AC 2008-634: INVOLVEMENT OF STEM PROFESSIONALS IN THE CLASSROOM ENHANCES EFFECTIVENESS OF SAE INTERNATIONAL'S A WORLD IN MOTION CURRICULUM

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As Manager of K-12 Education Programs for SAE International, Mr. Miller (Matt) leads a team of educators in the development and distribution of SAE's award winning A World In Motion® (AWIM®) program which joins together teachers, students, and volunteer engineers/scientists in an exploration of physical science.

Before his employment at SAE, Matt developed a passion for educating the country's youth in the STEM fields. As a middle school teacher in Pittsburgh, PA he taught math, science and technology courses to students from grades five through eight (1996 – 2001).

In 2001, prior to his involvement with AWIM, Matt joined SAE International's Publishing Group as a Product Developer where he focused on developing and managing a number of SAE electronic products. In 2004, Matt's fervor for education brought him to SAE's A World In Motion program as a Program Developer, and in this role he trained thousands of teachers and volunteers across the United States and Canada in the AWIM curriculum.

Matt Miller holds a Bachelor of Science degree in Elementary Education from Indiana University of Pennsylvania, and a Master of Science degree in Instructional Technology from Duquesne University. Matt is certified by the Commonwealth of Pennsylvania in Elementary Education (K-6) and as an Instructional Technology Specialist (K-12).

Matt is also a proud veteran of the U.S. Army (1989 – 1992) including Operation Desert Storm.

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Elizabeth R. Bachrach, Ph.D., Senior Research Associate and Manager of GRG West Coast Office, joined GRG in January 2000 as a Research Associate, with a strong background in child development and educational media and technology. She became a Senior Research Associate in 2002 and began heading up GRG's Los Angeles-based West Coast office in 2005.

Dr. Bachrach has designed and managed over 35 projects at GRG, ranging from national outreach initiatives accompanying public television series and documentaries to multimedia educational packages, and professional development workshops and distance learning for K-12 teachers. In addition to managing multiple projects, she has written proposals and designed evaluation plans for projects that have received funding from the NSF, NIH, and HHS, and serves as an internal consultant on several evaluations.

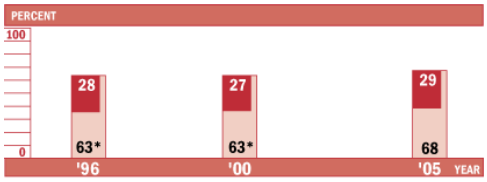
Dr. Bachrach earned a Certificate of Completion from RIVA (Research in Values and Attitudes) Moderator Training and has expertise conducting focus groups with children and adults as well as evaluating classroom curriculum materials and local news products. Dr. Bachrach earned a doctorate in Developmental Psychology from Brandeis University, where she studied the development of children's cognitive abilities with a focus on their attention to and comprehension of media. She earned an A.B. in Psychology at the University of Michigan.

Involvement of STEM Professionals in the Classroom Enhances Effectiveness of SAE International's *A World In Motion*® Program

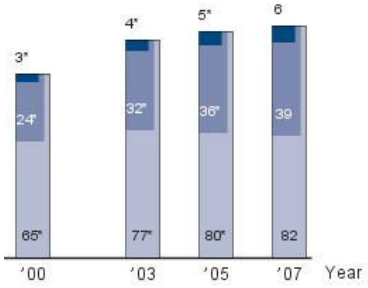
Introduction

Each year, fewer young people are choosing to direct their curiosity and intelligence toward the study of science, technology, engineering and math— widely regarded as imperative skills in the 21st Century. This is evident given that fewer than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in science, and nearly one-fifth of the 4th graders and one-third of the 8th graders lacked the competence to perform basic mathematical computations[1].

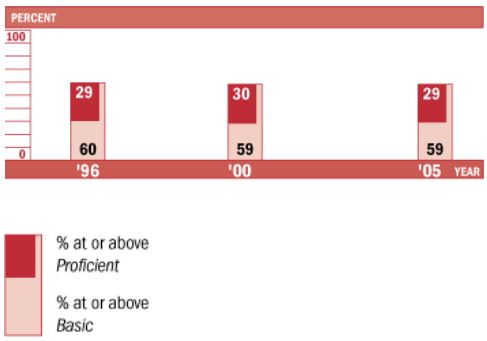
US 4th Grade Science Achievement (NAEP)



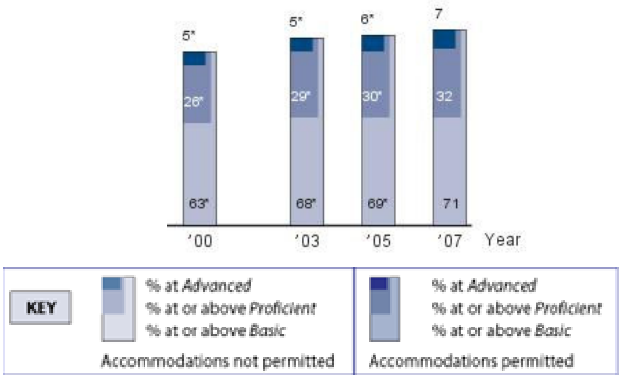
US 4th Grade Math Achievement (NAEP)



US 8th Grade Science Achievement (NAEP)



US 8th Grade Math Achievement (NAEP)

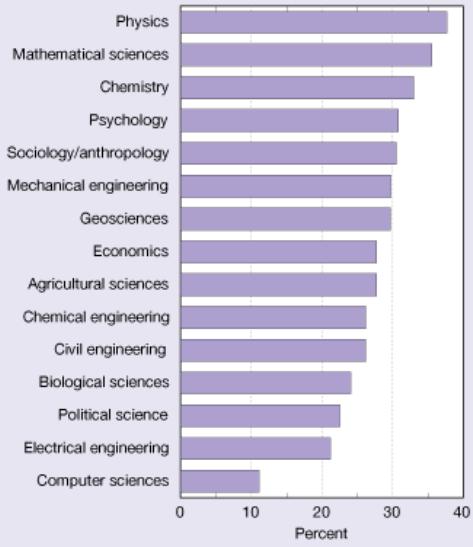


The inability to engage students, even those as young as elementary school, in these core subjects has resulted in an emerging crisis for the technical, scientific and engineering disciplines. Not surprisingly, a loss of interest in these important academic subjects leads to a decline in scientific literacy among the general public, slowing our nation's technological and economic advancement.

This loss of interest in math and science leads to a reduction in the number of students pursuing science and engineering degrees at the college level. For example, from 1985 to 2001, the U.S. experienced a decline of over 20% in the number of degrees granted in engineering[2]. This trend

has continued during a time when the number of retiring scientists and engineers is dramatically increasing (twenty-nine percent of all S&E degree holders in the labor force are age 50 or over[3]).

Figure 3-34
Employed S&E degree holders older than 50, by selected field: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT), preliminary estimates (2003), http://sestat.nsf.gov.

Science and Engineering Indicators 2006

The result is a significant and growing gap between the supply of and the demand for qualified engineering graduates, which serves as the talent pool of the future workforce in North America.

SAE International

For over a century, SAE International has served the professional needs of engineers and transportation needs of humanity. Since 1905, mobility pioneers have led initiatives and expanded the impact of the society. Membership in this international technical society has steadily increased, and today more than 90,000 SAE International members – including engineers, scientists, business executives, educators and students from 97 countries – share information and exchange ideas for advancing the engineering of mobility systems.

In 1986, the SAE Foundation was established to connect corporations and classrooms by giving Science, Technology, Engineering and Math (STEM) professionals, teachers, and students the opportunity to work together and learn from each other by bringing authentic engineering design experiences into elementary and middle school classrooms. Four years after the establishment of the SAE Foundation, SAE International developed and released the *A World In Motion*® program with the goal of improving students' aptitude and attitudes in science, technology, engineering and math.

A World In Motion

In 1990, SAE International released its first set of *A World In Motion* (AWIM) educational materials. Included in this program were projects aligned with the educational standards for grades 4, 5, and 6. The curriculum is a set of challenges designed to provide students in grades 4–6 with an engineering design experience, as well as to promote an interest in mathematics, science, and technology by giving students opportunities to work with materials that embody scientific and technical phenomena. The challenge put forth in each of these experiences involves student design of a toy vehicle. Engaging scenarios provide a context in which students develop problem-solving, science, and math skills. As student design teams work to get their toy vehicles to meet specified performance criteria, they wrestle with authentic science, math, and engineering problems.

Building on the enthusiastic reception of the materials, SAE International was awarded a renewable grant from the National Science Foundation for the development of middle school science curricula known as the Motorized Toy Car and Glider Challenges. Through private resources and industry support, the Electricity & Electronics Challenge was developed in 2003. The Motorized Toy Car and Glider activities serve grades 7 and 8, respectively, while Electricity & Electronics contains materials suitable for grades 4 through 10. Each of the kits remains true to the engineering design experience and is modular so that it can be successfully integrated into the classroom over the course of several class sessions.

Since 1990, it is estimated that the *A World In Motion* program has reached nearly 4 million students in all 50 U.S. states and every province in Canada. SAE International has provided more than 60,000 free AWIM kits to teachers and involved over 17,000 industry volunteers in the program.

The following is a summary of the activities in each of the *A World In Motion* (AWIM) Challenges:

Elementary School Grades 4 - 6	*Skimmer Challenge*: The goal of this Challenge is to design a set of paper skimmers (sailboats) that reliably meet specific performance criteria. Friction, forces, and the effect of surface area are some the of the physical phenomena students encounter in this challenge. *JetToy Challenge*: This activity challenges students to design an appealing toy that performs in a specific way; for example, the toy must travel far, carry weight, or go fast. Students experiment with different chassis designs and nozzle sizes to determine their effect on the toy's performance while testing the relationships between energy, force, air pressure, friction, and air resistance. *Electricity & Electronics Challenge*: Students engage in activities that focus on principles of electronics by providing hands-on experiments in static electricity, batteries and capacitors.

Middle School Grades 7 & 8	*Motorized Toy Car Challenge*: This Challenge requires students to work together in engineering design teams to research, market and build a motorized toy vehicle. Students explore the math and science associated with gears and gear ratios and how the manipulation of gear trains will impact performance specifications of their motorized toy. It also integrates learning activities in science, math, technology education, social studies, and language arts. This activity gives students the opportunity to incorporate cognitive learning with creativity and imagination. *Glider Challenge*: Students' fascination with flight makes this Challenge a favorite classroom activity for upper middle/junior high students. These activities demystify the relationship between force and motion and the effects of weight and lift on a glider. Students gain comprehension of the relationships between data analysis and variable manipulations, and the importance of understanding customer demands. The curriculum content also focuses on problem-solving skills and career orientation emphasized in school-to-work initiatives. *Electricity & Electronics Challenge*: This middle school kit provides students with team activities that experiment with series and parallel circuits, magnetism, and an introduction to electronics.
High School Grades 9 & 10	*Electricity & Electronics Challenge*: This Challenge takes high school teams through in-depth experiments involving transistors and semiconductors, analog integrated circuits, and digital integrated circuits.

The AWIM Curriculum

The AWIM materials possess three unique attributes. First, all of the AWIM materials, including replacements for consumable materials that are provided with the kits, are supplied to teachers, schools, and volunteers who request them, free of charge.

Second, SAE International makes every effort to provide teachers with the opportunity to train with Master AWIM teachers to enhance their own understanding of the subject matter and delivery of the curriculum. This is crucial in the many schools where teachers are teaching subjects that are not within their certification or specialization.

Finally, the curriculum is written to include the participation of an industry volunteer in the classroom. While it is not necessary for strictly educational purposes to utilize the volunteer, it adds a sense of importance and excitement about the project for the students. SAE International

encourages its members, whether they are practicing engineers or not, to participate in their local classrooms. However, volunteering is not exclusive to the SAE membership; any interested and capable STEM professional who partners with a teacher and classroom will have an impact on the learning and interest of the students.

The Industry Volunteer

A key element in the AWIM program is the use of industry volunteers in the classroom. Volunteers who are science, technology, engineering, and math professionals are especially valuable as they can provide students with an awareness of the STEM professions. More importantly, STEM professionals serve as science and math content experts in the classroom where more than a quarter of U.S. math and science teachers lack full certification in their field or do not have a college major or minor in math or science[4].

The exploratory nature of the AWIM experience requires that teachers and volunteers facilitate student learning by presenting an engaging challenge through materials provided by SAE. This approach takes more time, but it leaves students with a deeper understanding and helps students develop the ability to frame questions and seek solutions.

As designed, it is the intent of SAE International that the AWIM industry volunteers contribute in many ways to student learning. First, by talking with the students about their professional work and bringing demonstrations, pictures, or samples of their work, AWIM volunteers provide a context in which math and science seem relevant and practical.

Next, volunteers also help to make connections between what students are doing in the classroom and what STEM professionals are doing in the workplace. Volunteers also provide insight to students on the importance of teamwork in today's work environment where members of design teams often have different backgrounds yet all are important in contributing to the overall project. Volunteers also help teachers to assess student understanding of math and scientific concepts allowing teachers to focus on areas of student strengths and weaknesses.

Finally, AWIM volunteers validate student work simply by being there to listen to students' thoughts, ideas and questions.

Over the past 19 years, SAE has collected a vast amount of anecdotal data demonstrating the success of the AWIM program and specifically the impact of the industry volunteer in the classroom. As a result of the success and growth of the AWIM program SAE became interested in determining, through a science-based research study, the long-term impact of the AWIM program on students and teachers.

The AWIM Study

Goodman Research Group, Inc., (GRG) a research firm that specializes in the evaluation of educational programs, materials, and services, has contracted with SAE to carry out an external evaluation of AWIM. The evaluation consists of a two-part multi-method longitudinal experimental study of the effects of the AWIM program.

First, GRG conducted a retrospective study of teachers and volunteers who had used AWIM materials in the past five years. This was followed by a four-year experimental study (currently in progress, in its third year) with students in grades five, seven, and eight, designed to compare short- and long-term outcomes among students who have and have not been exposed to the AWIM curriculum. One of the specific goals of the study is to examine how the involvement of industry volunteers impacts the experience, both for students and for teachers.

Evaluation Methods

Retrospective Research Design

During the winter of 2004-2005, prior to beginning the longitudinal study of AWIM, GRG conducted one-time post-only surveys with industry volunteers who had been involved with AWIM teachers and classrooms, and teachers who had ordered AWIM in the past five years. The retrospective study examined past AWIM users' satisfaction with the program and perceptions of its effectiveness in achieving its stated goals.

Longitudinal Research Design

GRG employed a three-group pretest-posttest experimental design for the first year of the longitudinal study. Teachers were recruited and randomly assigned to one of three experimental conditions:

1) **Veteran Group Teachers:** Had used AWIM in the past, and would use AWIM during the 2005-2006 Academic Year
2) **Novice Group Teachers:** Ordered AWIM for the first time, had never used it before, and would use AWIM during the 2005-2006 Academic Year
3) **Control Group Teachers:** Ordered AWIM for the first time, had never used it before, and would wait until the 2006-2007 year to use AWIM

Within each experimental group, teachers in three grade levels, corresponding to three different AWIM Challenges, participated in the study. Students and teachers completed surveys and feedback forms designed to describe the process of AWIM implementation in the classrooms and to measure the extent to which program goals were achieved, including both student and teacher outcomes. Students will be tracked and a follow-up paper survey will be sent to them each spring for the next four years, in order to examine their STEM-related path, interests, and pursuits.

This paper highlights study findings that relate specifically to how the involvement of industry volunteers affects the AWIM experience. After descriptions of the data collection and study samples and a summary of the typical AWIM teacher/volunteer working relationship, as described both by volunteers and by teachers, findings about the effects of volunteer involvement are presented from the perspective of volunteers themselves (from the retrospective study only), from AWIM teachers (from the retrospective and longitudinal studies), and from the students (from the longitudinal study).

Data Collection and Study Samples

For both the retrospective and the longitudinal studies, SAE provided GRG with databases of contact information for industry volunteers and teachers who had requested AWIM materials either in the past five years (i.e., for the retrospective study) or just before the first year of the longitudinal study. GRG sent correspondence to these contacts to describe the evaluation and to invite participation in the research.

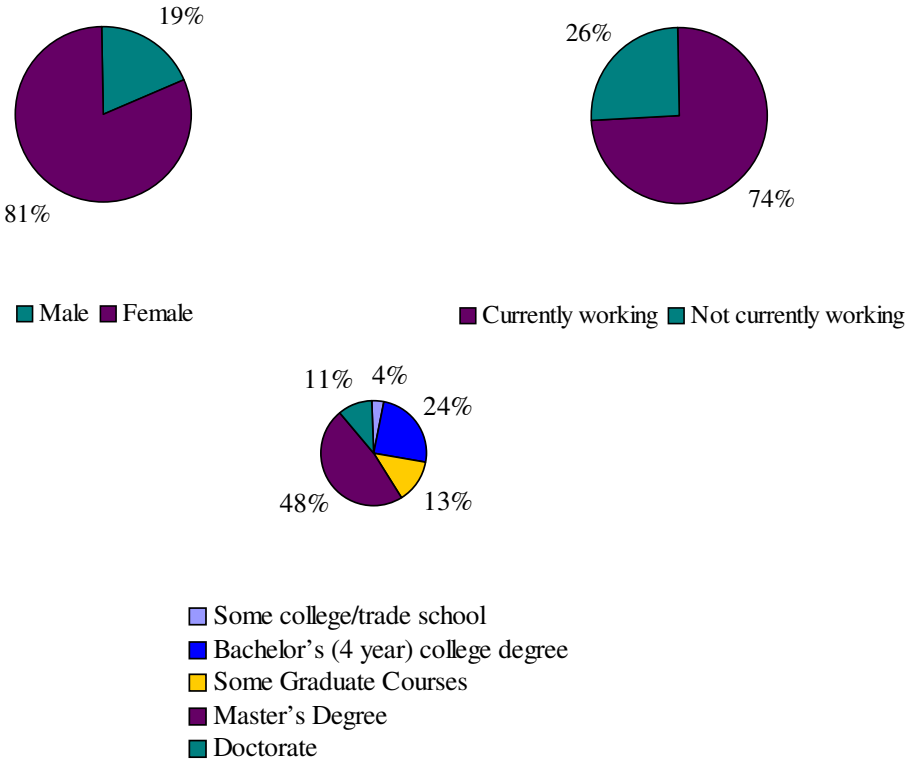
Industry Volunteers

For industry volunteers who had ordered AWIM materials directly or in conjunction with a teacher, GRG designed a paper survey to obtain information, from the volunteers' own perspective, about the contribution of industry volunteers to students' and teachers' AWIM experience. Survey questions addressed the following:

- demographic and background information
- how volunteers originally became involved with AWIM
- what their involvement has included
- how satisfied they have been with the experience
- their perceptions of students' response to their involvement

In all, 54 industry volunteers returned completed surveys to GRG[5]. As shown in the figures below, most were men and were currently working, with half (51%) in the automotive industry, nearly one quarter (23%) in education or education consulting, and 8% each working in aerospace and in engineering design or construction. Nearly half had completed a Master's degree, and one quarter had completed a four-year college degree.

Profile of Industry Volunteer Respondents
N=54



AWIM Teachers

For teachers who had ordered AWIM materials in the past five years (i.e., retrospective study), GRG designed, programmed, and launched a web survey to collect the following information:

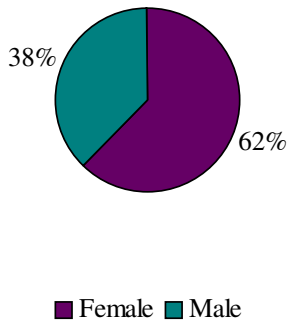
- demographic and background information
- current teaching style
- when and with whom teachers used AWIM
- if teachers had not used AWIM, whether they planned to in the future
- experiences with and opinions of AWIM
- perceived student interest in and reactions to AWIM
- experiences with industry volunteers
- perceived industry volunteer impact on their own teaching and on students

For the longitudinal study, teachers completed three separate online surveys. Pre-surveys were designed to obtain information about any previous experience with AWIM and their attitudes toward science and science teaching methods. Detailed implementation forms were designed for teachers to describe which specific AWIM activities they used and over how many class sessions. Post-surveys included information similar to the pre-survey, along with additional questions about perceived changes in teaching style, students' reactions to AWIM (or a typical science unit for Control teachers), and perceived impact of industry volunteers. A sub-sample of 11 teachers was interviewed by phone to share information about their preparation to use AWIM, modifications they made to the Challenge, student response to AWIM and the industry volunteer (if applicable), and overall opinions of their experience using AWIM. GRG conducted on-site classroom visits to eight AWIM classrooms to observe and record the structure of one class session and the student and teacher reactions to AWIM.

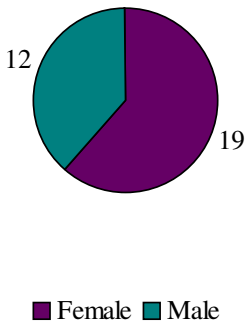
In all, 422 teachers completed the retrospective survey[6], and 33 teachers participated fully in the first year of the longitudinal study. In both samples, more than half of the teachers were women and the majority held a Master's degree or higher. See Figures below.

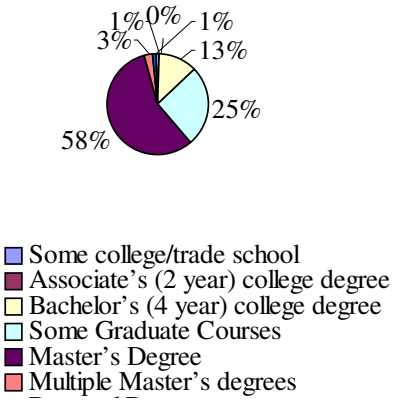
Profile of Teachers

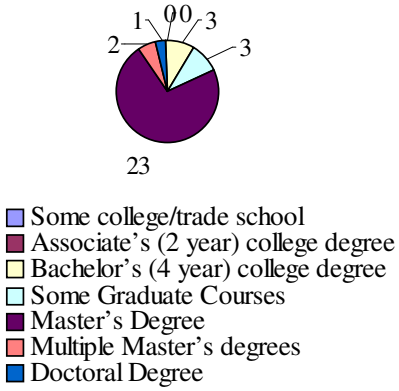
Retrospective Sample (N=422)



Longitudinal Sample (N=33)







The majority of teachers in both samples worked in a public school. The retrospective sample included relatively equal numbers of teachers in urban, suburban, and rural areas; the longitudinal study included teachers primarily in urban and suburban areas. See Table 1.

Table 1
Teachers' School Type and Setting

	% of Teachers Retrospective (N=417)	**# of Teachers Longitudinal (N=33)**
School Type		
Public	91%	26
Private	6%	4
Other (e.g., Charter, parochial)	3%	3
School Setting		
Urban	31%	15
Suburban	41%	14
Rural	26%	3
Other (e.g., mixed)	2%	--

Among the retrospective study teachers, about one quarter to one third were currently teaching 4th through 8th grade, and less than 20% each were teaching 9th or 10th grades. Among the 33 teachers in the longitudinal study, 22 participated with their 5th grade students, five teachers participated with their 7th grade students, and six teachers with their 8th grade students. Most longitudinal teachers were in the Veteran group (see Table 2) and had used AWIM at least one time prior to the study.

Table 2
Teachers in the Longitudinal Study

	Veteran	**Novice**	**Control**
5th Grade/ JetToy Challenge	10 (216 students)	7 (151 students)	5 (218 students)
7th Grade/ Motorized Toy Car Challenge	3 (32 students)	1 (94 students)	1 (69 students)
8th Grade/ Glider Challenge	4 (51 students)	1 (36 students)	1 (134 students)
Total	17 (299 students)	9 (281 students)	7 (441 students)

N=33

Teacher and Volunteer Partnerships

Among the retrospective sample, just under half (46%) of teachers reported they had partnered with an industry volunteer when conducting AWIM Challenges with their students. Among teachers who participated in the longitudinal study, nearly two-thirds (n=16) reported they invited a volunteer to visit the classroom; most were Veteran teachers, and a greater proportion of Motorized Toy Car and Glider Challenge teachers than JetToy Challenge teachers worked with a volunteer. Veteran teachers reported working with volunteers during more of their AWIM class sessions than did Novice teachers.

In both samples, teachers who had not worked with a volunteer reported that either they chose not to work with a partner, could not find a corporation to partner with, or did not feel they had the time or resources to locate a volunteer. Most expressed interest in seeking out such a partnership in the future.

Common Teacher/Volunteer Partnership Scenario

About two thirds of the volunteers reported they became involved with AWIM either through their own or their corporation's involvement with SAE. On average, volunteers had partnered with AWIM schools for five years (range = one to 15 years), and they had partnered with three different AWIM schools, on average (range = one to 12 schools). In their history of working with AWIM teachers and students, most industry volunteers had worked with students in grades 4 through 6 and worked on the elementary school activities.

Both volunteers and teachers described volunteer involvement with students at various points during the AWIM Challenges including at the beginning, when students first start working on the Challenge, in the middle, when students are conducting activities, and at the end, when students complete or present the activities. As stated by one representative volunteer, "*It's important to be present at all stages of the project to provide guidance and to be consistent.*"

Nearly two thirds (64%) of teachers reported that typically one industry volunteer works with their classrooms multiple times during the course of an AWIM Challenge; 29% said a volunteer typically comes in one time during the course of an AWIM Challenge and that the timing of that visit varies.

In the classrooms, volunteers typically spend time discussing their STEM-related careers with students, telling students about their own background, and helping teachers plan and execute the AWIM activities (See Table 3). Most industry volunteers (82%) also interact with teachers outside the classroom, primarily to plan and schedule activities and to introduce and explain the activities to teachers. Such interaction has been initiated both by the teachers and by the volunteers.

Table 3
Activities Industry Volunteers Have Conducted During AWIM School Visits

	% of Volunteers (N=54)
Discussed careers in science, technology, engineering or math (STEM) with the students	78%
Told the students about my own educational and career experiences	70%
Helped the teacher plan an AWIM Challenge activity	70%
Helped the teacher execute the AWIM Challenge activities	67%
Helped students conduct various AWIM Challenge activities	65%
Helped students start their AWIM Challenge	57%
Helped students present their completed AWIM Challenge	43%
Helped teacher with non-AWIM activities	35%
Executed my own planned activities	33%
Helped students with non-AWIM activities	24%

Benefits of Volunteer Involvement

Volunteers' Perspectives

Overall, volunteers perceived that the students enjoyed working on AWIM and that their own involvement added to this enjoyment. Most volunteers considered their own experience with AWIM to be successful and personally rewarding. In fact, volunteers reported they had worked with the same school for three to four years, on average, suggesting that strong and sustainable relationships are formed through the AWIM program.

Volunteers perceived positive student reactions to their involvement in the AWIM activities, from their interest in the activities to their interest in learning more about STEM topics in the future. Table 4 shows mean ratings of the extent to which volunteers believed several statements (i.e., AWIM's intended outcomes) accurately reflected students' reactions to their participation with the AWIM Challenges. Ratings were made on a scale from 1 *(Not at all)* to 5 *(Quite a bit)*.

Table 4
Volunteers' Perceptions of Students' Reactions to their Participation

	N	Mean ratings (Scale: 1 to 5)
My involvement made the activities more interesting for students.	43	4.44
Students were excited to have a professional working with them at school.	47	4.38
Students were excited to learn about STEM topics.	33	4.30
As a result of my visits, students have a better understanding of STEM concepts.	34	4.09
As a result of my visits, students seem to be looking forward to studying STEM topics in the future.	31	4.06

Overall, volunteers felt students reacted quite positively to the AWIM Challenges, with an average rating of 4.41 on a scale from 1 *(Did not enjoy it at all)* to 5 *(Enjoyed it a lot).* Several volunteers (n=22) shared some examples of students' reactions to support their rating. Table 5 presents the

general comments made by a subsample of volunteer respondents along with a few representative quotes.

Table 5
Volunteers' Comments about Students' Reactions to the AWIM Challenges

	% (N=22)	Representative Quotes
Students seemed excited to work on the activity and to show what they learned	36%	▪ *Always looked forward to the next week. Worked diligently during each session.* ▪ *Students on more than 1 occasion, when asked what they were doing, would light up and go into detail about the experiment and what they learned.* ▪ *They were excited to show me their products.*
Students (over time) told volunteer they enjoyed AWIM	23%	▪ *I had each child write me a short letter explaining what they learned and it surprised me how much they did learn and how thankful they were.* ▪ *Students continue to relate their experiences with me well after the fact.*
Students wanted to come to school/came to school sick to work on the Challenges	14%	▪ *Students would come to school sick to finish project* ▪ *Student expressed to his mom that he wasn't feeling good and she suggested he stay home and he said, "No way. I don't want to miss Mr. R's presentation."*
Students spent extra time working on projects	9%	▪ *A team of girls worked with me through recess time to better understand their steel can rover.*

Volunteers also rated their own overall impressions of the success of the AWIM Challenges positively; average rating was 4.23 on a scale from 1 (*Not at all successful*) to 5 (*Completely successful*). A few shared some general positive feedback about their experiences and suggested ways to enhance and sustain these partnerships between schools and industries. Some representative quotes follow.

> *My career at GM was very rewarding with many significant accomplishments; however, working with these students has provided the most personal satisfaction.*
>
> *Very rewarding to work with teachers in a workshop and even more to work with students.*
>
> *What satisfaction it is to be a role model for kids and help them know they can have a fun technical career.*
>
> *Get more SAE members involved. Once they do it they will probably be hooked.*

Teachers' Perspectives

Overall, teachers perceived that students responded quite positively both to AWIM in general, and to the involvement of an industry volunteer. They personally appreciated the extra technical support provided by having an industry volunteer in their classroom; they felt more confident and had more time to tailor the program and they described a more manageable workload and a positive working relationship. Teachers' suggestions centered around expanding the AWIM

program, helping to promote it in such a way that teachers and volunteers may easily connect with one another, and providing more training for both teachers and volunteers.

Teachers in both samples who had worked with an industry volunteer (N=172 in retrospective sample; N=16 in longitudinal sample) reported on the effects the volunteers' presence had on the teachers themselves, the perceived impact of the experience on students, and their perceptions of students' reactions to the experience of working with the volunteers. Using the same scale as volunteers, teachers in both samples also perceived that the intended outcomes for the industry partnership have been achieved.

Teachers' Perceived Personal Benefits

Teachers indicated the industry volunteers' involvement affected their teaching quite a bit. In both study samples, the greatest effect was seen in the assistance provided while conducting hands-on activities with students. Teachers in the retrospective sample focused on the technical support provided by volunteers, while teachers in the longitudinal study emphasized that having the volunteers there made it easier for them to lead the hands-on activities. Using a scale from 1 (*Not at all*) to 5 (*Quite a bit*) to rate the extent to which the industry volunteers' involvement affected their own teaching, all ratings were quite positive.

In the longitudinal study, Veteran teachers' average ratings were higher than those of Novice teachers. This may reflect Veteran teachers' familiarity and previous working relationship with the volunteers. Recall that volunteers report working with the same school, and likely the same teachers, for multiple years once they begin a partnership. Veteran teachers may have been better able to plan and refine the volunteer's role and responsibility based on past experience in order to make the most of the experience for themselves and their students. See Table 6 for average ratings made by both studies' teacher samples.

Table 6
Teachers' Ratings of the Influence of Volunteers' Involvement on Their Own Teaching

	Mean Rating Scale: 1-5		
	Retrospective	**Longitudinal**	
	N=161	**Novice N=5**	**Veteran N=14**
It was easier for me to lead the hands-on activities.	3.79	2.80	3.86
It was easier for me to work with students in small groups.	3.86	3.00	3.79
I had more technical support during the hands-on activities.	3.98	3.00	3.79
I learned more science content.	3.79	2.80	3.71
It was easier for me to guide students' learning.	3.74	2.80	3.71
It was easier for me to teach the science content.	3.72	2.60	3.71

In phone interviews with longitudinal study teachers, those who had worked with a volunteer described their experiences as positive; the volunteers had discussed career options with the students and helped with the AWIM activities. The teachers who did not work with a volunteer noted that they would like to in the future.

He was great. In the beginning he came in and did introduction, who he is, what he does. Had a little video of something they do at Toyota (e.g., crashing cars). Kids respected it. He was a good help. They liked that he was there. He came for final presentation. I would have liked to have him there more often – make it easier on me – especially on days the paraprofessional wasn't there.

He came out twice. At the beginning he talked about what he does and answered question on gears and flight. Then he returned for the final presentations. Our area is a depressed socioeconomic area, so kids who met an engineer hadn't heard of that before and didn't know about opportunities in engineering. It was good to talk about possibilities.

I would have loved one to come in but I didn't have enough time to schedule it. Already planning to have someone come in next year.

Perceived Impact of Industry Volunteer on Students

For both studies, while they saw clear personal benefits of working with a volunteer partner, teachers reported even greater benefits of volunteer involvement for their students. Across both samples, teachers assigned the highest ratings for the extent to which the volunteer motivated students to make real-world connections to the science activities and served as a role model for students. Using a scale from 1 (*Not at all*) to 5 (*Quite a bit*), even the lowest rated items were well above the scale midpoint. See Table 7.

In the longitudinal study sample, Veteran teachers rated each statement slightly higher than did Novice teachers. Again, this may reflect Veteran teachers' potentially longer established working relationships with the same industry volunteers.

Table 7
Teachers' Perceived Impact of the Industry Volunteer on Students

	Mean Rating Scale: 1-5		
	Retrospective	**Longitudinal**	
	(N=167)	**Novice (N=5)**	**Veteran (N=14)**
The volunteer taught students about the importance of teamwork.*	4.25	3.80	4.21
The volunteer served as a role model for the students.*	4.29	3.60	4.21
The volunteer motivated students to make real-world connections to the science activities.*	4.31	3.40	4.21
The volunteer taught students about the field of engineering as a career option.	4.25	3.60	4.14
Students were excited to have a professional working with them at school.*	4.29	3.60	4.07

** In the retrospective study, item was rated significantly higher by K-5 teachers than by 6-12 teachers.*

Perceived Student Reactions

Finally, teachers rated the extent to which several statements accurately reflected students' reactions to the AWIM Challenges as a direct result of an industry volunteers' involvement. As shown in Table 8, teachers assigned the highest ratings for their perception that the AWIM Challenges were more interesting (particularly among the retrospective sample), and that

students were more aware of STEM-related career opportunities and more excited to learn about STEM topics due to an industry volunteer's involvement in the activities. In the longitudinal study, Veteran teachers attributed slightly more positive student response to the volunteer than did Novice teachers; although all teachers believed the visits had a positive impact.

Table 8
Perceived Student Reactions to the Volunteer

As a result of the volunteer's involvement…	Mean Rating Scale: 1-5		
	Retrospective	Longitudinal	
	N=161	Novice N=5	Veteran N=14
Students were more aware of career opportunities in STEM-related areas.	4.09	3.40	4.21
Students were more excited to learn about STEM (science, technology, engineering, and math) topics.	4.01	3.40	4.14
Students had a better understanding of STEM topics.	3.96	2.80	4.07
AWIM Challenge activities were more interesting for students.	4.10	3.40	4.00
Students were more interested in studying STEM topics in the future.	3.90	3.00	4.00

Six of the seven longitudinal study teachers who were interviewed and had worked with a volunteer noted that their students asked a lot of questions and *"loved"* having the volunteer visit the classroom.

> *[The students] enjoyed it, respected him, and asked questions about how they could fix things.*
>
> *They loved it. They dressed up that day. The girls wore dresses like they were going to church. They were really excited. They really liked it. Both girls and boys enjoyed it.*

Students' Perspective

In the first year of the longitudinal study, about two thirds of teachers reported they worked with an industry volunteer in the classroom during AWIM activities. In the 2nd year of the longitudinal study (students only), just under one third (28%) of students who had used AWIM the previous year said they did not have someone visit their classroom during the AWIM Challenge. Nearly half (48%) said someone did visit the classroom, and one quarter did not remember whether a volunteer visited or not.

Among those who did remember a volunteer working with them (N=106), nearly three quarters (71%) believed they learned what engineers do and more than half (55%) said they became more interested in engineering as a result of the visits. More than one quarter (29%) said they wanted to find out more about engineering, and 31% said they decided engineering was not for them. Among those who said engineering was not for them (n=31), most were girls, and they were divided between students who had completed Challenge 1 in 5th grade and Challenge 3 in 8th grade in the first year of the study.

Examination of STEM-related attitudes and interests among students who did or did not recall whether a volunteer visited, revealed that students who did remember the volunteer visiting their classroom during AWIM activities agreed less strongly than those who could not recall, that engineers usually work alone. In other words, those who remembered the volunteers' visit were able to demonstrate some understanding of how engineers work, a year after meeting an engineer or scientist.

Preliminary Evaluation Conclusions

Based on findings from the retrospective study of AWIM use as well as the initial two years of the longitudinal study, we conclude that the AWIM program is perceived by teachers as well as industry volunteers to be affecting student learning and interest in STEM-related topics quite positively. The involvement of industry volunteers during AWIM implementation enhances both the teachers' and students' experience. Volunteers reported both personal rewards and the belief that their involvement adds value to the learning experience for both teacher and students. Teachers reported feeling more confident and more prepared to teach science after using AWIM and had more time to implement the program the way they wanted to when an industry volunteer assisted in the classroom.

Both teachers and volunteers felt that students were even more excited about AWIM and about STEM topics and were more aware of STEM-related career options when a volunteer had worked with them at some point during the Challenge. All teachers who worked with an industry volunteer believed the volunteer effectively taught the students about teamwork. A year after their experience, students who remembered working with an industry volunteer reported learning about what engineers do and expressed their own interest in engineering.

How SAE is Increasing & Improving AWIM Volunteerism

Recognizing the positive impact that industry volunteers have had in the AWIM program over the years, SAE has developed a strategy focusing on "Quality Usage" of the AWIM program. A significant portion of that strategy involves increasing the overall number of volunteers in AWIM classrooms as well as enhancing the volunteers' AWIM experience. Increasing and improving AWIM volunteerism has required the development of and access to AWIM Workshops, appropriate resources, and networking opportunities for AWIM volunteers.

AWIM Workshops

Through surveys of AWIM volunteers, SAE found that the major obstacle for volunteers entering the classroom was feeling as though they were unprepared to do so. As a result, SAE has developed AWIM workshops for both AWIM teachers and industry volunteers, in which the volunteers have the opportunity to interact with the AWIM curriculum, understand their roles and responsibilities, and meet the classroom teacher(s) with whom they will be working. Since 2006, over 2,100 industry volunteers have received training from SAE with over 95% of them going on to volunteer in an AWIM classroom.

Access to Resources

AWIM volunteers also conveyed their desire to have more information regarding the AWIM program in order to better prepare them for their classroom experience. In response to this common request, SAE identified existing AWIM resources, developed a number of volunteer implementation guides, created a volunteer forum and made all of the resources accessible to AWIM volunteers through the *A World In Motion* website: www.AWIM.org. Since 2006, over 3,000 individuals have registered for access to the AWIM website and its resources and thousands more have accessed the site as unregistered visitors.

AWIM Network Groups

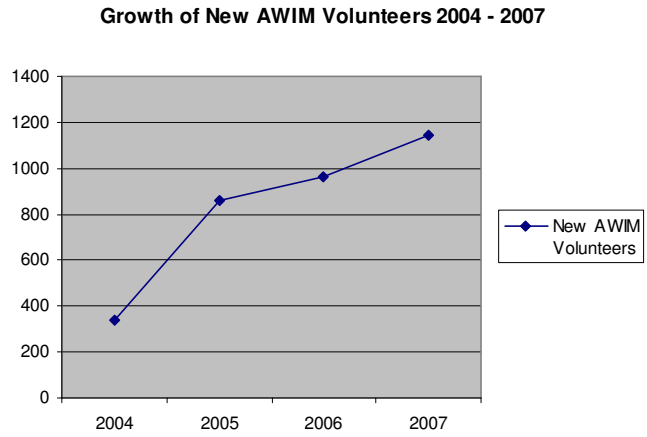
Until recently, many AWIM volunteers have been managing the logistics of their volunteering efforts independently, adding an unnecessary time burden for volunteers. In 2005, SAE established the AWIM Company Coordinators Team comprised of representatives of companies whose employees are engaged in the AWIM program. The AWIM Company Coordinators Team members work to promote a volunteer policy regarding AWIM within their company, manage the logistics of volunteer visits, coordinate AWIM training events, guide the development of online resources, and share best practices regarding the program. Since 2005, this group has coordinated the logistics of over 3,000 AWIM volunteers.

SAE local member sections also provide valuable resources and networking opportunities for AWIM volunteers. SAE sections host AWIM training sections, coordinate AWIM initiatives, and promote the program to schools and potential volunteers.

Since implementing these improvements to the AWIM volunteer experience, overall stated likelihood for AWIM volunteers to continue to participate in the program rose to 87% (up from 78% just two years earlier). Over half of AWIM volunteers now say they are very or extremely likely to continue participation[7].

Conclusions

Based on our own surveys and correspondence with AWIM teachers and volunteers, and on GRG's research findings to date, SAE International is dedicated to expanding its cadre of AWIM volunteers in the classroom as the program continues to grow. Since 1990, the estimated number of AWIM volunteers is well over 17,000. Recent trends indicate that the number of new AWIM volunteers is rapidly increasing.



*New AWIM volunteers are defined as individuals that have never registered for the AWIM program. SAE tracks AWIM volunteers through the AWIM Statement of Partnership which asks teachers to list their industry volunteer when they order AWIM materials.

From 2004 to 2007, the number of newly registered AWIM volunteers per year has more than tripled, while the total number of new AWIM volunteers from 2004 to 2007 has increased almost tenfold. These volunteers come to the program in addition to the thousands of volunteers that are already participating in the program. The combination of existing and new AWIM volunteers presents SAE with a strong foundation for expanded "quality usage" of the program in future years. However, with three new AWIM activities set to launch by the end of 2010, the challenge for SAE lies in retaining existing volunteers while recruiting additional volunteers each year. SAE feels that this can be accomplished by providing volunteers with access to the appropriate resources and tapping into its existing network groups, and disseminating study findings that support the value of this school and industry partnership. The benefits, as perceived by volunteers, teachers, and students, continue to make the strongest case for maintaining and enhancing the volunteer resources and networks.

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[2] National Science Foundation, *Science and Engineering Indicators*, 2006 http://www.nsf.gov/statistics/seind06
[3] National Science Foundation, *Science and Engineering Indicators*, 2006 http://www.nsf.gov/statistics/seind06
[4] National Science Foundation, *Science and Engineering Indicators*, 2006 http://www.nsf.gov/statistics/seind06
[5] In early December 2004, GRG mailed a paper survey to a randomly selected sample of 600 industry volunteers, followed by two postcard reminders. Several surveys (N=174) were considered "invalid," either because the surveys were returned due to an incorrect address (n=147) or because the recipient contacted SAE to let us know they did not have the appropriate AWIM classroom experience to be able to complete the survey (n=27); several of these volunteers took the time to tell SAE they were interested in AWIM and hoped to have the opportunity to work in a classroom in the future.
[6] In March 2005, GRG sent an email invitation that included a direct link to the survey to 1,766 teachers from SAE's database, followed by two email reminders. 475 emails were returned to GRG due to invalid email address and 26 people contacted GRG to say they would be unable to complete the survey.
[7] JD Powers and Associates, *SAE Global Membership and Customer Needs and Satisfaction Study*, 2007