AC 2008-2690: A SUMMER TRANSPORTATION INSTITUTE EXPERIENCE AT MISSISSIPPI STATE UNIVERSITY

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A Summer Transportation Institute Experience At Mississippi State University

Abstract

In the summer of 2007, Mississippi State University's Bagley College of Engineering was awarded a grant from the Mississippi Department of Transportation (MDOT) to host the 2007 Mississippi Summer Transportation Institute (MSTI). The MSTI is a three-week residential program for 19 rising high school sophomores and juniors. The focus of MSTI was how science, technology, engineering, and mathematics (STEM) are related to transportation and career opportunities in transportation.

The MSTI included hands-on activities, development of communication skills, and utilization of technology and skills required in today's workforce. Field trips to the Nissan plant, Mississippi Department of Transportation (MDOT), and the Columbus, MS Air Force Base exposed students to real-world applications of STEM and introduced them to a wide range of careers in transportation. The curriculum included sessions about structural systems, system illustration (CAD), transportation system layout, hydraulic engineering, environmental and water resources engineering, pavement materials design, building materials design, and traffic management. Leadership training and team building activities were also included.

According to student feedback, there was an increase in interest across all subject areas after their participating in the MSTI. Post-program follow up also suggest that the MSTI had a positive effect on encouraging participating students to take more science and math courses. When asked how MSTI will influence their career choices, some of the participants specifically noted overall desires to become engineers. The more specific comments included, "I will most likely be an engineer and MSTI has helped with that choice." "This camp has enforced my interests in engineering…" "This camp definitely made me want to be an engineer."

This paper will present the overall curriculum of the MSTI camp with specific emphasis on activities that could be implemented at other institutions. In addition, detailed assessment results of each activity will be presented to help institutions interested in implementing similar camps to choose activities which appear to be of most benefit to the students.

Introduction and Overview

The Center for Science, Mathematics and Technology (CSMT) and the Bagley College of Engineering (BCoE) at Mississippi State University were recently awarded a contract by the Mississippi Department of Transportation (MDOT) and the Federal Highway Administration (FWHA) to develop and conduct a three-week residential summer institute for rising high school sophomores and juniors. The resulting Mississippi Summer Transportation Institute (MSTI) was developed with several specific objectives. First, we wanted to expose the participating students to science, technology, engineering and mathematics (STEM) as it applies to the transportation and the civil engineering profession. MSTI was also designed to introduce participants to the numerous technical and professional career opportunities that exist in the transportation industry. A third objective was to provide opportunities for the students to develop leadership skills and

improve their work ethic. Finally, it was hoped that the experience would provide a positive perspective of what to expect when these students attended college.

The MSTI program included hands-on activities that fostered the use of the team approach to solve problems, the development of communications skills, and the utilization of technology -- skills required into today's workforce. Field trips to transportation-related industries, government facilities, and transportation providers exposed students to real-world applications of STEM and introduced them to a wide range of careers in transportation.

The curriculum included activities from TRAC™, currently implemented in select seventh grade Career Discovery classes across the state as part of the Mississippi TRAnsportation and Civil Engineering program supported by MDOT. Developed by the American Association of State Highway and Transportation Officials (AASHTO), TRAC™ is a diverse set of on instructional modules related to actual transportation problems and issues. Students work in teams to solve simulations of real-life transportation challenges. The program modules are complex enough that each can be easily adapted for students of all ages. TRAC™ was adapted for the MSTI to challenge students to work in small groups to solve problems related to designing "MagLev" vehicles, structures, and intermodal urban transportation networks.

The program also addressed an important component in developing a workforce that can maintain America's competitive edge in STEM fields: leadership training. A key initiative of Mississippi State University President Robert H. "Doc" Foglesong is the development of leadership in young people through the Appalachian Leadership Honors Program. Dr. Cade Smith, director of the program, led the project session focusing on development of leadership skills.

MSTI opened with an orientation session for students and parents that introduced the MDOT and MSTI personnel, provided details of the program and its three weeks of activities, and outlined operating rules and conduct regulations. The closing ceremony included recognition of sponsors, a recap of the program with a slide presentation, and recognition for students.

Participant Recruitment and Selection

Rising 10th, 11th and 12th graders for school year 2006-2007 were recruited for the MSTI from all school districts in Mississippi. A project information letter, student application, and project brochures were mailed to all mathematics department heads, science department heads, guidance counselors and school administrators, requesting assistance in identifying qualified students interested in applying and participating in MSTI.

A total of 24 students were identified for participation from all submitted applications. The project directors and MSTI project staff graded the applications using a ranking system criteria including completion of the application, grade point average, an essay, and teacher recommendations. MDOT representatives were integrated into this process and were involved in selecting participants. Once the students were selected, an orientation package outlining the program requirements, including legal documents, and detailing institute activities was

developed and distributed to the invited students. This process resulted in 11 female and 8 male students electing to participate in the inaugural MSTI experience.

MSTI Curriculum

The curriculum was designed to provide the participants with a broad range of experiences related to various aspects of the intermodal transportation industry. A combination of presentations, computer simulations, hands-on laboratory-based manipulative activities, and field trips not only introduced them to the scientific, mathematical, and technological aspects of transportation system design and management, it also exposed them to the engineering and societal aspects of the diverse area. The goal of this program was to immerse the students in a program that shows the personal rewards and societal benefits of developing and maintaining a viable transportation infrastructure, and what it takes to design and operate such a conductive network.

Presentation of program information was provided through two primary formats; on-campus instructional exercises and off-campus field trips. On-campus instruction routinely utilized a single day to introduce the science, mathematics, and engineering approaches related to a specific transportation-related topic related to the design, operation, or use of highways and roads, railways, airports and airways, public transit, waterways, and pipelines. This instruction was subsequently reinforced by presenting the students with a design problem and allowing them to develop a solution and test it. Off-campus activities primarily consisted of field trips to give the students a tactile sense of the transportation industry and the diversity of activities and opportunities that it provides in terms of supporting society and as a career. These experiences were reinforced by bringing components of the field trip into the classroom instructional materials.

Of the fifteen weekdays that were part of the program, the last day was reserved for project displays, visiting families, and a concluding awards luncheon. Five days were used to provide opportunities for students to participate in a variety of off campus, transportation-related field trips. This left nine days for on campus instructional and experimental activities. Some on campus instruction did not involve laboratory activities; though the majority did.

On-Campus Activities

The goal of the instructional design was to expose student participants to a variety of transportation-related topics. To increase instructional effectiveness, we combined formal classroom-style instruction with manipulative exercises of a design nature that reinforced lecture concepts. To motivate student to pay attention and participate, each of the design problems were presented in a manner that allowed students' solutions to be evaluated and ranked. This ranking instilled a sense of competition and energized teams.

The on-campus program had a secondary goal of helping the students develop team skills. Issues of team development and operation were presented to the students along with team building exercises. This began at orientation and was reinforced by the activities in the program. For the

design problem competitions associated with the lectures, groups of two to four students were constituted each day with each day's groups intentionally different than those of others days.

The competitions were devised to foster a sense of daily excitement and to help keep the students' attention throughout the program. Specifically, the projects and presentations that the students gave at the conclusion of each on-campus day were judged by their peers and the staff. Each student earned points based on the performance of their team in completing the assignment and the effectiveness of their solution presentation. By changing a student's assigned team, exceptional students did not outpace good students as this could have an adverse affect on student morale and program effectiveness.

In this way, groups competed to devise the best design on a daily basis while promoting a sense of individual competition. In this way, we could reward individuals who remained focused and engaged throughout the MSTI experience. However, using teams helped keep students from having to rely solely on their personal skills. For this reason, teams were designed to keep the skill levels of each team comparable. By using group activities rather than individual project activities, we felt that each student would be able to participate at some level and become more engaged in the project learning process regardless of their level of academic preparation.

A generalized format for the daily schedule of activities was as follows. Start and ending times were selected so that participants did not have to compete with other students or campus traffic at time when either can be intimidating to younger people:

Table 1. Generalized MSTI Daily Itinerary

Time of Day	Activity
08:15 – 08:30	Review of previous day's activities, orient the students for the activities scheduled for the day ahead, and proceed to the instructional area relevant for the day's activities
08:30 – 10:15	Theme introduction, overview of the topic's significance to transportation, presentation of the mathematical tools
10:15 – 10:30	Break, organize competition teams, and introduce the team competition (experimental design) project
10:30 – 12:15	Present tools, materials, and approaches needed to undertake and resolve the experimental design problem
12:15 – 1:15	Lunch Break
11:15 – 3:30	Team problem solving exercise
3:30 – 3:45	Break and preparation for presentation of team solutions
3:45 – 4:45	Presentation of team solutions, evaluation, and scoring

The MSTI staff used a combination of TRAC™ Modules, undergraduate engineering design tools, and laboratory exercises supported by lectures and multimedia presentations to give the students desired exposure to a myriad of transportation-related topics. Though TRAC™ was

designed to target a younger population of students than those participating in this program, it is also diverse enough that students of all ages may benefit from components of the program.

This approach culminated in a set of team-orient project activities with an experimental, problem-solving component in addition to an instructional component. The activities required students to work in teams to solve simulations of transportation-related challenges. Examples of the simulation topics and solutions approach to which students were exposed include the following daily activities:

- Structural Systems – Utilizing West Point Bridge Builder® software, students were exposed to the topics of stress, strain and moment in relation to the development of structures. They constructed small structures and tested them, until they failed. The competition centered on getting the best design for a bridge per the West Point Bridge Program.

- Transportation System Layout – The students were provided with a brief course on surveying for highway planning, design and construction. This involved an introduction to the equipment uses, both land based and remote imagery, for the collection of survey data for proposed roadway sites. They were presented with some trigonometry and geometry pertaining to roadway alignment and staking. The competition project was to load data into the computer-aided drafting (CAD) software and use it to accurately depict a plot layout.

- System Illustration – Applying ModelSmart CAD or Bentley MicroStation®, students were introduced to graphical presentation of engineering systems. This project had them take measurements of an engineered system and develop a set of two-dimensional drawings to represent the three-dimensional system. The competition had the students do a layout of a railway with respect to grade and turn restrictions and the design was judged on the amount of "track" their design required adjusted for failure to meet the design criteria.

- Satellite-Based Location - In a separate experience, students were presented with an overview of the Global Positioning System (GPS) and how it is being used to manage transportations systems. The students experienced the process of using remotely-sensed data for identifying land use and the issues of developing a transportation corridor. They were instructed on using hand-held GPS units to find locations. Using this latter skill, the students worked in teams as part of a GeoCache activity where they had to accurately locate and record the position of four hidden film canisters.

- Hydraulic Engineering – Examining the forces of water and the impact it can have on transportation systems, students were introduced to the forces of drag and buoyancy. They studied energy dissipation in manmade structures. The competition project was to design a container to carry a defined load with the lowest drag in rapidly moving water when fully loaded without being submerged or capsizing.

- Building Materials Design – While concrete is used for many roadways, it also has significant application in a variety of building systems; transportation related and not. A summary of what it takes to convert cement into concrete and the subsequent properties was reviewed. A project involving the design of a concrete with maximum strength and minimum weight was the project-oriented competition for this topic.

- Traffic Management – The topics highlighted during this presentation included traffic flow and safety (e.g., reaction time, braking distance, sight distances, impulse and momentum), roadway planning, cost estimating, geometric design, and basic computer programming. Computer programming for design of signal timing and operation and flow calculations using TSIS® 6.0 was presented. The design problem was to design a traffic management system for a defined intersection to provide the maximum, safe traffic flow.

A variety of short topics were also presented at various point in the program to chance the pace, give the students some "downtime," and to allow the presentation of information that did not readily lend itself to the development of a daily exercise or experiment-based activity. These involved the students doing internet-based research and interacting with visiting representatives from MSTI sponsors who made short presentations. Topics that were covered during these sixty to 75 minute presentations included safety statistics and why Mississippi has a poor safety record, innovative and alternative transportation systems, urban planning, interfacing intermodal systems, and environmental impact issues related to transportation needs and society's expectations.

A leadership component was also included in the on-campus activities involving MSTI. Currently, because of the many challenges that confront Mississippi, our citizens fail to see the opportunities of shared community investments yielding shared community growth. Although the timeframe for overcoming these challenges is long, the formula for success is simple: enhancing the leadership skills of our emerging adults likely to remain in Mississippi will result in shared community investment, which will yield shared social and economic growth. This formula begins at the individual level; however, individuals who have been transformed will reinvest their success in other citizens. These reinvestments ultimately yield community wide progress. The Sonny Montgomery Chapter of the Appalachian Leadership Honors Program conducted a three-hour program that focused on the role of leadership in economic emergence, which included industry recruitment and infrastructure development. The program also included a case study for students that centers around leadership and the previously mentioned economic development topics.

Off-Campus Activities

Field trips were conducted with consideration given to weather when possible. Examples of the types of transportation-related activities that were observed during a field trip included the demolition and forming of concrete pavement sections, laboratory processes to design asphalt binders, operations at an airport, and operation of a lock and dam system. These students traveled down the Mississippi River on a barge provided by the Corps of Engineers. They experienced a lockage operation while on a twenty-foot research boat belonging to CEE. They

observed an airport firefighting vehicle in operation. Industrial visits were also incorporated to observe activities at Nissan, Vicksburg District Corps of Engineers, and MDOT facilities. These were augmented with visits to Mississippi State University (MSU) research centers which have transportation-related activities; e.g., Center for Advanced Vehicular Systems and the GeoResources Institute.

With the cooperation of federal, state, and corporate sponsors, opportunities were provided for MSTI participants to visit the Columbus Air Force Base (CAFB) where they saw air traffic control operations, flight line operations, and were afforded the experience of flying aircraft simulators. At the Golden Triangle Regional Airport, they visited an active runway and were introduced to the ILS approach system, runway markings, and commercial airport operations. They also observed a demonstration of fire control using airport equipment. With the help of the US Army Corps of Engineers (USACE) Tennessee-Tombigbee Waterway Authority, students were allowed to go into the control room of a waterways lock, walk on the dam and inspect the pool control gates, and experience a 23-foot vertical lockage while riding on a personal watercraft in the lock. This was followed by a tour of the lower "Tenn-Tom" Waterway providing opportunities to see a port operation, navigation aids for waterway systems, and tow operations and procedures.

Weekend and Night Activities

We planned this camp to overlap with our annual Quest camp for rising high school seniors. Where feasible and appropriate, we combined the weekend and evening activities of these groups. Typically the Quest students participated in activities such as bowling, going to the movies, having home movie nights in an engineering classroom or residence hall lobby, dancing, team sport events, video gaming competitions, etc. On Sundays, we arranged transportation to local churches for interested students in both groups. Parents were encouraged to visit students on weekends and students were allowed to be signed out by their parents for the weekends, if desired.

Sponsors

There were a number of organizations that were approached by Mississippi State University and MDOT about supporting the Mississippi Summer Transportation Institute. Many provided monetary support while others facilitated tours. The cooperation of federal, state, and corporate sponsors was integral to the activities. Opportunities for field trips were identified through contacts with a number of groups. Other opportunities were developed by working with the CAFB base commander, the Golden Triangle Regional Airport, and USACE Tennessee-Tombigbee Waterway Authority, Ergon, Paragon Laboratories, and Intergraph.

The organizations identified for sponsorships were chosen because of their longstanding relationship with the Department of Civil and Environmental Engineering, the Bagley College of Engineering, and the Mississippi Department of Transportation. They have a demonstrated interest in supporting education, promoting interest in the transportation industry, and fostering a better understanding of the engineering profession. A personal solicitation was made to garner in-kind and financial support for the MSTI project. Those providing some level of support, in

addition to those listed previously, include: Mississippi Asphalt Paving Association, Mississippi Concrete Industries Association, and the Mississippi Road Builders Association.

Program Evaluation

The project team developed an evaluation plan that utilized both formative and summative assessment of the project. Student's attitudes about the transportation industry in general, the role of STEM in transportation, awareness of careers in the transportation arena as well as their perception of the skills necessary for success in engineering were assessed through post tests to determine the effect of MSTI on the students' attitudes and knowledge in these areas. Each individual activity as well as the overall MSTI experience was assessed.

The MSTI evaluation was designed to provide information to MDOT, MSTI project management, and other interested stakeholders regarding the effectiveness of the project's implementation and to explore opportunities for program improvement. Evaluation strategies were developed in an effort to determine if the project was meeting the following objectives:

- Expose students to transportation and STEM roles in the transportation industry,
- Provide career awareness in the field of transportation and the civil engineering profession, and
- Provide opportunities for students to develop leadership skills and improve their work ethic.

To provide a comprehensive framework for the triangulation of evidence, and to increase the validity, reliability, and general applicability of the evaluation findings, a mixed-method approach utilizing quantitative and qualitative data was employed throughout the evaluation process. Methods and data sources used over the course of the project included the following:

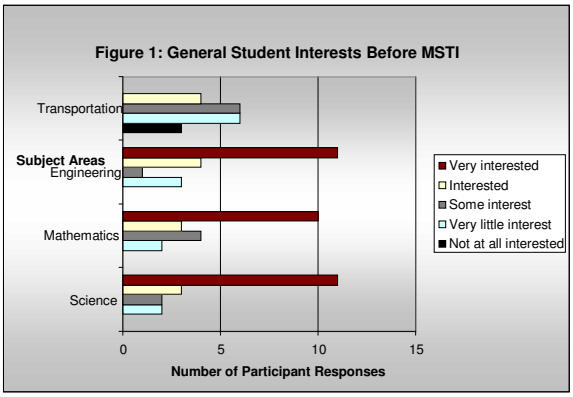
- Surveys - Surveys were used to assess the effectiveness and impact of the summer institution. All student participants were surveyed upon completion of MSTI. Surveys gathered information regarding program components including, but not limited to pre- and post-program attitudes toward STEM and the transportation industry, recruitment efforts, changes in career awareness, role of STEM in transportation, importance of developing leadership skills, strengths/weaknesses of the project, and recommendations for project improvement. Additionally, student participants were asked to evaluate faculty presenters, sponsor presenters, field trips, facilities, and meals.
- Observations - Observations of project activities (e.g. presentations, activities, field trips, etc.) were used in assessing program effectiveness and impacts.
- Interviews - Structured interviews were scheduled and conducted with MSTI project staff. These interviews provided greater depth and understanding of the success of the overall project including, but not limited to general project implementation processes, student recruitment efforts, strengths/weaknesses of the project, and recommendations for project improvements.

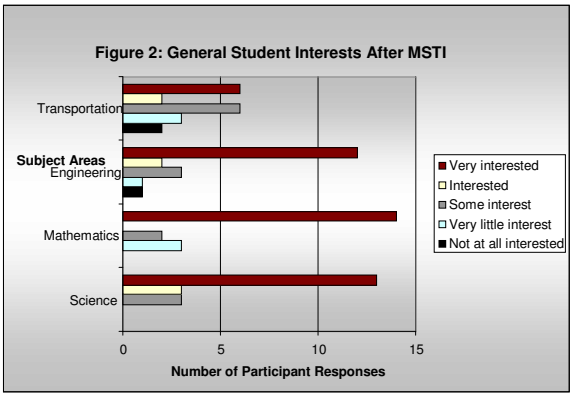
Demographic Information

Participating students were asked to provide basic demographic information to assist in better understanding the population. During the inaugural year of this program, 53% of the nineteen students participating in the MSTI were females. Thirteen participants identified themselves as African American, five as Caucasian and one as Asian. There were ten rising tenth grade participants, three rising eleventh grade participants and five rising high school seniors.

General Interest and Knowledge

Participating students were asked to rate their general interest in science, mathematics, engineering, and transportation before and after their participating in MSTI. Figure 1 indicates their responses before participating in MSTI while Figure 2 summarizes their responses as the three-week program came to a close. These figures suggest there was an increase in interest across all subject areas after participation in the MSTI. These numbers indicate a positive effect on student general interest in transportation, engineering, mathematics, and science.





Additionally, students were asked to rate their general knowledge of STEM roles in transportation, careers available in the transportation industry, the overall civil engineering profession, and opportunities for students to develop leadership skills before and at the end of the MSTI program activities. The data gathered supports a significant increase in general knowledge across all categories after participating in MSTI. According to the data collected the most significant increases in students' understanding were found in the areas of careers available in the transportation industry and their overall knowledge of the civil engineering profession. Only 31% of participating students reported being *knowledgeable* of careers in transportation and none of the students reported being *very knowledgeable* prior to their participation in MSTI. After their participation, 53% reported being *knowledgeable* of careers in transportation and 37% reported being *very knowledgeable*. Although no student reported being *very knowledgeable of* the civil engineering profession before their participation in MSTI, 53% of the participating students reported being *very knowledgeable* of the civil engineering profession after participating in the summer institute.

Benefit of MSTI Components

Participating students were also asked to rate the overall benefit of each component of the MSTI. An overwhelming 84% of student respondents indicated the Tennessee-Tombigbee Waterway field trip component (visit to the Stennis Lock and Dam and boat tour of the waterway facilities and navigation system) was *very beneficial*. Closely following this activity was their perceived benefit of having taken the Nissan Tour with 79% of the respondents reporting it to be *very beneficial*. The Columbus Air Force Base Visit and the Leadership Training components both received *very beneficial* ratings from 74% of student respondents.

Only three components received any ratings of *not beneficial at all*; the Traffic Management and Concrete Materials sections with 11% of the participants giving this as a response for each of these activities and the GPS and GIS session which was given this evaluation by 5% of respondents. Even with a few low ratings, these sessions were noted to be beneficial to the majority of the participants. Several factors may have contributed to a few students missing the benefit. The Traffic Management activity involved students working in close quarters and sharing a computer to model flow through an intersection. The Concrete Materials session required the students to get a little dirty as they sieved aggregate and mixed concrete. The GPS and GIS session involved running around outside with a hand-held GPS unit looking for GeoCaches which were difficulty to find. In each of these sessions, overall student success at completing tasks was not high and this might have yielded a level of frustration that diminished the perceived value. Finally, each of these events came toward the end of a week of activities. It could be that being the activity before the end of a week adversely impacted student interest.

Influence of MSTI

Students were asked to comment on how they anticipate their experience with MSTI would influence the choices they make during the next school year. Answers varied, but all responses were positive. Some students reported their experience will influence them to work harder and make better choices. Other students were more specific saying, “It will help me in the college selection process…” and “I will take physics and challenge myself to do better on the (college entrance exams).” Still others reported taking school more seriously and choosing their classes more wisely.

Participating students were then asked how their experience in MSTI will influence their choices regarding their education beyond high school. Students responded they now know they will need to work hard and study. Many of the responses specifically mentioned a desire to return to MSU for college, while other reported their decisions to pursue a degree in engineering.

When asked how MSTI will influence their career choices, some responses were very vague, while others specifically noted overall desires to become engineers. The more specific comments included, “I will most likely be an engineer and MSTI has helped with that choice.” “This camp has enforced my interests in engineering…” “This camp definitely made me want to be an engineer.”

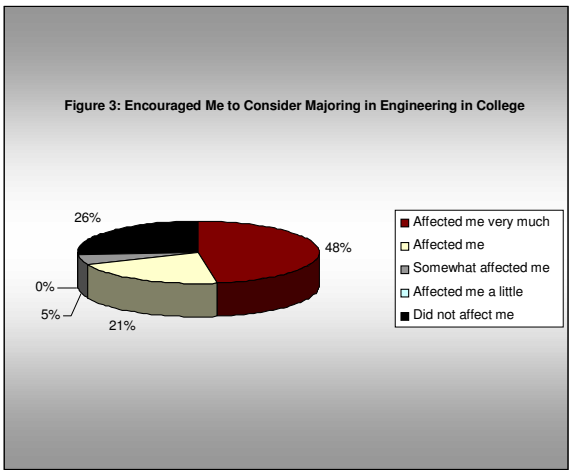
Student Experiences

When participating students were asked to identify the more interesting parts of the MSTI, they identified the tours and interactive, hands-on activities. Specific components mentioned were the Water Transportation Session, Nissan Tour, MDOT Visit, TRACS Activities, Concrete Materials Session, Riverboat Tour, Columbus Lock & Dam, and Leadership Training. Of all the comments, the most common response was the field trips. Some of the comments included, "I loved the field trips. Especially the riverboat tours and going to Jackson.", "The trips were more interactive than the classes", "Going on the trips (was) interesting to me…because I am a hands-on person…" and "The trips because we got to travel and have fun…" Other comments included, "I like being taught by several…professors." and "There was never a dull moment…Everything we did was interesting."

Student Impact

In order to assess the overall impact MSTI had on the students' interest and confidence level in science and mathematics, students were asked to what extent the MSTI affected each of them. Overall, students reported that MSTI had an effect on their ability to understand new information presented to them in science and math classes. More than 40% stated that MSTI increased their confidence to participate in science and math classes. Students participating in MSTI may have already developed an interest and high skill set in STEM fields prior to their MSTI experience. This previous interest may have had some affect on the way participants responded to questions regarding student impact.

When asked specifically about the affect MSTI had on encouraging students to major in science, mathematics, or engineering in college, the students noted that MSTI had positively affected their consideration of career and subject areas to study in college. Regarding the sciences, 39% indicated they were notably encouraged to consider this as a major area of study. Similarly, 37% felt encouraged to consider mathematics as a field of study when in college. Figure 3 shows the survey results with regard to engineering.



Participating students were also asked to think specifically about the Leadership Training portion of MSTI. Comments suggested a very positive impact. One student noted that, "…it has helped

me learn to be an active listener instead of taking control (of conversations)." Another felt "…it will help me in interacting with others and communicating my ideas." Overall, the data gathered supports the positive impact MSTI had on the participating student over the course of the three weeks. Students, after participating in MSTI, report having a greater ability to understand new concepts in science and math, having more confidence to participate in science and math classes, understanding the importance of taking science and math classes, and having been inspired to major in engineering in college. Additionally, having gone through Leadership Training, students report understanding what it takes to be a leader.

Program Strengths and Weaknesses

In review of the data, CMST and BCoE team members collaborated to identify the primary strengths of MSTI. Based on survey and anecdotal data, it was concluded the following components of the program were important to our successes: providing hands-on activities, participating in field trips, developing meaningful friendships, providing opportunities for peer interaction, engaging students in campus life, covering various aspects of civil engineering and recruiting a diverse group of students to participate in the three-week program. When asked to identify some of the factors contributing to these strengths, leaders identified having strong leadership team who gave their time and energy to the success of the project. The enthusiasm of the professors was contagious. "…[the professors] are good at what they do…they like it and…that …helps the students like it too." One person elaborated on the competition aspect of the MSTI as a contributing factor explaining, "…you get a prize for doing things and that helps them want to learn…" In review of the responses, it is clear the leaders worked hard to provide the participating students with a meaningful experience. "We tried to develop activities…we thought they could understand."

Although, there were no significant weaknesses reported, long lectures and the lack of preparing students to sit through long lectures were also identified as weaknesses. One leader reported, "We tried to be as engaging as we could…" given the skill set of the participating students. One recommendation was made to change the spacing of the field trips. "…take the materials covered…in the two classroom sessions and spread it more uniformly throughout…let's say leadership in the morning and then…go on to [another] topic…rather than do a whole day on leadership."

When asked what might improve the effectiveness, one person commented that having more industry representatives speak during session activities might have been helpful. The respondent shared that it might be helpful to bring in people working on pavement systems when the campers are talking about pavement systems, or have someone who designs bridges present when they are designing bridges. Along these same lines, a different respondent suggested having enough college students helping as tutors or mentors during project activities for each competing group to have constant guidance and support. Respondents identified having more hands-on activities and fewer lectures might be beneficial to the overall effectiveness of the program, "…the hands-on was really effective, so yeah, just do more hands-on." One class was reported as needing to be relocated due to the lack of air conditioning in the room. The suggestions provided are good ones and should be considered when preparing future transportation institutes.

A logistical concern defined was the size of the program. Originally designed for 25 students, the slightly smaller group actually facilitated smaller teams and made activities easier. On one of the field trips six students from a similar camp being held concurrently with MSTI were invited to participate. Hence, leaders found dealing with this number initiated concerns regarding transportation and the overall effectiveness of site tours. As a result those involved noted what one of the coordinators noted. In summary, "I'm not going to say we would have been closed out of any field trips, but if we'd have had 30, there's a good chance we might not have seen as much. If we'd had 30, it would have been harder to pull off some of the exercises that we did…because of laboratory …[and] classroom space…"

Overall, the project staff reported the program was effective in educating student participants about transportation careers and opportunities. After participating in MSTI, students recognized the transportation industry is much more than the people they see working on the roads or in airports. The majority of individuals enjoyed all of the activity. Most developed an understanding of the technical issues and could relate topics presented to events or activities at home. The MSTI helped couple individuals make up their mind as to what career they wanted to pursue, albeit not necessarily civil engineering related. For example, one project leader became familiar with a particular student who was interested in aerospace engineering. Through participation in the various MSTI activities, this student was able to make the connection between aerospace engineering and transportation. Another leader reported that many of the participants really did not know what they wanted to do prior to MSTI but the various activities had helped them develop a clear understanding of civil engineering profession and transportation opportunities.

Conclusion

Overall, MSTI met its objectives. Students were able to understand the basic STEM concepts related to transportation and civil engineering, while developing leadership and interpersonal skills. Survey and anecdotal data confirm that the participants left the program with a significantly improved understanding of the academic requirements of the engineering profession and the diversity of career opportunities available in the transportation industry and related fields. All of the students said MSTI had affected them in not only an academic way, but also a personal way.

We plan on continuing MSTI for years to come. We anticipate the number of students involved will increase and this will present us with new challenges. However, there are several lessons learned by the staff which will apply. We found that:

- The effectiveness of exposing students to STEM concepts and technically-oriented problems is enhanced as the degree of personal contact increases. While computer programs can be sufficient to illustrate problems and their solutions, a tactile experience with real materials provides invaluable insights and vests the students more deeply in the learning process;

- The competitive environment used in the inaugural year of MSTI paid dividends as it engaged many of the students in ways that helped maintain interest through the last day of the experience. However, feedback during the program is needed to keep the interest elevated in more of the students; and

- Providing opportunities for the students to bond with each other, and with program staff, is essential in the development of leadership skills and improvement in work ethic. This bonding develops a greater sense of accountability and personal responsibility.