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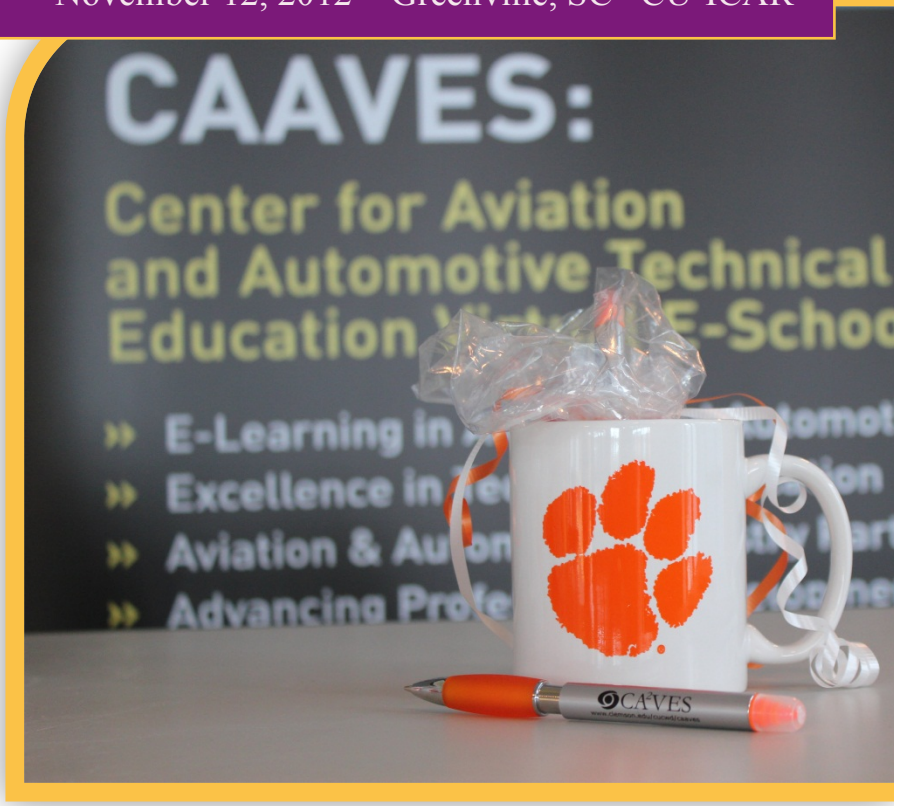
CA²VES

Center for Aviation and Automotive Technical Education using Virtual E-Schools

Upstate STEM Forum

November 12, 2012 Greenville, SC CU-ICAR



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CLEMSON CENTER FOR WORKFORCE DEVELOPMENT

SOUTH CAROLINA'S COALITION FOR MATHEMATICS & SCIENCE SCCMS - ACHIEVEMENT BY DESIGN -

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Executive Summary

On November 12, 2012 the Center for Aviation and Automotive Technical Education using Virtual E-Schools (CA²VES) hosted a science, technology, engineering and math (STEM) forum for educators at CU-ICAR in Greenville, SC. Partners for the event were the Clemson Center for Workforce Development, Clemson Office of Economic Development, the Youth Learning Institute, and the South Carolina Coalition for Mathematics and Science. Invitees to the day-long seminar included P-12 educators and representatives from technical colleges, industry and the legislature. In addition to an industry panel discussion, two breakout sessions were held with small groups identifying challenges and opportunities for improvement in the current STEM curriculum in South Carolina schools. At the end of each session, attendees were asked to complete a survey ranking the activities, programs, or resources they would most like to see CA²VES support. Analyzing the discussions and surveys from each of the sessions provided three key findings.

1. *Participants stressed that current curricula in elementary and middle schools are not preparing students well enough to succeed in STEM studies at higher levels.*

   Participants wanted to see more resources focused on bolstering reading and math comprehension. Once a strong foundation is laid, virtual reality modules, after-school and elective STEM programs, and student apprenticeships will have a greater chance of generating students' interest in STEM studies.

2. *Educators need adequate resources and training to foster a strong STEM learning environment within the current set of educational requirements.*

   Participants were very receptive to the idea of professional development programs that would educate them about the manufacturing industry and train them to incorporate such lessons into the classroom. Other requests for help related to learning how to create an integrated STEM lesson plan and workshops on writing grants. Additionally, nearly 100% of participants indicated they would be likely to use an online hub that provided a variety of

STEM resources such as career exploration for students and a list of industry speakers and contact information.

3. *The current perception of manufacturing in America must change. Resources need to be used to tackle the stereotypes and biases that exist around manufacturing careers.*

   Participants felt that students and parents, especially, must be shown that manufacturing is successful and respectable. In addition, working to encourage students to enter STEM fields could help diversify the population in the manufacturing industry. Apprenticeships, mentoring programs, grant funding, and marketing campaigns can all be sources of a positive impact on the way students and parents view manufacturing.

At the end of the day, participants completed a survey of the overall forum experience. Almost all of the respondents said they would recommend the forum to a colleague or participate again. Forum organizers and attendees left feeling optimistic about the opportunities for improvement in STEM education; however, it is important not to let the momentum generated by the conference stall. This forum brings CA²VES and its partners one step closer to advancing the future of STEM education in South Carolina schools.

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Overview of CA²VES

The Center for Aviation and Automotive Technology Educations using Virtual E-School [CA²VES] exists for the advancement of automotive and aviation technician education programs across South Carolina. CA²VES is comprised of Clemson University, the SC ATE National Center, Florence-Darlington Technical College, Greenville Technical College and Trident Technical College, and has established partnerships with SpaceTEC®, AMTEC, CARCAM, and many aviation and automotive industries throughout the state. The objectives of CA²VES are (1) creating a virtual e-school by expanding automotive and aviation (A²) technician education programs via innovative and cost-effective e-learning options; (2) increasing access in order to support recruitment and learning for automotive and aviation students through this SC- A² network; (3) broadly disseminating advanced technology e-learning modules for use by automotive and aviation technician education programs and industry; and (4) advancing the long-term workforce impact of CA²VES initiatives and programs. CA²VES will create a regional community of scholars among research universities, community colleges, P-12 educators and industry to implement the next generation of aviation and automotive manufacturing technology curricula. Results are expected to significantly improve student learning and to encourage underrepresented students at two-year colleges to study aviation and automotive maintenance. National Science Foundation Advanced Technological Education center partnerships will expand implementation and impact across the southeastern region and nationally.

In recognition of the importance of a system wide approach to A² technician education, CA²VES engages in P-12 activities, programs and partnerships. A broad range of P-12 experience and expertise has been built through partnerships with the following organizations:

The Youth Learning Institute at Clemson University operates over 100 programs annually all designed to provide hands on learning and leadership experience for youth and young adults. Since 1934, more than 250,000 participants have been touched by the vision of YLI; to learn more, teach more, and do more to change the culture of youth development.

The South Carolina Coalition for Mathematics and Science works together with advocates from industry, education, government and community organizations to promote quality in science, technology, engineering and math education (STEM) in South Carolina. Through advocacy, professional development, instructional material support,

innovation, and research and evaluation, SCCMS aims to make South Carolina a national leader in these fields of education.

The Clemson University International Center for Automotive Research (CU-ICAR) is an advanced-technology research campus where academia, industry and government organizations engage in synergistic collaboration. ICAR supports efforts to extend STEM opportunities in K-12 schools throughout South Carolina.

The Clemson University Office of Economic Development works with public and private partners to create jobs in SC, in keeping with Clemson University's teaching, research and outreach missions.

P-12 STEM Related Objectives of CA²VES

The P-12 STEM related objectives of CA²VES as described in the grant proposal are to create, implement, and disseminate innovative ways to bring STEM education to students across South Carolina. Planned deliverables include three sample e-learning lessons for high school technology teachers. These lessons would be inquiry based, use CA²VES virtual reality, and be designed for integration into widely used educational standards. One goal is to make e-learning and STEM materials more accessible, focusing on underrepresented groups and communities. Six aggressive, program specific recruitment activities will be designed to increase the number and diversity of students enrolling in target programs. CA²VES also hopes to offer online student internship placement services. Through their programs and e-learning modules, CA²VES aims to impact the STEM education experience of more than 2,000 high school students and more than 100 P-12 teachers.

Purpose of the Forum

The CA²VES Upstate STEM Forum was held on November 12, 2012 at the CU-ICAR facility in Greenville as a means to gather information on the needs of upstate South Carolina STEM educators. Also invited were those who have a stake in the STEM education of today's students, including industry representatives and legislative representatives. Teachers, guidance and career counselors, and administrators in attendance represented P-12 education and technical colleges in five upstate counties (Greenville, Spartanburg, Pickens, Oconee, and Anderson). Attendees participated in an industry panel discussion, a tour of the CU-ICAR facility, STEM education showcases and collaborative feedback sessions.

Overview of Activities

The six hour forum began with registration of participants and an opening session with speakers from the Clemson University Center for Workforce Development, the Youth Learning Institute, the South Carolina Coalition for Mathematics and Science, and the Clemson University Office of Economic Development. The participants were then separated into four groups of six to eight people each. Each group was led by a moderator who read the prewritten scripts including open ended questions and guided discussion. There were two group sessions, each lasting 45 minutes, and the sessions were recorded (after receiving participants consent).

Session 1

The first session used a technique called "jigsaw readings" where excerpts were selected from articles and then specific questions related to the general topic of the article were addressed to participants. There were four readings; the moderator was instructed to spend about eight minutes for the discussion of each. After the last reading, participants collaborated to generate the top five or six strategies they would like to see CA²VES pursue. A survey using a five point Likert scale was used for group members to then rate how likely they would be to use each strategy.

Session 2

The second session used an activity called "Fact or Fiction." There were six short statements to be read by the moderator. After each statement, participants voted whether they thought the statement was true or false. The moderator then read the correct answer and a detailed explanation of the answer. Participants then answered discussion questions before moving on to the next statement. The same concept generation and survey process used in session one closed out session two.

Afternoon Sessions

After the lunch break there was a short talk on supporting STEM strategies for schools followed by an hour long industry panel session. A speaker from the Youth Learning Institute succeeded the panel session, and then the director of the SC ATE Center of Excellence made closing remarks.

Findings

Session 1: STEM Resources and Classroom Support

Session one was entitled "STEM resources and classroom support." For this session, excerpts were read from real articles and then specific questions related to the general topic of the articles followed.

Virtual Reality and CUrriculum

The first topic was not a reading but a video that demonstrated examples of virtual reality and curriculum tools that have been created to support an introductory session for precision measurement.

Questions and Responses:

1. **Would these simulations or simulations like these be beneficial in your educational environment? Do you believe that you or teachers that you work with would use these types of tools?**

   The first question following the video asked about the benefit of simulations such as the one seen in the video to the participants' respective educational environments. Participants praised the virtual reality simulation as a great way to teach students unit conversions and scale modeling, pointing out that "they live in a virtual world." Students could become more engaged in the lesson by creating avatars within the VR world. Teachers, however, may have a more difficult time adjusting to this teaching method. Many participants felt that the virtual reality tool could be improved by providing a better idea of the big picture of the lesson first, and then becoming more detailed. There was concern that the learning process is more difficult for students if they do not know the end goal of the lesson. Additional suggestions included using physical tools alongside the virtual reality presentation so that they can see and touch the metrology tools as well.

2. **What will a high-impact, technology-intensive STEM learning environment look like in the near and long-term future?**

   The second question had participants try to imagine the future of STEM education if high-impact, technology intensive tools such as virtual reality become the norm. Participants stressed that using computers and virtual reality simulations is a great way to engage students. By altering the "everyday" experience of the classroom and letting students work at their own pace in an environment where teachers are more facilitators than content deliverers, the learning

experience could be enhanced. Technology would allow students to take virtual field trips. Additionally, more students would get the chance to "work with" expensive or sensitive instruments that might not currently be widely available in classrooms. A technologically intensive STEM learning environment would be beneficial; however, educators had some concerns. The most common point was that students learn best when they are working with their hands. Another fear was that students would spend too much time looking at computer screens. It was also important that the virtual images be as realistic as possible, and that this kind of technology be made affordable for widespread classroom use.

3. **What kinds of research and development work should be encouraged and sponsored in order to assure that educational experiences and practices reflect the best of current knowledge about the STEM disciplines, STEM learning, and STEM teaching?**

   The last question that related to the virtual reality video asked about the kinds of research and development that should be promoted in order to assure that educational experiences and practices reflect the best current knowledge of STEM disciplines, STEM learning, and STEM teaching. Participants responded that they would like to see content developed for lessons on topics such as safety, electricity, and introductions to the world of manufacturing. Also, creating modules to introduce students to different career pathways could help gain their interest in STEM fields. Another idea would be to make e-learning modules available at home as well as in the classroom.

Classroom Grants

Session one's second topic of discussion was a reading from various classroom grant descriptions. These grants included the Jordan Fundamentals Grant, for teachers developing lesson plans; the Lowe's Outdoor Classroom Grant for class projects outside the traditional classroom; the Lemelson-MIT InvenTeams encouraging student innovation; the Mars Foundation grant for educational support including equipment and capital projects; and the Mobil Foundation which funds projects aimed to affect change.

Questions and Responses:

1. **How can funding agencies and professional organizations best stimulate, respond to, and develop the community of STEM educators to assure that important innovative curriculum and instructional material development and research is conducted and widely disseminated in a timely manner?**

   When asked what funding agencies and professional organizations could do to stimulate, respond to, and develop the community of STEM educators, one of the biggest concerns was that current standards do not emphasize STEM studies enough. Because teachers are bound by standards that dictate what material must be taught in the course of the school year, educators feel that there is little time left over to add to the curriculum. One participant group commented that the lesson requirements set by administrators pushes breadth more than depth, and compromise needs to be made between the two. Ideas for overcoming such current restrictions included creating afterschool STEM programs or elective classes where students can learn on their own time. Another idea was to for businesses in the STEM industries to encourage legislators to push for educational standards that put more emphasis on STEM learning. Another existing hurdle that grant funding could work to overcome is the disparate level of STEM education at the elementary school level. Participants were concerned that existing curricula do not do enough to build a strong foundation for students to succeed in technical fields. Other groups suggested that getting technology companies to fund the development of STEM teaching applications and equipment would be helpful. Grants that participants currently receive include one from the Roper Mountain Science Center, allowing students to use Apple iPads for the telescope application. Other sponsored learning programs, such as robotics lessons from Lego robotics, are great teaching tools to complement the traditional classroom experience.

2. **What are the greatest needs in STEM education that could be met using classroom grants?**

   The second question in the grants segment asked participants to identify the greatest needs in STEM education that could be met using classroom grants. A common response among groups was the need to provide teachers with professional development for integrated STEM education. Participants also returned to the issue of inadequate preparation at the elementary and middle school levels. In particular,

rigorous curricula to build reading and basic math comprehension are lacking and the results show at the high school and college levels. One concern was that American students are not succeeding at a rate comparable to their peers in other countries due to these gaps in the standard curriculum. Educators observed that students are not interested in learning about math and science because there is not enough emphasis placed on STEM knowledge as integral to their future careers. Classroom grants could also extend to purchasing physical tools to aid STEM learning, such as moveable computer labs for districts lacking the infrastructure to build their own.

3. **Do you believe that you and/or teachers you work with would apply for a STEM classroom grant?**

   In response to the third question on the topic of grants, one group had much to say. Participants noted that grant writing is a time consuming process and teachers have little time to spare. They also admitted that grant writing is seen as "a scary process" and "a long-shot." They requested workshops on the mechanics of grant writing, or suggested that allowing video applications could be beneficial.

STEM Tools and Resources

The third topic of discussion centered on online STEM tools and resources that currently exist. These tools include the PBS Teachers STEM resource center, Intel skool™, and the Office of Naval Research Focus Education Web Site.

Questions and Responses:

1. **Have you found any valuable digital resources that have supported STEM education? What are those resources and why were they valuable?**

   The first question asked participants to identify any digital resources they have found valuable in supporting STEM education. There were several institutions listed; however, very few were listed multiple times by different groups, perhaps suggesting that such resources are not common knowledge. The Boston Museum of Science and Khan Academy were listed twice among the four groups. The Boston Museum of Science website offers engineering design challenges, while Khan Academy offers a fun

learning environment with topical modules, progress trackers, and rewards that allows students to work at their own pace from any computer. Other online resources were the websites for PBS Kids, the Society of Automotive Engineers (SAE), You for Youth, the International Technology and Engineering Educators Association (ITEA), and A World in Motion. The You for Youth website even offers a downloadable curriculum. One group of participants also mentioned the social media website Twitter as a useful digital tool for communication, saying that the frequency of mass emails has diminished the effectiveness of email as a medium for instant communication. However, they did not think using Facebook would be a good alternative.

2. **Would an online hub containing STEM resources specific to South Carolina be useful? If so, what should it include?**

   The second question on the topic asked about creating an online hub of information and resources specific to educators in the state of South Carolina. This idea was acknowledged as beneficial providing that the website had links to the English Language Association and Common Core teaching standards. Another suggestion for content of the website was a current list of industry representatives who might be available through a speaker's bureau.

3. **What are some valuable non-digital resources that would improve STEM education in your learning environment?**

   The third question, about non-digital resources to improve STEM education generated a few responses. Participants suggested requiring an integrated STEM course for education majors, as well as parent/student information sessions with industry representatives.

Professional Development

The last topic of session one dealt with professional development. The reading came from a report by the president's council of advisors on science and technology from February 7, 2012 entitled *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* The report stated that "classroom approaches that engage students as active participants improve retention of information and critical thinking skills and can significantly increase STEM-major interest and perseverance…" The article segment suggests faculty training. The questions posed to the participants explored opportunities related to professional development.

Questions and Responses:

1. **Are teacher professional development programs an effective solution to help prepare STEM teachers in integration of emerging and/or best practices and teaching methods in the STEM classroom?**

   The first question asked if professional development programs are effective in preparing teachers for the best practices of teaching STEM. If participants thought such development programs would be useful, they were asked how the programs should be structured. Two groups suggested facility tours that would allow teachers the opportunity to see and experience the STEM industries as well as speak with professionals in the field. It would also allow them to focus on the outcomes of a strong STEM education. Another couple of groups suggested doing afterschool training that is practical and applicable. Planning a STEM integration unit for grade school would provide practice and can be taken directly back to the classroom. One group identified that developing STEM lesson plans is the hardest part for teachers trying to bring thorough STEM education into a curriculum. There were no groups that objected to the idea of professional development programs to support STEM teaching.

2. **Explain the best professional development session you have attended. Why was it the best?**

   The second question asked participants to explain the best professional development session they have attended. The Dream Connectors program was mentioned several times as an example of a great development session. In this program, students and teachers participate in classroom lessons about the career opportunities in STEM fields then visit the workplaces. The in-person experience is deepened by further classroom discussions. Another program mentioned was Clemson University's Youth Learning Institute science field study series.

Summary of Session 1

The "Jigsaw Readings" exercise generated a good deal of discussion from the four small groups. Participants liked the idea of virtual reality modules for teaching because they would really engage the student and provide an opportunity to experience tools and equipment that they might not be able to otherwise. Three groups listed digital STEM resources, virtual reality simulations, or three dimensional experiences as ideas they would like to see developed. Twice as many participants answered they were "extremely likely" to use such tools than only "likely." However, there was the concern that teachers need to feel comfortable using this method and that it is still very important that students have a physical learning environment. Any lessons that are developed should provide the bigger picture of that which the module is focusing on to aid student retention of the lesson. The cost of virtual reality modules and equipment, if developed, must not be prohibitive. A less high-tech idea was the centralization of STEM resources and lesson plans on an online hub. 95% of those who listed the idea on their survey sheet rated themselves "likely" or "extremely likely" to use it.

Several groups pinpointed weaknesses in early fundamentals education as one of the things that is failing older students when studying STEM. Changing statewide education standards to reflect an early emphasis on STEM could help. Reading comprehension focus should be bolstered as well. One educator at the technical college level stated that many students enter technical schools without proper reading skills. Participants expressed worry that American children are falling behind their peers in other nations. Current elementary and middle school curricula nationwide should be evaluated to see how they compare to other countries. Offering after-school or elective virtual reality STEM programs, and networking to find grants from business that support education were two solutions proposed to combat the problem.

While teachers recognize the importance of STEM studies, they often lack the resources, or even training, to create intensive integrated STEM lesson plans. Two-thirds of survey participants responded positively to the idea of professional development workshops, and came up with characteristics of their ideal workshop. Experiencing STEM industries through tours would help educators create lesson plans that referenced real world jobs. Training after school that would allow teachers to plan a unit on STEM would be practical. Additionally, making sure that

colleges include classes on STEM teaching in their own curricula for education majors is important. Other professional development topics should include grant writing. All four groups listed some form of grant writing help on the survey as something they would like to see from CA²VES. 100% of those who listed this idea said they were either "likely" or "extremely likely" to use it. Many people are daunted by the grant application process, so offering the right resources to teachers seeking classroom grants could make the process more appealing and more successful.

Partnerships between industry and schools, whether it is in the form of virtual tours, speakers, or field experiences, were highly rated on the survey, but only a quarter of participants wrote this down as a tool they would like to see used.

Session Two: Recruitment and Improved Accessibility

The second session was titled "Recruiting STEM and manufacturing students and improving accessibility for rural and underserved populations." Six statements were read by each groups' moderator, and participants were asked to vote whether they thought each statement was true or false. The correct answers were then revealed, and discussion questions related to each statement were used to guide conversation.

Under-represented and unserved Populations in STEM Fields

The first statement claimed that under-represented and underserved groups have enhanced perceptions of STEM careers and more confidence in studying such subjects when they have a STEM role model. The discussion question asked what the ideal "role model" program would look like. Some groups wanted mentoring to start at the high school level, while other groups thought STEM mentoring should begin in elementary school. One common idea was to provide high school students with hands on experience through summer camps and after school programs. Opportunities for girls to work with machinery and design could encourage them to pursue STEM education. Another characteristic of an ideal mentor would be someone who has the same diverse qualities as the student target market. Having someone who knows the challenges of being a minority in the STEM fields could inspire and encourage students. Industry representatives should be heavily involved in a mentorship program by serving on advisory boards and interacting with parents in career fair type settings. Other characteristics suggested were sustainability and a nurturing atmosphere to create an emotional connection. The ideal program would be one that is "win-win" for mentor and mentee.

STEM Apprenticeship Programs

The second statement of the session said that apprenticeship programs are not valued by manufacturing companies in South Carolina. This statement is,

in fact, false. There are currently over 3,000 active apprenticeships in the state. The discussion question was two-fold, although only one group tackled both questions. The first question asked what way companies can become a part of the K-12 community, and how they can impact student interest in STEM education. Company sponsorship of programs such as National Engineering Week, Society of Women Engineers and Society of Hispanic Engineers allows these programs the funds to extend their reach and offer scholarships. Another way to garner interest is to offer virtual apprenticeship programs or job shadowing so younger students can learn and attend school at the same time. The MicroCareerBurst partnership with Fluor was cited as a best-practice model of virtual career exploration. Asking companies to come speak to students at middle schools would raise awareness of STEM jobs at an early age. A second avenue for increasing student interest in STEM was to better educate teachers themselves about the resources available. A "staff development day" that would allow teachers to learn first-hand how manufacturing works. It would also provide teachers with contacts in industry that can be additional resources. The second discussion question asked about the ideal qualities of an apprenticeship program. One group made a list of the following characteristics: it challenges the student, it leads to a job when the program is over, an apprenticeship should be hands-on and involve teamwork, it should build a student's job search skills by giving them practice in interviewing and resume writing, and it would allow students to learn while providing industries the chance to train prospective employees to meet their standards. In the creation of apprenticeship programs, it is also important not to cut teachers out of the picture. One group suggested having a tiered program where the first step is using virtual lessons, such as the previously mentioned MicroBurst, to allow younger students, and those not ready to commit to an apprenticeship, the opportunity to explore manufacturing jobs. The next step would be shadowing in industry. Finally, if the student continued to show interest, he or she would be able to enter an apprenticeship or intern program. The group suggesting such a system was concerned that having to register youth apprenticeships with the Department of Labor might be a deterrent for companies and that internships might be the better option. While participants said that state career centers will allow second semester students to co-op under the age of

18, they were also worried that low income families might discourage their children from participating at the risk of losing dependency checks. Parental guidance might prove to be another stumbling block unless the stigmas of technical college and manufacturing jobs are removed. Positive marketing campaigns about the successes of technical college education and the productive careers in manufacturing are needed.

Activities Supporting STEM Career Pathways

Only one group had responses for the third question in the session two series. Similarly to the second question, it asked about the kind of activities that would help inform students about STEM career pathways. The group suggested that students could be tested to indicate their interest level in different disciplines, and then they could be given career suggestions based on the test results. They said the public should be educated to help students make good decisions.

Desirability of Manufacturing in America & Parent Education

The fifth statement was about the desirability of manufacturing jobs in America, and the sixth statement asked what role parents play in their children's choice of a STEM career. The responses to both of these statements were overlapping, and the groups chose to focus on ways to change the public perception of such jobs. Groups said that manufacturing industries need to get out and "sell" what they do. Marketing programs aimed at parents through mediums such as television commercials, social media, and eye-catching billboards were some ideas. The groups saw these communication channels as more effective than newspapers or articles. One group expressed the idea that, due to socio-economic and geographical differences, there is no "one-size-fits-all" answer. Tailoring marketing campaigns and hands-on opportunities by region would allow the unique needs of each student population to be better met. For example, STEM programs trying to operate in lower income areas may need to work harder than those in high income neighborhoods to make the program economically available. As recognized in previous session two discussions, parent involvement is also critical. Teachers noted that parents are more engaged at the elementary school level, but begin to move away from that as the student gets older. Having a parent-teacher contract that emphasizes involvement in the child's education could help alleviate the problem. Industries and educators need to show parents that manufacturing and technical jobs are stable, respected, and successful. Having parents as a positive voice for STEM in the home would be an invaluable resource.

Summary of Session Two

The "fact or fiction" activity was a good way to dispel myths about STEM education that participants may have had. The first statement got groups thinking about mentoring programs, especially for segments of the student population that are normally a minority in the STEM fields. Several examples of programs that are already working to serve under-represented groups were named, and participants brainstormed more ways to involve the community at large. They raised the point that it is especially important to do away with racial and gender stereotypes regarding STEM careers. Mentoring programs can focus on cultivating mentors who come from minority groups in addition to drawing positive role models from the existing STEM workforce. Mentors from industry can exist for educators as well, to help them develop a perspective on STEM to share with their students. 100% of participants who listed a mentor program on their survey answered that they would be "likely" or "extremely likely" to use it, or promote it to their students.

In general, participants saw apprenticeships as a great way to get students involved in STEM. The ideal apprenticeship would teach responsibility, job search skills, as well as the technical tools of the trade. Companies would have a chance to groom potential employees, and apprentices would gain a world of knowledge and an idea of their desired career path. Participants agreed that actual apprenticeships were best suited to working age high school students. In the survey portion of session two, some groups even mentioned apprenticeships for teachers, especially if a stipend could be offered. 80% responded that they would be "likely" or "extremely likely" to allow their students to participate in an apprenticeship program while more than 90% indicated they would be "likely" or "extremely likely" to participate in such a program themselves. In addition to apprenticeships, three out of four groups suggested broadening STEM exposure by bringing businesses into schools starting at the elementary school level. Almost all the survey responses regarding this approach were rated as "extremely likely" to use. There, there was not much interest in special career counseling services; however, participants were educators and advocates at all different levels of the school system, so it is possible they did not find that idea applicable to their position.

Another widely raised point, both in the session and the surveys was the need for positive marketing to change the perception of manufacturing jobs. Almost two-thirds of participants cited a need for this among students, parents and even educators. The groups concluded that marketing strategies would have to be tailored to appeal to the target region in hopes of achieving more success than with

an appeal designed to be universal. Greater than 90% said they would be "likely" or "extremely likely" to use marketing or media that promoted a perception of STEM careers as meaningful and successful.

Industry Panel Discussion

An industry panel composed of representatives from local companies including Fluor, BMW, GE, Milliken and Michelin were asked several questions related to employment needs, P-12 and industry collaboration, and general education and workforce requirements.

1. **The panel was first asked about their workforce needs, key competencies employees should possess and recommended post-secondary certifications and degrees recommended for employment in advanced manufacturing.**

   Responses focused around the importance of:

   - Technical and communication skills with practical applications
   - Basic skills with technical problem solving abilities
   - Ability to work in high performance teams and think as problem solvers
   - The value of MSSC and industry recognized certifications
   - Value of both 2 year degrees and demand for 4 year engineers

2. **Next the panel was asked to relay best practices and real life instances of their involvement of P-12 initiatives that have served to connect a bridge between industry programs and education or worked to address the skills gap between education and mastering skills required to enter the workforce**

   Recommendations of the panel urged educators to continue to support:

   - Apprenticeship programs, internships and co-ops

- Allowing industry representatives to partner with elementary and middle schools to mentor
- Dream It! Do It! Middle schools partners telling students about needed skills
- Work Keys – math, reading, writing, problem solving, critical thinking and soft skills
- Science Fairs, Design Competitions and Capstone Projects
- Plant tours – introducing students to real jobs
- 1st Robotics Competition
- Team based working environment –
    - Building a cultural environment with world perspectives
    - GAP: Graduates Advancing Towards Professionalism (small team approaches)

3. **Panels were next asked to discuss what they perceived were the greatest challenges faced by their company?**

Responses from panelist included:

- The greatest challenge is worker shortage
- High costs of training (one company reported a minimum of 40 hours training per year for employees)
- Recruiting the Workforce of the Future – technicians are extremely important with 37% percent expected to leave and only 8-10% passing pre-employment tests
- Need for a model supporting partnership with industry, technical colleges and high school and aligning the curriculum across all stages
- Negative perceptions of Advanced Manufacturing
- Skills gap between graduated and employees entering new jobs
- Technology continues to advance rapidly which puts additional pressures on educational systems

4. **Finally, panelists were asked to consider how in a constantly evolving marketplace, how P-12 classrooms can help to prepare entry-level workers with 21st Century Literacy Skills (digital literacy, collaboration, media literacy, and global literacy) needed for jobs in your organization?**

   Suggestions from industry panelists included:

   - Exploring student communication through video which provides the benefit of lowering student boundaries and providing quick access and on-the-job knowledge
   - Include communities online, blogs to support student and employee communication – one company reported revamping their Knowledge Management System to make these accommodations
   - Recognize that the speed of the world has changed which has changed how people learn
   - Students are smarter because new technology information has emerged and fields of knowledge have grown where more specialization is required

Conclusion

The participants and organizers of the CA²VES Upstate STEM forum ended the day optimistic about the possibilities for improvement in STEM education in South Carolina. Of the twenty-two participants that responded to the exit survey, the largest group was middle and elementary school administrators: 7 respondents fell into this category, 4 were K-12 STEM teachers, 3 were K-12 counselors, 2 and 1 were career center counselors and instructor respectively, 1 attendee was a representative from a 2-year college, 3 were representatives from 4-year colleges, and 1 participant was a representative from STEM industry. They appreciated the chance to share ideas, give their input, and raise awareness of the constraints educators face in terms of curriculum requirements and administrative support. All attendees rated the conference at or above "good," with greater than 50% rating it "excellent." The topics chosen for the industry panel were well received and more than 75% of participants responded "excellent" when asked about the variety of topics. Additionally, the topics for sessions one and two were rated by almost all participants as "excellent" or "very good." Two areas that attendees noted might have room for improvement were delivery and organization of the forum. While both received over 50% "excellent" or "very good" ratings, several attendees' comments indicated that it was difficult to hear when separated into the small groups because all the groups were in one room. Overall, twenty of the twenty-two respondents said they would be "likely" or "extremely likely" to recommend the forum to a colleague. Twenty thought the forum should be repeated, and two said it should with different topics.

The forum was well received by participants and generated many great ideas. Surveys indicate that another similar forum would be well attended, especially if there is more industry and legislative participation. Attendees also encouraged organizers to provide the forum on a larger scale to expand the impact beyond the upstate. It is important that the momentum generated by the forum is not allowed to stall. CA²VES and its partners need to use the data gathered to advance the future of STEM education in South Carolina schools.