toured the Alticor corporate hangar, where they were able to watch the landing of both a fixed-wing plane and helicopter. The last stop was a tour of the West Michigan Aviation Academy (WMAA).

The camp culminates with a fly night during which each girl flies the plane she has built under the direction of a member of the Warped Wings Model Airplane Club of Allendale, MI, and the West Michigan Soaring Society of Sparta, MI.

Throughout these activities, campers are introduced to female role models who serve as counselors, lead teachers, speakers, activity leaders and volunteers. The campers also meet female high school students through a FIRST Robotics demonstration and the field trip to WMAA. The camp is supported by a female GVSU student worker.

### Long-Term Assessments

In this section, the findings supported by the long-term, 10-year, assessment of the camp are discussed (Community Research Institute, 2012). This discussion focuses primarily on the second educational and student development goal: Increase interest in STEM and knowledge in these areas.

A twenty-one question telephone survey was conducted with participants from the 2002, 2003, and 2004 cohorts following their high school sophomore year, high school senior year, and two years after high school graduation. The survey contained questions about participant interest in science, math, and engineering majors; their beliefs about potential success in science, math, and engineering careers; interest and success in high school math and science courses; plans for pursuing a college degree; and, if they did pursue a degree in science, math, or engineering after high school graduation as well as participant demographics. Respondents were asked to agree or disagree on a one to 10 scale, with one meaning completely disagree, and 10 completely agree.

Participants also received a Contact Information Update form. Those who completed and returned the form received a \$10 Barnes and Noble gift card. Participants who completed the telephone survey received a \$20 Barnes and Noble gift card.

Perhaps the most important assessment question is whether the STEPS camp influenced a choice of a science career. In the 10-year tracking study, 47% of the STEPS campers ( $n = 117$ ) claimed an interest in a STEM career. By contrast consider the percent of women college freshman who indicated an interest in science and engineering. The 2002, 2003, and 2004 STEPS camp cohorts correspond to freshman entering college in 2008, 2009, and 2010. For these years, National Science Board (2012) data shows the following: 2008, 16.7%; 2009, 17.5% and 2010, 19.7% or an average of 18.0%. Thus, the proportion of STEPS campers interested in a STEM career is significantly larger, over 2.5 times, than in the general postsecondary population ( $p < 0.00001$ ). This provides evidence that the second goal of the STEPS camp is being achieved: Increase interest in STEM.

A second survey question was related to the first: *I think I will major in a science, math, or engineering field.* Table 1 contains a summary of the average responses to this question by year.

**Table 1: Average Response by Year of Interest in a STEM College Major**

Year	Number Responding	Average Interest Score
2007	52	7.9
2008	43	7.8
2009	23	7.4
2010	32	6.4
2011	14	7.1
2012	14	6.3

The average response shows a noticeable decline over time. These results suggest that participants gradually lose interest in STEM careers over time.

Two related questions are the following:

- I have enjoyed my high school math courses.
- I have enjoyed my high school science courses.

Table 2 contains a summary of the average responses to these questions by year.

**Table 2: Average Response by Year of Interest in a STEM High School Courses**

Year	Number Responding	Average Math Interest Score	Average Science Interest Score
2007	52	7.9	8.9
2008	43	7.8	8.4
2009	23	7.7	8.8
2010	32	7.2	8.0
2011	14	7.9	8.9
2012	14	7.2	7.5

Note that the average response to each question declined noticeably over the course of time as did the average response to the question about pursuing a STEM major in college. That is, the more time that passed after camp involvement, the less positive the campers are about enjoying high school math and science courses.

Thus, a connection between enjoyment of high school science and math courses and intent to major in these fields needs to be considered. The nearly equal reduction in mean scores between enjoyment of high school math and science courses and choosing to major in those fields suggests that strategies may need to be developed to help make high school math and science more interesting and/or enjoyable to students to augment the momentum begun in the STEPS program.

### Under-Represented Populations

Participation by female who are also members of other populations under-represented in the engineering profession is a priority and value of the GVSU STEPS camp with a target

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participation level of 30%. Recruiting efforts include visiting three racially diverse middle schools in the greater Grand Rapids Public School (GRPS) District, making classroom presentations to students and interested teachers, and attending parent-teacher conferences to meet and interact with 6th grade teachers and parents. These efforts are supplemented by Grand Valley’s Educational Support Program, TRiO which helps students overcome socioeconomic, social, academic, and cultural barriers to higher education. The TRiO middle school advisor works within the middle schools to support communication with students, parents, teachers, and administrators. In addition, free van transportation for the campers from Grand Rapids Public Schools is provided.

As seen in Table 3, the participation level of under-represented populations has ranged from 14% to 38% per year, exceeding the target level of 30% in three of 11 years. The participation level was 23% or higher in 10 of 11 years. Thus, recruitment efforts continue in this regard.

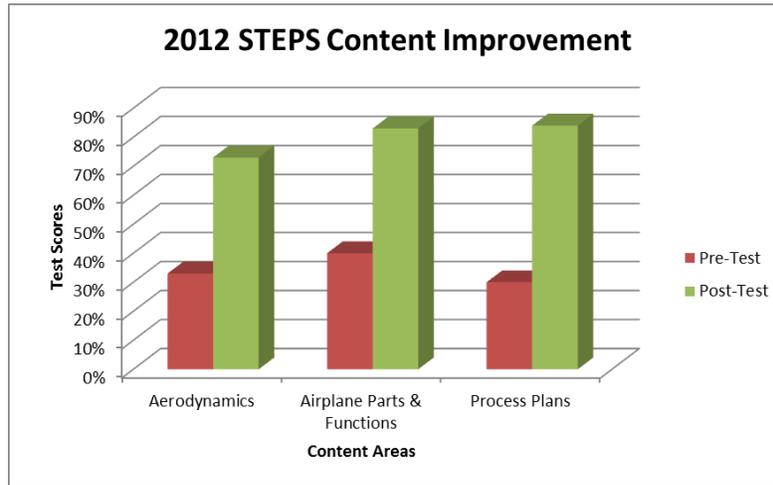
**Table 3: Participants from Under-Represented Populations**

<b>Year</b>	<b>Campers</b>	<b>Campers from Under-Represented Populations</b>	<b>Percent from Under-Represented Populations</b>
2002	84	23	27%
2003	79	19	24%
2004	74	25	34%
2005	82	27	33%
2006	78	22	28%
2007	79	11	14%
2008	79	21	27%
2009	74	28	38%
2010	80	18	23%
2011	86	20	23%
2012	80	19	24%

**Annual Assessments**

Assessments concerning the experience of campers in each camp are done annually. Pre and post tests are utilized to assess content knowledge in aerodynamics, airplane parts and their functions, and process plans. Pretests are done at the beginning of the week, while post tests are done at the end of the week. The 2012 campers (n=80) demonstrated an increase in content knowledge in Aerodynamics by 40% (33% to 73%), Airplane Parts and their Functions by 43% (40% to 83%), and Process Plans by 54% (30% to 84%) as showed in Figure 1. Each of these differences is statistically significant ( $p < 0.00001$  for each). These results provide evidence that Goal 2: Increase interest in STEM and knowledge in these areas was successfully addressed.

Figure 1: STEPS Content Improvement in 2012



A post camp student impressions survey is conducted one month after camp graduation. Student impressions survey questions were strategically developed with the camp goals in mind. The campers are asked to rank various aspects of the camp including learning activities, recreational activities, staff, counselors, instructors, and volunteers, with comments welcomed. The campers may also offer accounts on their personal growth experience. The survey questions in italics and typical responses follow.

*What have you learned about yourself as a result of participating in the camp?*

- That I enjoy Aviation, and loved the challenge
- I am very interested in and am considering a career in math or science.
- I can do more than I thought and I could be a great engineer.
- I can make a difference and I have potential.
- I learned that it is important to try new things (like engineering)

*Has your perception of engineering changed after camp? How?*

- Yes, I don't know there were that many fields.
- Before camp when I thought of engineering I [thought] it was a job for men. Now I realize women can do it too.
- I understand more things you can use for math and science more
- Yes. Made me feel more powerful and that I could make a difference.

*How has STEPS influenced your confidence in studying science and math?*

- It helped me understand that they are important studies.
- It made me want to learn more about them.
- Showed me more fun ways to use science and math.
- It has helped and made me feel able to succeed even more!
- STEPS influenced my confidence in math and science by making me realize that math and science is [interesting] to study, it's not boring.

*What related activities have you signed up for or thought of signing up for outside of your normal classes as a result of your experience at STEPS*

- My schools [Robotics] team is something I am interested in.
- Woodshop class.
- Maybe a Robotics or Film camp.
- I was in the structures magnet at North Rockford Middle School in the sixth grade and that inspired me to potential so I signed up for STEPS and I signed up to take a Tech 1 elective class next year.
- I have considered West Michigan Aviation Academy.

Further, at least 20% of the campers will report something new that they have learned about themselves as a result of participating in the camp.

A parent impressions survey is designed to evaluate the overall camp experience and to also gage the enjoyment level of their child. There are nine question areas for the parents/guardians who are also encouraged to leave comments and suggestions for improvement. The open-ended questions in the surveys validate all three of the goals in the project design and provide much-needed feedback for the STEPS steering committee. Typical responses follow.

- Camper name was excited to go every day. All the activities [were] very exciting, especially the airplane ride- it was her first. She has talked so much about the high school opportunity.
- My daughter is seriously considering a career in the math/science fields now! Thank you =)
- Excellent program and very fun! Am recommending it to all 6th grade girls that I know =)
- Wow! Thx for a top notch experience- everything was awesome- thx to all who volunteered to make it possible! What a blessing for Syd to have this experience!
- Thank you for offering this program to my daughter. I think it is great to get girls involved in science and math, and make it fun
- My daughter was very excited about everything she did and learned. I am very intersted(sp) in finding additional oportunities(sp) for her. Where do I find such things??? While she still has an interest!

### Summary

The GVSU STEPS camp for girls entering seventh grade provides a four-day introduction to science, engineering, and technology via an aviation focused experience. It is designed to achieve a balance between technical, developmental and recreational activities. All of these activities are supported by numerous community organizations and individual volunteers, many of whom are females working or studying in the STEM professions. The camp culminates with a fly night during which each camper flies the radio-controlled airplane she has built during the week.

The target participation level for under-represented populations is 30% in each year. The actual participation level has ranged from 14% to 38% per year from 2002 through 2012 and was

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23% or higher in 10 of these 11 years. Thus, additional recruiting efforts in this regard are required.

Campers from 2002, 2003, and 2004 were invited to participate in a 10-year tracking study. The study showed that the STEPS camps influenced the choice of a career in STEM, 47% of campers versus 18% for the general female population. Additional tracking study survey questions showed that interest in a STEM college major as well as expressed enjoyment of high school mathematics and science courses decreased over time after participation in the camp. This suggests that reinforcement of the positive influence regarding STEM gained from the camp is necessary during the middle and high school years.

There is an annual assessment for each camp as well consisting of pre-instruction and post-instruction tests regarding technical content, post camp student impressions survey, and a post camp parents impressions survey. In 2012, the tests showed that content knowledge at least doubled in each of three areas: aerodynamics, process plans, and airplane parts and their functions. The student impressions survey results typically show that at least 20% of the campers feel they have learned something new. The parents impression survey results show that parents and guardians perceive that their daughters had a positive and influential experience in the camp.

Overall, the STEP camp at GVSU has proven to be an effective mechanism for increasing the interest in STEM for girls entering middle school.

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