

Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach

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ABSTRACT

The Consortium for Oceanographic Research and Education (CORE) implements the National Ocean Sciences Bowl (NOSB) “to enrich science teaching and learning across the United States through a high-profile national competition that expands high school students’ knowledge of the oceans and enhances public understanding and stewardship of the oceans” (CORE, 2001). This research study—*Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach*—was implemented in 2002-2004 to gauge the broader impacts of this unique competition on participants.

Incorporating the findings and questions raised in the 1999-2000 study and a comprehensive literature review to formulate guiding questions, the researchers used a “two-tiered” approach to evaluating the accomplishments and programmatic components of the NOSB in its primary context—the regional competitions and the national, final competition. Tier one considers the NOSB as a competition-based learning methodology. Tier two considers the NOSB as a mechanism to influence secondary students’ career path decision-making. Data were collected through four primary methods: extensive surveys; site visits and observations at ten geographically dispersed regional NOSB competitions; structured interviews; and a limited, online discussion forum. The analyses included data collected from over five hundred individuals. Themes and categories which emerged from the analyses included: the significance of teamwork and cooperative learning in the program; the value of the competitive dimension of NOSB to motivate participants; the importance of the social networks that develop for the students and other audiences; and the centrality of the academic, communications, and leadership skills that are developed among the participants.

The significant findings of this study are that the NOSB program has evolved beyond the specific, programming dimension to become a complex, learning community. This community provides support, communications, and social opportunities for its audiences to address missions, goals, and objectives for numerous organizations, agencies, and individuals. As a complex system, the NOSB contributes powerfully to the affective, academic, and leadership characteristics of participating students—while facilitating the public education, community involvement, and outreach goals for the various entities who sponsor, support, and staff the regional and national events. This community further exemplifies a significant scientist-educator linkage, and a successful infusion model to reach into the classrooms of the coaches. Additionally, the data collected support a conclusion that the NOSB effectively meets CORE’s mission, goals, and approaches, as well as its own program objectives.

The curricular impact of the NOSB in supporting the infusion of ocean sciences content and standards into secondary classrooms by teachers seems robust and profound. And importantly, the NOSB has contributed to an enhanced understanding, awareness, and perceived importance for stewardship of the ocean, its resources, and related research.

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Executive Report

Introduction and Summary

Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach was an ambitious, two-year (2002-2004), multi-tiered research study of a national, ocean science education program implemented in 24 regions throughout the nation, and annually at a national finals competition. The two primary research tiers, i.e. *Factors Influencing Career Selection* and *Characteristics of Effective Competitions*, were identified from literature to form the initial thematic categories to develop the instruments and to guide the data sorting and analyses.

Research Questions

The initial, guiding research questions were:

1. Does participation in the National Ocean Sciences Bowl impact secondary students in affective, academic, developmental, and social ways which are durable and important in later college, career, and/or life settings?
2. Does participation in the National Ocean Sciences Bowl influence the manner in which secondary student participants view careers in the ocean sciences community, and does participation provide an environment conducive to career decision-making?

Underlying these formal research questions is a foundational question: is the NOSB “just a competition” or is it something more durable and complex than simply a weekend program?

Methodology

To collect data to answer these questions, the researchers used four survey instruments, two interview protocols, site visits and observations at ten locations, a participant observer, and a limited, online discussion forum. The researchers collected a significant quantity of data from over 500 individuals. These data were analyzed separately, i.e. by survey and audience, to identify major thematic issues and clusters, and then re-analyzed cross-wise for consistency of view—both internally and in view of a significant body of literature reviewed to triangulate both the data and their interpretations.

The research team visited ten of the regional sites to observe the program, to formally interview members of each audience, and to collect anecdotal print materials. The instruments were piloted by one of the researchers in a previous 1999-2000 study of the NOSB program, and those initial instruments were revised based on their performance during that study, and in light of the research literature and specific contextual needs of this 2002-2004 study.

Select Findings

The data were found to be internally consistent, with perspectives shared by the different audiences evidencing strong similarities when they were compared cross-wise, i.e. set to set comparisons. Themes and categories which emerged from the analyses included: the significance of teamwork and cooperative learning in the program; the value of the competitive dimension of NOSB to motivate participants; the importance of the social networks that develop for the students and other audiences; and the centrality

of the academic, communications, and leadership skills that are developed among the participants.

The researchers find that sufficient data exist, with high internal consistency across the audiences studied, to demonstrate the effectiveness of the NOSB in a number of important areas. These include the following and are discussed further in the report.

- The NOSB is an exemplary, socially dynamic network which links secondary students with peers and key adults through a programming context that supports the development of academic and professionally transferable process skills;
- The NOSB provides an environment to support secondary students in obtaining a greater understanding of specific careers and career paths in the ocean sciences community consistent with current research on career selection by these students;
- The NOSB is an exemplary model for curricular infusion—linking recent and emerging science knowledge to secondary classrooms for the benefit of the general student body, not only NOSB participants. This infusion model is multifaceted and is an important area for further research using the NOSB context, and suggests the NOSB could be an important exemplar for discussions around the development and implementation of national standards for ocean sciences education and professional development;
- The NOSB is a working model of the type of scientist-educator linkage moving to the forefront of nationally-scaled, science education programs in this country. Consequently, the NOSB should be viewed and interpreted as a prototype for emulation;
- The NOSB has evolved and expanded in a manner which clearly addresses and supports the published mission of CORE, and which is consistent with the goals, approaches, and educational objectives established by CORE; and
- The NOSB is a complex and broad learning community which impacts a number of stakeholders and contributes to the attainment of goals and objectives for public education and outreach, community service, and public relations, for numerous agencies. The data reveal it is much more than *just a competition*.

Select Recommendations

While the researchers find, generally, that the NOSB operates with a high degree of effectiveness, it is not accurate to conclude it should not be refined. As noted above and discussed in the following report, the NOSB has been analyzed with respect to contributing to the career decision-making path of high ability secondary students, and with respect to the use of the competition model to support academic attainment. In each

of these areas, a comparison of programming in the NOSB, both nationally and regionally, with the literature published previously in these two conceptual areas, suggests specific program improvements which could be made to enhance the effectiveness of the NOSB. These recommendations are specified with respect to these two tiers, as well as more generalized, logistical concerns. In brief, these recommendations include:

- A need to improve the communications process and career information dissemination via parents of participating students;
- A need to substantively invest in the development of a program database to facilitate communications and research associated with the NOSB;
- A need to track and record the curricular infusion pathways of the participating teachers/coaches, as this addresses one of the most highly important research questions in science education today;
- A need to enhance the specific, academic-focused feedback provided to students to improve their overall performance, future preparation, and to inform coaches' curricular and planning decisions; and
- A need to contextualize and communicate with key audiences the relationship and contributions of the NOSB and CORE in creating the scientist-educator linkages called for in numerous settings, and the potential relationship and contributions of the NOSB and CORE to the ocean sciences education standards movements through the *NSES* and *AAAS' Benchmarks*, as well as *No Child Left Behind*.

Conclusion

The National Ocean Sciences Bowl is a significant, regional and national ocean sciences education program that provides a context to inspire and motivate students toward leadership and involvement in ocean sciences and toward a greater sensitivity toward environmental stewardship. It contributes to these students' career paths and college decision-making by engaging them in a social network that provides specific, contextualized information about careers and entry pathways to those careers. It contributes to the overall development of these students by facilitating leadership and academic-focused skills that are highly transferable to other settings. It meets a widely

perceived need for high ability students to compete with, engage with, and share experientially with other students of similar ability levels. All of the audiences reporting for this impact study conclude that the act of competition is singularly important as a motivational strategy to engage these students' "best performance" skills in both academic and interpersonal domains.

The National Ocean Sciences Bowl is also a dynamic social system. It is comprised of numerous sub-populations who satisfy and sustain some dimension of their individualized personal, professional, or institutional identity through participation in the NOSB program. Students address their social and academic identities. Teachers address their professional learning and engagement identities, as well as curricular and science content enhancement needs. College and university personnel address their recruitment needs. Scientists and researchers address their needs to engage with educational programs and to recruit high ability and interested students to their fields. Numerous agencies, institutions, and businesses meet their needs for community involvement, support of youth programming and education, and public relations.

In conclusion, the researchers find that the NOSB is significantly more complex and substantive than "just a competition." This complexity is difficult to ascertain and describe "in the trenches"—particularly during its incredibly fast-paced and dense weekend schedule. NOSB contributes far more to the larger ocean science community than the competition *per se*. This view is an important contribution of this impact assessment, and the researchers believe this view will and should support continued refinement and programmatic development of the NOSB—and through the NOSB, of CORE.

Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach

Introduction to the Study

Background Research on the NOSB

The Consortium for Oceanographic Research and Education (CORE) implements the National Ocean Sciences Bowl (NOSB) “to enrich science teaching and learning across the United States through a high-profile national competition that expands high school students’ knowledge of the oceans and enhances public understanding and stewardship of the oceans” (CORE, 2001). This mission is addressed through four primary NOSB objectives:

- Broaden students’ and teachers’ awareness of the latest scientific research on the oceans and the critical impact of the oceans on global climate, weather, economic well-being, history and culture;
- Help teachers use the oceans as an interdisciplinary vehicle for teaching biology, chemistry, geology, physics, and mathematics by giving them access to marine science education and scientific professionals;
- Give oceanographic research programs the opportunity to develop new links with their local pre-college community and open student’s eyes to ocean-related career options; and
- Reach out to new students and communities to boost participation by minorities, women and disadvantaged students.

CORE has sponsored the NOSB for seven years. In 1998, sixteen regions from the United States sent a regional winning team of four students and one alternate to participate in the national competition in Washington D.C. By 2003, the number of regional competitions had increased to 24.

The NOSB program has been conducted as a partnership between CORE and the National Marine Educators Association with funding and /or sponsorship provided by The Office of Naval Research, The Oceanographer of the Navy, The National Aeronautics and Space Administration, The National Oceanic and Atmospheric Administration, National Science Foundation, The U.S. Geologic Survey, as well as other public and private entities.

Previous Evaluation Activities

Evaluation of the program in its early years utilized participation data limited to numbers of students, regions, and teacher/coaches. Further, attitudinal surveys for both students and teachers were designed and implemented to measure perceptions of the program as it has been conducted. Typical items from the surveys included reasons for involvement, desire to repeat the program, sources of communication about the program, perceptions of program quality, assessment of accommodations, assessment of informational displays at the competitions, and ratings of various programmatic elements.

For the year 2000 competition, funding agencies communicated a need to develop a more comprehensive and robust evaluation of the educational accomplishments and benefits of the NOSB. In that vein, educational researchers at The University of Southern Mississippi's (a CORE member institution) College of Marine Sciences/J.L. Scott Marine Education Center and Aquarium (a regional NOSB site) implemented three avenues of data collection to develop a base upon which to evaluate the NOSB, i.e. content testing and analysis, attitudinal surveys of teachers and students, and structured interviews. Data and the study findings were supportive of the effectiveness of the program, and also revealed potential approaches for growth and development of the NOSB both

programmatically and through further contribution to teaching and learning and the educational research field more broadly.

Planning for Current Research Study

In 2001, a planning team was selected and convened to develop a strategic plan for the NOSB program for years 2002-2006 [the author of this current report participated on this planning team]. The strategic plan which was developed included goals related to numeric expansion of the program, fiscal enhancement, and the leveraging of technological resources for communications and participant recruitment. Further, and more significantly to this current study, these goals incorporated a strengthening of the NOSB infrastructure to support teaching and learning, and an ongoing assessment process which focused on career development of the student participants. From this plan, and in part based on the previously discussed research effort, the current research study was developed.

Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach

This current research project—*Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach*—represents a refinement and expansion of the assessment effort implemented in 1999-2000, and was implemented in 2002-2004. Incorporating the findings and questions raised in the 1999-2000 study, the researchers describe below a “two-tiered” approach to assessing the accomplishments and programmatic components of the NOSB in its primary context—the regional competitions and the national, final competition. Additionally, this study examined the NOSB as a competition-based learning model, the potential of such a model to enhance the infusion of ocean sciences content in pre-college classrooms, and the relationship of

competition-based learning to the learning needs of high potential students. These students are widely perceived by the NOSB supporting agencies as being of great capability to enter career paths in ocean-related disciplines. As such, this study of NOSB represents a distinctive opportunity to ascertain the secondary and systemic impacts to student learning and career selection, and teacher performance and curricular selection. Finally, a sizable cohort of state and federal agencies, and public and private sector institutions, perceive the NOSB as instrumental to achieving their own educational missions. This function of NOSB in facilitating other agencies' accomplishments could represent a distinctive, cooperative model of pre-college educational programming, and research sector-education sector partnering.

It is believed the findings from this research will contribute to a better understanding of the educational accomplishments of the NOSB at the primary level, i.e. the content enhancement and perceptions of the ocean, and awareness and interest in ocean-related careers among pre-college student participants, as well as broader impacts in affective domains of adolescent development. Further, the data collected and their analyses describe the impact on the teachers/coaches and the subsequent infusion of ocean science content into their classroom instruction with the much larger group of students they teach. This study contextualizes the NOSB within the literature of educational research related to competition-based learning models, the career-path decision matrix of high achieving students, and the program planning issues related to scientist-educator interactions, multi-agency programmatic efforts, and career education and recruitment issues for pre-college students.

Approach

The research team implemented this two-year study in part as an evaluation process, monitoring the regional and national bowls during each of the two years with feedback procedures to inform NOSB regional and national coordinators formatively and summatively. More significantly, this study was primarily a research activity incorporating qualitative and quantitative methodologies based on a comprehensive review of the relevant literature to guide the interpretations of the findings.

Literature Review

Following standard research protocol, the researchers identified and summarized related and pertinent literature related to secondary students' career selection. Further, as the NOSB program utilizes a competition-format as the basic motivational methodology to encourage student learning and participation, the literature of academic competition was reviewed. From these sources, the researchers ultimately identified six factors related to how secondary students select career paths, and seven factors associated with quality indices of academic, competition-based programs. Chart 1 summarizes these factors with the primary citations from which they were derived. Further, this chart contains the sources of the data required to observe the presence or absence of these factors in the NOSB program, and the primary audiences who could provide these data. The questions referenced in column four are the draft items eventually incorporated in the instruments, which are attached in the appendixes.

Following completion of the Literature Review, the researchers operationalized these thirteen factors by refining and revising the instruments used in the earlier pilot study reported above. By overlapping the audiences and instruments for each of the

factors, the researchers were able to triangulate the responses to monitor the credibility of the data and the findings extrapolated from them.

Source of Factor	Factor	Source of Data	Audience
Eccles/Lupart	Student perception of specific tasks of a particular career	Survey—questions: Interview—questions: A1, A2, A3	Student
Eccles/Lupart	Student perception of role models' beliefs, attitudes, and expectations	Survey—questions: Interview—questions: A5, A10, B2,B1	Student
Eccles/Lupart	Students' previous, positive experiences related to the career	Survey—questions: Interview—questions: A6, A10	Student
Eccles/Lupart	Student's view of self—goals, self-concept of ability, ideal self-image, and view of success	Survey—questions: Interview—questions: A8, A9	Student
Eccles/Lupart	Student's estimation of difficulty of attainment vs. the value of the attainment	Survey—questions: Interview—questions: A4, A7	Student
Lupart/Cannon	Student's personal support network	Survey—questions: Interview—questions: A5, A10, B1, B2, B10	Student, Parent, Coaches
Tallent-Runnels	Competition: student motivation to participate, i.e. self-selection	Survey—questions: Interview—questions: A11	Student, Coaches
Tallent-Runnels	Competition: clear purpose for the competition	Survey—questions: Interview—questions: B4	Coaches, RCs, CORE
Tallent-Runnels	Competition: resources available to prepare students	Survey—questions: Interview—questions: B1, B2, B5, B10	Coaches, RCs, CORE, Students
Tallent-Runnels	Competition: promotion of academic excellence through constructive feedback	Survey—questions: Interview—questions: B6	Coaches, RCs, CORE, Students
Tallent-Runnels	Competition: promotes skills transferable to other settings	Survey—questions: Interview—questions: B7	Coaches, RCs, CORE, Students
Tallent-Runnels	Competition: accessibility of program information to audiences	Survey—questions: Interview—questions: A10, B2, B8	Coaches, RCs, CORE, Students
Tallent-Runnels	Competition: focuses student performance on an authentic audience	Survey—questions: Interview—questions: B7, B9	Coaches, RCs, CORE, Students

Chart 1. Competition Effectiveness Factors and Career Selection Factors utilized in the current study.

The literature review below is developed in two major sections. The *Career Selection* section addresses a breadth of literature looking at developmental and psychosocial dimensions of adolescents, to the role of mentors and “key individuals” in the lives of these young people. Additional citations address the functions of gender and ethnicity. The second section addresses *Academic Competition*—although little empirical research exists looking at large-scale programs with respect to how participation impacts the students who are involved.

Career Selection

An annual rite of passage for American secondary students is the gradual realization that high school graduation is not the end of their lives, but the beginning of a new phase. The decision to enter the workforce or higher education is more complex as opportunities for high salaried technical positions—which do not require college—compete for the attention of students. The tradeoff to commit to the research career pipeline seems more difficult in uncertain economic environments, as well as environments where senior research positions are difficult to obtain. While little empirical research has addressed career decision pathways among high ability students, ancillary developmental studies have produced some evidence to describe these pathways.

Pearson & Dellman-Jenkins (1997) discussed that as high school students begin to consider their options after graduation, more than half will choose to attend a college or university. Among those who choose college, a small number will know exactly what they want to do, and will declare a major upon entering college. As for the rest, Olson (1996) says “if someone asked a high school student what career he or she expects to have...the answer would probably run something like this: a doctor or a movie star; a

lawyer or a professional athlete; an electrician or a corporate executive.” The projections would most likely be all over the map and wildly unrealistic.

This problem is shared by all students, including the gifted. Grant (2000) observes that academically talented college students making career decisions tend to experience frustration with multi-potentiality, to delay career decision-making, and to change majors more often than average students (Kerr & Erb, 1991, p. 309). Olson (1996) cites Bidwell as saying one group of young people is missing: the group of young men and women who expect to go into the same well-paying, blue-collar jobs as their parents. “These kids are simply not there,” Bidwell says. “They don’t want to do it. It’s not that the jobs have all dried up or that the opportunities have all dried up. They simply do not want to follow that particular track.” (Olson, 1996). So how do students make their career decisions? What influences their career choices?

Shoffner & Vacc (1999) state that based on research, selecting a career involves a process that includes a person’s background, personal qualities, motivation, and environment (Farmer, 1987).

The strongest influence in a student’s background comes from the student’s parents. Shymansky (2000) says that parental involvement in schools has been documented as a positive influence on children’s achievement, attendance, attitudes, behavior, and graduation rate regardless of cultural background, ethnicity, and socioeconomic status (National Parents and Teachers Association, 1998).

In an introduction of his book, *The Young Scientists*, in *NEA Today* (1994), Berger says that one way for a student to succeed is to have parents who value and encourage curiosity, autonomy, initiative, and hard work. Mihaly Csikszentmihalyi, in a

conversation with Marge Scherer (2000), says that modeling is the best strategy parents can use to inspire their children. They must both support and challenge their children. “Challenge gives children vision and direction, focus and perseverance. Support gives the serenity that allows them freedom from worry and fear” (Scherer, 2000).

Olson (1996) finds that families play a strong role in adolescents’ development and outlook. Teenagers from families that are both supportive and challenging feel more secure at school, have higher self-esteem, and report doing more homework. They also tend to view school-related activities as more relevant to their futures and to get higher grades. Children whose families engage them in hands-on learning also have higher educational aspirations and clearer career interests. Kaplan, et al. (2001) believe that those children, with the encouragement and support of their parents, should increase their own educational aspirations (Marjoribanks, 1986) and be less likely to feel the need to act out academically their rejection of parental academic pressures.

There are other significant factors to be considered involving parental influence. These are the children’s perceptions of parental expectations, and the parents own self-feelings. This very complex relationship may account for some student performance. Children seem to react more strongly to parental negative self-feelings than to parental expectations. Kaplan et al. (2001) said children’s feelings of high parental expectations may be counterproductive if the parents, hampered by their own negative feelings about themselves, are not able to provide the educational environment and resources important to their children’s academic success.

While parents can have formidable influence on their children’s career choices, Olson (1996) found that today’s students harbor expectations that have little to do with

their families' circumstances. Students may choose or reject a career based more on their own perceptions of the career. The career may leave too little time for raising a family (Grant, 2000), or the lifestyle of persons in the career may be un-appealing. A career might be tempting if it offers a good salary (Subotnik, 1993).

Wang & Staver (2001) found that student career aspiration has been identified as the most important variable influencing students' later work experiences. The development of career aspirations can help students clarify their career goals, and thus, make the learning experience more meaningful in high school (p. 312). Aspiration can be specified by two components: ambition and inspiration (Plucker, 1998; Quaglia & Perry, 1995). Ambition refers to students' sense of educational and vocational goals for the future. Inspiration refers to students' involvement in an activity for its intrinsic value and enjoyment (p. 314).

It is important that schools be attentive to the need to educate and inspire students. In fact, Murnone and Levy (1996) observed "The most important problem U.S. schools face is preparing children for tomorrow's jobs" (p. 317).

Csikszentmihalyi (Scherer, 2000) reports that the more [educators] can show the relevance of what they're doing to the life of the student, the better (p. 15).

Csikszentmihalyi also indicates that to educate is to expose kids to many possibilities until they find a connection between what is really important to them and the world out there (p. 17). So how do educators inspire students, especially in the area of career choices?

Shoffner and Vacc (1999) found that school counselors played a critical role in providing appropriate career education and guidance for secondary students. "School

counselors can be instrumental in encouraging career aspirations, providing accurate information about local and national labor trends to help students make better informed choices, and offering opportunities for students to learn about careers...Counselors also can provide career investigation and decision-making activities so that these various interventions can be placed in the context of individual abilities and interests.” School counselors also can help increase family collaboration by working closely with parents to increase family-school communication, and by providing parents with the skills and attitudes necessary to encourage their children to make appropriate career choices.

Kasov explains that it may be important for girls – and perhaps for many boys – to look at the big picture first, how everything fits together and applies to real life. Girls, particularly, have a strong need to know why they are learning about things and how it is connected to the way the real world works (p. 60). Kasov holds the belief that high school teachers can make a difference in the lives of adolescents as they make sense of their world, make decisions about academic work, and begin to think about possible careers (p. 60).

How can teachers make a difference? There are many strategies that educators can use to influence their students. Providing an appropriate, challenging curriculum is one of them. Grant (2000) reports that deficits in academic preparation are less likely to be barriers since reforms are standardizing college preparatory curricula; Subotnik (1993) reported some students who felt their schools had not done enough. They felt they suffered from a lack of preparedness for both the work and the competition which they encountered among students.

Providing role models is also important. Literature on career development of scientists supports the role of mentors as catalysts to the progress of young adults (Subotnik, 1993). Mentors are not only role models, they may also inspire with intellectual sparring, provide emotional support, or introduce their students to important people in the field (Subotnik, 1993). Mariane (1998) found that job shadowing and after-school internships were very effective by letting students see careers with their own eyes. He found that students could use job shadowing to explore all kinds of occupations. He explains that some students decide they would love a career in the occupation they've shadowed; others discover they would hate a certain type of work. By shadowing and personally experiencing the job, students can form their own perceptions of the tasks of the career; consequently, they are more likely to make good job decisions in the future.

Another way for educators to help students choose careers is by helping them build on their strengths (Scherer, 2000). Olson (1996) suggests that adolescents recognize that school and school-related activities play an important role in their futures. But the students most aware of this connection are those who are academically challenged and engaged.

One way to challenge and engage students is through competitions. There are many different types of competitions in which students can become involved. Quiz bowls, spelling and geography bees, science fairs, essay contests, debates, music competitions, speech contests and many more competitive opportunities are available. Different competitions may appeal to different types of student. Educators should help students carefully select those which match their interests and abilities. Karnes and Riley (1999) found that by placing scientifically gifted students in an atmosphere of challenges

via competitions, the spotlight shines on their abilities. Competitions can also be used to spark motivation (Cropper, 1998). Being motivated to experiment, thus thinking and acting like a scientist, can lead to a lifelong love of science.

Summer programs have successfully influenced students' career decisions. These summer academy programs feature classroom and hands-on-clinical practicum experiences to introduce students to the rigors of academic preparation required for the health professions. Students are engaged in active research, clinical practice, technology, and inquiry-based science courses. Students are provided with resources, mentors, and advisement regarding career plans. Students are tracked, and it has been found that approximately 81% of former participants chose a major area of study in a science field (Cavallo, 1999).

Cavallo (1999) also notes that in the academy environment, students develop lasting friendships among peers with like interests and motivations. Peers are, of course, another source of influence on students' career decisions. Pearson and Dellman-Jenkins (1997) recognized the powerful bond an adolescent shares with his or her peers, but they do not acknowledge that those peers have significant influence upon career decisions. How much influence peers might have seems to be uncertain.

Many community colleges and universities offer programs for junior high schools and high schools with on-campus events for students; tech-prep curricula for high schools; and programs to bring high school faculty to [college] campus (Quimbita, 1991). Many of these are pilot efforts to encourage students to enroll in science, mathematics, and engineering technology programs.

Magnet schools for specific interests or for special populations offer many successful programs. The Omowale School is one example. It targets African-American girls in a way that not only affirms that they can become scientists but also allows them to study with scientists in colleges, universities, and industrial laboratories. Adenika-Morrow (1996) reported that the program provided extensive exposure to African-American, female role models employed in the sciences. It used after-school leadership workshops, academic booster groups, enrichment workshops – including field trips, community resources and reading materials, summer pre-college programs at prestigious universities, and frequent guest speakers.

One educational strategy that has a measurable effect when used correctly is the Armed Services Vocational Aptitude Battery Career Exploration Program. It is primarily a recruitment and placement tool, but any student can take the two-hour test and fill out the accompanying survey to find out what occupations match his or her interests and abilities. Viadero (1997) reports that the program is an effective way to get students to think hard about what they want to be when they grow up and what they need to do to get there. Research conducted by Levine and Associates using 1,100 students from 48 high schools shows that kids who participated in ASVAB showed significant improvement in terms of their career maturity. The students were more likely to seek career advice. The program seemed to have the same effect on students regardless of their race, their gender, or whether they were enrolled in an academic track or a general track (Viadero, 1997).

There are many factors involved in student selection of a career. Students' own aspirations seem to be the most important; however, students do seem to consider parental expectations and the expectations of their teachers and mentors. Mentoring by

significant adults and personal hands-on experience through internships and other programs which provided specific, career-task specific understandings seem to be very effective influences. Educational preparedness also plays an important role. Challenging curricula and meaningful and challenging extracurricular activities also help students make the decision about what to do after high school.

Academic Competition

Sports Illustrated featured the Scripps Howard national *Spelling Bee* in its May 20, 2002 issue. “The kids train incredibly hard,” says Paige Kimble, President of the *Bee*. “They’re committed to learning origins and definitions; it’s exhausting, and they must have poise. The *Bee* has the drama of a sporting event” (Kennedy, King, White, Deitsch, and Kim, 2002).

The Scripps Howard national *Spelling Bee* is one of hundreds of academic competitions which are compared frequently to sporting competitions (Tallent-Runnells, 1996). These events have rules, trials, judges, points, winners and losers, time keepers, “buzzers” and significant prizes for those who excel: frequently including college scholarships, trips, and cash awards.

Academic contests are not a new phenomenon. In the 19th century, spelling bees were a popular form of entertainment. The famous *National Spelling Bee* dates its origins to 1925. The Scripps Howard newspaper chain took it over from *The Courier-Journal* of Louisville, Kentucky in 1941 (DiegmueLLer, 1990).

The Scholastic Art & Writing Awards Program has existed two years longer than the spelling bee and may be the oldest of the competitions. Maurice R. Robinson started the contest in 1923, two years after he founded Scholastic Inc. “He felt that students in

junior and senior high school who pursued creative endeavors did not receive the same sort of recognition as student-athletes did” (Diegmueller, 1996).

Academic competitions cover the spectrum of academic subjects: math, science, writing, foreign languages, history, geography, civics and government, economics and the arts (Diegmueller, 1996). In the past two decades, academic contests in all fields have emerged to capture students’ interest, grant deserved recognition, and foster the qualities that athletic competition has long emphasized: teamwork, a quest for excellence, and the valuable lessons of winning and losing (Nifong, 1996). Many of the academic competitions have borrowed from sports terminology: decathlon, triathlon, Olympiads, leagues, invitationals, tournaments, coaches, teams, and so forth. Some of the contests are run by the same state associations that govern interscholastic sports (Diegmueller, 1996).

Some recent additions, however, trace their roots to the publication of *A Nation At Risk*, the 1983 report that decried the “rising tide of mediocrity” in education and spurred today’s campaign for education reform (Diegmueller, 1996).

How do academic competitions assist in education reform? What is their purpose? Academic competitions like *Quiz Bowl*, *Odyssey for the Mind*, and the *United States Academic Decathlon* provide an opportunity for students to compete and excel on a mental level much the way they do on a physical one in sports (Parker, 1998). The idea behind programs like the Scholastic Art & Writing Awards is to “give a kid a pat on the back” (Walters, 1997). They are “about promoting learning and lifting the profile of the student so that instead of being the nerdy kid, they are somebody who has achieved something” (Harp, 1995).

Who are the participants in academic competitions? Is there an issue of equity? Are they just for the gifted? Are they gender specific? Is there room for the physically handicapped student, or for average students?

All students are eligible to participate in competitions such as science fairs. The primary goal of a science fair is to complement school curricula by encouraging students to use and understand the scientific method in designing and performing experiments (Abernathy, 2001). A few contests such as *We the People...The Citizen and the Constitution*, require entire classroom participation (Diegmüller, 1996).

School teams for the *Academic Decathlon* must have three students who have “A” averages, three with “B” averages, and three “C” students. Even *Olympiad* competitions are not only for high achievers. Only about one-half of the participants have been members of the National Honor Society, and only one-third are generally from the top ten percent of their class. The average SAT score of the students was about 600 in both math and verbal abilities. Approximately one-third of the students had earned a varsity letter in some sport (Cairns & Putz, 1990).

Some students may be better than others at academic competitions, just as some students play basketball better than they play baseball. It is important that parents and teachers guide students toward competitions in which they can succeed. Student motivation should be the key. “Many students are scholars who want to match minds with other serious students across the country...The chance to compete with kids with similar interests is a wonderful motive” (Walters, 1997). Contests can be a means for bringing out excellence, “for encouraging students to do things they didn’t know they

could do...The very act of being engaged with other competitors, the very synergy of that...summons up the best in everybody” (Nifong, 1996).

Once students become involved in a competition or contest, preparation time can become a real issue. Some students put in as many as 40 hours a week preparing for the U.S. Academic Decathlon (Shooting, 1996). Students arrive at school early to practice. They stay late, and practice during lunch breaks and on weekends. Their practices are a test of mental endurance (Parker, 1998). Even when students get to travel for a competition, they report that they only get “to see downtown through our window...because of continued practice between events. Some feel that the intensive...training sessions create burnout (Diegmüller, 1996).

Practice time can be intense, but it cannot compare to the intensity of the competitions. Lightning rounds, toss up questions, extemporaneous speeches in front of a panel of judges, a misspelled word that means losing a \$40,000.00 college scholarship – “so much is a stake: the money, the prestige, the guest shot on Letterman” (Kennedy, King, White, Deitsch & Kim, 2002). Even though the practices and the competitions are stressful, many participants have no regrets. One student participant is quoted, “I think decathlon is one of the greatest experiences I’ve ever had” (Diegmüller, 1996).

While many competitions are free, some charge a modest fee for registration or curricular materials...The real cost is for transportation and lodging (Diegmüller, 1996). Many schools face budget crises; when neither they nor their Department of Education can fund the competitions, teachers and students must look for corporate sponsors and hold fund raisers in order to continue to participate (Parker, 1998). Corporate sponsors sometimes underwrite contests with little or no product tie-in to engender

goodwill...others have a clear product linkage. “The question becomes whether or not the contest is being promoted in the interest of the children” (Diegmüller, 1996). Some schools may simply be unable to participate because the money needed is not available.

Understanding the motivations for participation in competition becomes important. Kohn (1991) defines competition as mutually exclusive goal attainment; “my success requires your failure.” Kohn further reports research that suggests extrinsic rewards...often lead students to become less interested in the subject area, even if they were initially intrinsically motivated to succeed (Gay & Rueth, 1993).

This suggests another significant issue impacting academic competition: rewards. There are educators who feel that students’ actions should be based solely on learning for learning’s sake. Some [competitions] offer scholarships, or travel opportunities to winning participants. In fact, the financial rewards can be great. The Grand Prize winner in the Westinghouse Science Competition earns a \$40,000.00 college scholarship (Diegmüller, 1996).

While financial rewards can be great, students receive many other rewards. Among them students list: having fun, learning new things, competing against other students, working with friends, learning the scientific process (Abernathy & Vineyard, 2001). Other rewards students mention include recognition for academic achievement (Fitzgerald, 1994); meeting new people (Cairns & Putz, 1990); contacts for future jobs (Walters, 1997); improved self-esteem, leadership, and the newfound joy of learning (Daily, 1996).

Perhaps the most controversial issue regarding academic competitions is whether competition has a place in academics at all, or whether all learning should be cooperative.

Proponents of cooperative learning may believe that students learn more from their peers than from the teacher. They believe that learners are cooperative beings who like to work together with other pupils. Pupils should work in committees effectively since life itself consists of working well with others (Ediger, 1996). They may feel that girls would be short changed in a more competitive atmosphere (Nifong, 1996). They may believe that some students would shy away from a risky situation such as publicly sharing one's work (Abernathy & Vineyard, 2001)

Cooperative learning has been found to be an effective method in many contexts. However, it may be that "a rational balance between cooperative learning and competitive learning would be more sensible since life in school and in society consists of both" (Ediger, 1996).

Children frame their experiences to a large degree on how their parents and teachers react (Diegmüller, 1996). If parents and teachers frame competition positively, contests can prompt pupils to push for their best (Nifong, 1996). By introducing the spotlight of competition to academics, program sponsors hope to inspire students to push themselves beyond learning the bare minimum and into learning for pleasure (Shooting, 1996). Competitions can serve as worthwhile tools to help motivate students. The trick is to "select contests designed solely to benefit students' educational, civic, social, or ethical development" (Diegmüller, 1996).

What types of competitions are recommended? Competitive events that make students aware of skills required in their future occupations are excellent (Daily, 1996). Others may help students gain experiential learning that leaves them thinking about additional solutions to problems (Mentors, 2001).

Some competitions focus on service-oriented projects with academics included. One such competition is *A Pledge and a Promise Environmental Awards* which focuses on the area of environmental science. The focus is primarily on the actions that school groups take to help protect the natural resources of our planet (Karnes & Riley, 1999).

“The Future City Competition allows students to learn about their surroundings in a very fun and interesting way through the SimCity program. Engineer mentors ...show the potential engineering applications” (Mentors, 2001).

Theater Sports is a competition in which teams of students vie to produce the best improvisational skits. They must listen to each other and work as a team to succeed (Diegmüller, 1996).

Math Counts and *Quiz Bowl* teach students sportsmanship, discipline, social skills, and how to handle stress. These programs specifically address and focus on leadership skills (Parker, 1998). Science fairs and Science olympiads promote problem solving.

These competitions and many more encourage students to participate and to invest in their school. They may have serious and enduring effects on shaping career patterns and life choices (Anderman & Maehr, 1994).

Methodology

This impact study was undertaken and implemented with consistent interaction between the researchers and the CORE staff. An initial meeting at the CORE office in Washington in Spring of 2002 was followed up with additional meetings in September 2002 in San Diego during the regional coordinators training session—and which also included a discussion session between the researchers and the regional coordinators. A follow-up meeting with a mid-project report was implemented in Washington in conjunction with the COSEE evaluators training meeting in 2003, and numerous emails and phone conference calls have facilitated communications through this project. This type of communication was important to ensure the project ultimately provides data to support program refinement and sustainability. Additionally, as the researchers utilized a qualitative methodology, the design parameters required this communications process to establish credibility of the findings. This aspect of the study is viewed as a foundational, essential component of the methodology. The data for analyses were collected beginning in fall 2002 through fall 2003 to overlap one entire series of regional competitions and one national competition, and again, represented approximately 500 subjects.

An additional communications dimension of this research study was the use of distance communications applications to interactions among the research team members. The College of Exploration established private discussion and file sharing spaces on the www to allow researchers to post draft documents, constructive critiques of emerging analyses sections, and to develop a library of resources necessary for group thinking, analyzing, writing and editing tasks. Such an approach streamlined and leveraged the financial costs of the project.

Following development of the literature review, as indicated in Chart 1 above, the identified factors for effective competitions and for the relationship of academic competitions to student career path decision factors were identified and operationalized through instruments for past participants, regional coordinators, volunteers, coaches, and through interview protocols for parents, volunteers, and competition officials. These instruments were piloted in the 1999-2000 study and revised based on those study results. The instruments used in the current study have been appended to this report. The research design and methodology outlined initially for the study are as follows.

The National Ocean Sciences Bowl was viewed as a complex system of programs implemented within local high schools throughout the country, at centralized, regional locations hosted by coordinators representing a variety of agencies, and incorporating a larger variety of institutional partnerships and strategies. Finally, the regional winning teams proceed to a national competition hosted by CORE and implemented through an additional, complex partnering strategy.

Consequently, the data required to effectively capture and view the operation of the NOSB is multifaceted, and represents information held by a broad constituency. The methodology to enable research of this system is consequently also complex, relying on multiple instruments and access points into the NOSB system. The researchers utilized multiple site visits and field interviewers with a standardized interview protocol, with multiple surveys implemented through internet facilitation and “paper and pencil” methods, and relying on the expertise of one of the research partner’s—the College of Exploration—for online coordination.

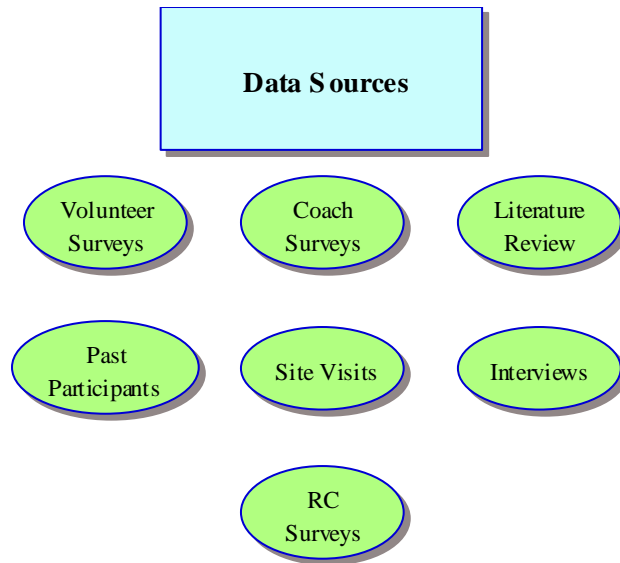


Figure 1. Sources of Data for the Research Study

Figure one above illustrates the sources of data collected for analyses. These sources are summarized independently in the first data summary section below.

A review of the literature was implemented to identify relevant factors used by other researchers to monitor or track career decision-making among secondary students. Ultimately, six factors were identified from other research and used as the conceptual basis for both instrumentation and analyses of the NOSB data in the area of career decision-making. These six factors are reiterated in Figure two below.

Additional review of the literature for secondary student development focused on the impact and characteristics of academic competitions. The literature is vague and indeterminate with respect to event-based competition such as the NOSB. The

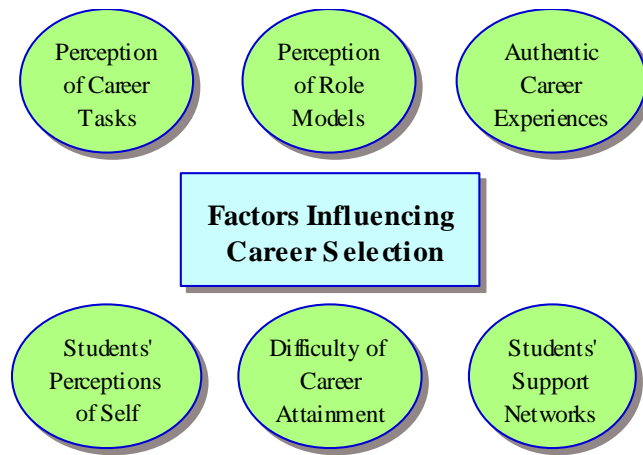


Figure 2. Factors which influence secondary students' career selection.

researchers could find no example studies which attempted to measure or document direct impact on students from an academic-oriented event, although a few anecdotal studies looked at select student response or motivational factors. One important text was identified and became the conceptual basis for development of instrumentation and data analyses protocols for viewing the NOSB as a competitive treatment on students (Tallent-Runnels, 1996). From this source, the researchers developed a series of open-ended questions for surveys and interview protocols to characterize the NOSB. These factors regarding academic competition-based programs are illustrated in figure three below.

The multiple audiences involved in the NOSB necessitated a set of instruments targeted to the specialized experiences or understandings of each separate audience with respect to the type of knowledge each audience would possess. Separate survey instruments were developed for the regional coordinators, the coaches, the volunteers, and the past participants in the NOSB. Forms of the coach, regional coordinator, and past participant instruments were previously

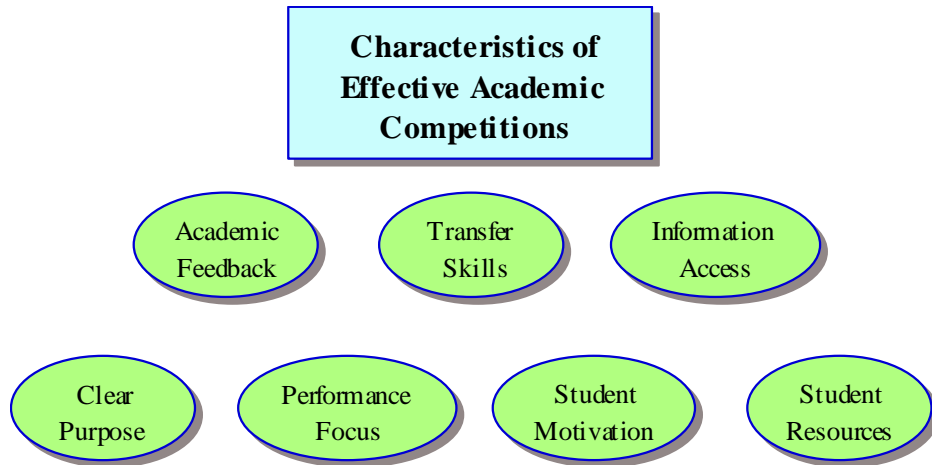


Figure 3. The Tallent-Runnels (1996) factors for gauging the effectiveness of academic competitions used in the NOSB study.

piloted by one author (Walters) in a study of the NOSB in 1999-2000. Additionally, ten of the regional sites were visited by members of the research team for observations and implementation of select interviews with parents and volunteers. Initial guiding questions—developed from the factors and characteristics delineated in figures two and three above—were organized into interview protocols. These initial, guiding interview questions are also appended to this report.

Surveys by Audience

With respect to the sources of information, the *coaches* served as a highly important population for the study, as they “bridge the gap” between the students and the administrative infrastructure of the NOSB. The term “coach” is used as a label for the high school teachers who serve as sponsors and, in most but not all cases, teachers for the students who comprise the teams from each school. Data were collected from the coaches through a survey instrument implemented through the internet.

The *volunteers* who facilitate the event at the regional and national sites were an important source of data, as they connected CORE and the regional coordinators, and the

institutions and agencies which sponsor and support the NOSB regionally and nationally. Consequently, these individuals could directly address the causal relationships and linkages that describe participation by the broad community of agencies and institutions necessary to implement the NOSB. The volunteers could further clarify the associations of mission statements among the institutions and agencies which merge to create a systems-view of the NOSB and CORE. Volunteers were both surveyed and, on a select basis, were interviewed by members of the research team during site visits. The interviews were transcribed and the initial guiding questions have been further appended to this report. Cross comparisons were made between the volunteer surveys and interviews to monitor for consistency of response.

The *regional coordinators* provided an important link between the NOSB and the broader community of agencies and institutions which collectively provide the volunteer support and supplementary fiscal support to implement the programs regionally. These individuals, therefore, can provide not only data to analyze the communications structure and programming components, but also to clarify the relationships and affiliations that characterized the program as a system.

Recognizing the stated importance of career development as a goal for the NOSB, the researchers located and surveyed a sample of *previous NOSB students* who are now engaged in or have completed college level scholarship. Working through regional coordinators, coaches, and with existing partial databases provided by CORE staff, these students were surveyed to ascertain continuing interest in ocean science, current standing in college and current degree and career path plans. The pool of past participants who were ultimately identified for study was small, n=32. The task of locating these

individuals proved much more difficult than anticipated due to federal privacy act limitations on teachers' and regional coordinators' abilities to provide contact information. Most teachers do not maintain contact information with students under any circumstances, but rely on office personnel to supply this information if it is needed. Consequently, the teacher/coaches were not able to supply as many names as the regional coordinators provided. As with any attempt to create a longitudinal study group *ex post facto*, locating participants is the most difficult activity. Some additional anecdotal information relative to student involvement with science fields after NOSB participation is obtained in the Coach responses—who collectively mention an additional approximately twenty students who are engaged in science courses beyond the n=32 cited above. Nevertheless, past participant responses indicate approximately 50% (15 of the 32 students) of respondents are engaged in an ocean related career track in college, and cite the NOSB as the primary rationale in making that decision.

Observational and Anecdotal Data

It should be reemphasized that the research team individually or collectively visited ten, geographically dispersed regional competitions and the national competition. The use of a qualitative analysis model for the data required a deep, personal and contextual understanding of the situated environment of a phenomenon—in this case the NOSB. Consequently, while the expenditure for travel funds was a substantial part of this project to facilitate these site visits, if this activity had been minimized, the capability of the researchers to analyze the data in a contextually credible manner would have been compromised.

The previous, 2000 study further indicated numerous state and federal agencies provide support on many levels for implementing the regional NOSB competitions and the national finals. NOSB has identified long-term objectives to strengthen its program infrastructure and fiscal support. In this 2002-2004 study, the researchers collected select data to identify the specific, mission-related goals of the partnering agencies and individual researchers who participate in the competitions to describe the multiple contexts to which CORE appears to contribute through the NOSB. These data illuminate potential partnerships which could be developed and strengthened through leveraging of resources where overlapping missions and goals exist. By documenting the perception of benefits accruing to the existing partnerships, more systematic opportunities for infrastructure and fiscal development could be clarified to attract investments from federal and state sources, and from the private sector. These benefits, as derived from narrative analysis of the data, are described later in this report. Further, these multi-agency goals and objectives are additional support that the NOSB has evolved into a complex learning and social community.

Summary of Data Sets

While the most significant impacts of the NOSB are illuminated by comparing the data sets to each other to gauge internal consistency based on emerging patterns, it was clear to the researchers that valuable perspectives about programmatic elements could be obtained through an initial summarization of the individual data sets themselves. Again, even though the patterns and linkages which support the overall research tiers of this study lack clarity short of the cross-set analyses—the following individual data set summaries do provide important views on numerous facets of the competition. These

individual data set summaries are not parallel, in that the themes that emerge from the individual sets are independent, and potentially different from each other. Thus, these summaries in the section which follows should not be compared at this level, i.e. it is inappropriate to compare summary to summary instead of merging the raw data for each set for holistic comparison. The reader is thus cautioned to refer to the cross-set comparisons later in this report for analyses at that level. It is further noted that the surveys were not parallel in format, and the following summary sections reflect this lack of parallelism.

Regional Coordinator Surveys

Regional Coordinators were provided a URL to access an electronic survey instrument hosted at the College of Exploration. This instrument, included in the appendixes to this report, captured narrative organized around questions matching appropriate study factors from Chart one. The themes which emerged from narrative analyses are presented in summary fashion organized by question as follows.

1. What personal benefits do you derive from your coordination of your regional bowl?

Students who participate in the NOSB build their self-confidence, get excited about ocean sciences and have fun. The regional coordinators responded that that these were the reasons they personally participated in the NOSB. Additional personal benefits included the opportunity to travel and help students. Coordinators enjoyed fostering collaboration amongst the student competitors. Other reasons included doing something good for the students, spreading the word about ocean sciences and bringing people together.

2. What professional benefits do you derive from your coordination of your regional bowl?

The greatest professional benefit reported by NOSB coordinators was the opportunity to network with other professionals as well as graduate students and ocean science partner organizations. Professional benefits included working with teachers and developing relationships with others. Additional benefits included developing leadership, management and multitasking skills.

3. Why did your institution decide to be a regional site?

The primary reason institutions decided to be a regional host site was because the NOSB is in line with the mission of the organization. One coordinator said, "Participation would raise the profile and credibility of existing educational efforts." Several indicated that they were a member of CORE. Coordinators also said "hosting the NOSB was a useful tool in recruiting students."

4. What benefits does your institution receive because of its support and participation in the NOSB?

Hosting the NOSB provides several benefits to the coordinators' institutions. These benefits included primarily visibility within the educational community, improved reputation of the institution, and positive publicity. The RCs also indicated that it provided an excellent opportunity for networking for faculty and graduate students who are interested in K-12.

5. What accomplishments are you most proud of with respect to your NOSB?

Philosophically, regional coordinators were proud of the increased awareness of ocean sciences as well as being able to help teachers to incorporate marine science into their

curriculum. The NOSB also provides the opportunity for increased connections between faculty, staff and potential students. Logistically, regional coordinators were happy to see the number and diversity of teams increase. They were also pleased to see sponsor support increase and to have a well-run competition.

6. Why do you think students participate in the NOSB program?

The Regional coordinators indicated that they believe students participate because they enjoy competing, the prizes are a good motivator, and their teachers encourage them. Most of all they enjoy the competition because it is fun.

7. What benefits do you think students receive through their participation in the NOSB?

The top three benefits of student participation, as reported by the regional coordinators included: an increased awareness of ocean science; the opportunity to meet with scientists and build their knowledge of careers in the field; and the opportunity to build teamwork and interpersonal skills. Coordinators also indicated that they believed the students benefited from the challenge of the NOSB through raising their self-esteem sportsmanship and sense of purpose. It also looks good on their resumes/ applications for college.

8. What academic, social and or life skills do students acquire by participating in the NOSB?

The predominant skills acquired or improved by students participating in NOSB include teamwork, leadership, discipline, sportsmanship, scientific knowledge and improved study habits.

9. What career information related to ocean sciences have you provided to student NOSB participants?

Regional coordinators provided many different career resources to students. These included program brochures, textbooks, internet resources, research presentations and exposure to experts in the field. Unfortunately, several coordinators indicated that they did not provide any career guidance to participants.

10. What career information related to ocean sciences have you provided to the parents of NOSB participants?

The majority of respondents indicated that they had provided no career information to parents except indirectly through the students. They indicated that interaction with the parents was minimal.

11. What obstacles do you perceive in students selecting ocean science career paths?

The primary obstacles perceived by regional coordinators included lack of correct information about careers in ocean science; the amount of education required being successful in the field and the lure of far more lucrative careers in other fields. In addition, coordinators believed that the lack of ocean science careers in certain regions certainly played a role in deterring prospective students.

12. What benefits do the coaches receive through their team's participation in the NOSB?

The schools, parents and students recognize the teachers/ coaches for all of their tremendous efforts that they put forth for the NOSB. In addition, they benefit through the access to a variety of educational resources in ocean sciences. The opportunity for the

coaches and their teams to network within the ocean science field is also an excellent benefit.

13. How do you think the NOSB program adequately and consistently supports its stated purpose?

There were broad differences in responses to this question, although they were overwhelmingly positive. “The program is well-designed maintains vigorous quality standards, and draws on the individual and collective knowledge” of professionals, indicated one coordinator. Respondents believed that the program promoted academic excellence while being fun for all involved. Scholarships and financial support were important qualities. Several coordinators indicated that the program would reach its goal of fostering more interest in marine science careers if it was not so restrictive and elitist, but was open to a broader span of students. Additionally, a few coordinators felt the objectives for the program could be clarified.

14. What could be done to make the NOSB more effective at your site?

Regional coordinators indicated that larger and more consistent funding for the program was the most important improvement that could be made. Funding was repeatedly reported as a concern. In addition, RC’s reported that there should be an increase in the number of faculty and graduate students involved, “particularly as volunteers.” Numerous coordinators reported that the coverage of the program should be expanded to include more schools with a broader geographic coverage (within their states). Several of the issues raised could be classified as resource issues: they felt that more help was needed in terms of coordination/ outreach, teacher and team materials were need, as well as increased volunteer training. Some respondents suggested that coordination efforts

should be made between the hosting school and the next year's school to make the transition easier [in regions where the competition rotates location].

15. Please explain the reasons for your rating of support you receive from CORE.

Many of the comments from the coordinators include positive remarks as well as constructive criticism. CORE has been very supportive and helpful in all facets of NOSB preparation. Communication has been good, although sometimes delayed (deadlines missed) or overwhelming. The staff of CORE is always soliciting input as a means of improving the program. One regional coordinator indicated: "I feel that the CORE staff does everything that absolutely must be done in order to enable us to run our competitions. They get a 5." The support materials provided are super. "CORE provides phenomenal direction and support materials to make the competition as smooth as possible. However, as the expectations on the regional coordinators and the regions grow every year, the financial backing must also grow." Financial backing for the program needs to improve, and fundraisers should be supported for the program. These will be needed if the program is to continue to grow successfully. In summary of the reasons for their ratings, the coordinators thought that the program and the people from CORE were outstanding, but it needs more support and financial backing to be "all it can be."

16. Has the program improved over time?

Ninety three percent of the respondents indicated that the program has improved over time.

17. If so, please describe in what ways?

Several themes were present when reviewing the ways the NOSB has improved over time. The addition of the team challenge questions "improved the use of more critical

thinking and application of knowledge rather than just factual recall.” Additionally having scholarships and internships available was an improvement. RCs also indicated that the program is reaching a broader base of prospective marine scientists through minority outreach and diversification of the participants. Other responses included logistical reasons for the improvement overtime including site coordination, rules clarification, CORE support, inclusion of evaluations and the on-line registration. Overall, the program has become “larger and more sophisticated.”

18. What enhancements or changes to the program have had the biggest positive impact on the participants (including yourself, volunteers, coaches, parents, as well as students)?

The team challenge was reported to be the biggest enhancement to the program. In addition, increasing the funding from 10k to 15k was a great assistance. The minority outreach and diversity programs are a positive change to the NOSB. Other enhancements included the Friday field trips for students, formalization of questions for judges, the wild card program and the side fun activities [responses to this item were highly regional specific].

19. Any other thoughts you'd like to share about the NOSB program?

“NOSB seeks to raise awareness of a subject area not required in most schools. To achieve the goals of widening awareness of oceanography and future marine scientists funding should be directed toward development of curricula for k-12.” The program has a great ripple effect that really cannot be measured in terms of how many it is reaching beyond the students, staff and volunteers. The coordinators need more help, assistance

PR/ Communication should continue to be improved “You are doing a fantastic job with the program. I am proud to be part of it.”

Volunteer Interviews

At site visits to 10 of the regional NOSB locations, research team members implemented brief interviews with select volunteers to obtain conformational data and input to compare with survey instruments as a credibility and reliability check. Data for the eighty interviews were collated and analyzed for themes and similar responses.

Summaries of these are as follows.

1. The primary motivation for volunteering seems to be an agency or institutional affiliation related to ocean science, or science generally—particularly for agencies and organizations associated with the regional coordinators either personally or with the regional coordinators’ agencies. For the regional sites associated with university campuses, the use of graduate students and faculty members appears to be a typical path for volunteer acquisition. Some individuals expressed that NOSB activities were viewed as community service in the university setting, while others expressed that this was an excellent mechanism to “get the right kind of potential student” on the campus. Clearly, the volunteer pool represents some long-standing relationships between the host organization and the institutions from which the volunteers are drawn. It further appears the NOSB regional hosts are active in other educational and outreach programming—and that the RCs have tapped these relationships to build the NOSB regional effort.
2. Benefits which accrue to the volunteers—as expressed by the interview group—are perceived as a great sense of personal fulfillment and satisfaction in supporting

students in an educationally valuable activity. Some individuals further express the need to support the “pipeline” for development of ocean science researchers, but this was not as significant a view as the desire to help students and contribute—both personally and professionally—to a worthwhile event. Cross-sectioning the data by whether the NOSB is viewed as education or as environmental action reveals a nearly equal distribution of the interviewees. Approximately half of the interviewees stated the NOSB was important as a science education activity. An approximately equal number expressed it was important to create environmental stewardship among the young people participating, and that the volunteers’ motivation was participating in anything that supported the environment.

3. The final significant cluster of interview data pertained to the benefits the students received by participating in NOSB. Among the themes expressed by the interviewees were the importance of competition for “this type of student”—an expression interpreted as “highly academic and capable.” Further, the importance of learning to work as a team as a valued science research skill was expressed by 22 of the interviewees. Others viewed the opportunity for personal growth, leadership development, enhanced content knowledge for the oceans, and the resources and career information that are provided to the students as the major benefits of participation—whether the students’ teams won or lost.

Coach Surveys

Analyses of the surveys completed by 123 NOSB Coaches indicates or reveals a number of observations likely to be preserved in further analyses and cross-comparisons of the data sets. As with the surveys for volunteers and regional coordinators, these

surveys were administered via a URL to a site hosted by the College of Exploration.

These include the following generalized perceptions of the coaches.

1. In general, coaches believe the NOSB has been a positive component of the curriculum for the students directly participating, and that they [coaches] have further infused ocean sciences content into classroom instruction for a majority of their students because they are more informed, see course interconnections, and see the interest level which ocean sciences generates.
2. The coaches believe that participation in the NOSB results in direct, positive academic-oriented benefits for the team members. Additional benefits to the students include improved study skills and habits, a competitive association with academic content and standards, and an interdisciplinary understanding of ocean sciences as a field of study.
3. A large majority of the coaches perceived the addition of the team challenge questions a positive revision of the NOSB. Similarly, a majority of the coaches were satisfied with these questions themselves—although it should be noted a significant minority of coaches expressed a variety of concerns with regard to the consistency of these questions in terms of difficulty, and with the time associated with waiting for scores.
4. The coaches perceive NOSB to be a very high quality science education program, which informs and motivates students about the academic and research field of ocean sciences. There is a strong statement that the program is challenging and is consistent throughout with its stated purpose.

5. Coaches report, perhaps as their strongest observation, that the NOSB possesses a strong academic focus. Participants are primarily involved in mastering academic content for use in a competitive, problem-solving environment.
6. Coaches report that critical thinking, teamwork, problem solving, confidence, leadership and organization skills—are all ancillary benefits of participation in the NOSB which accrue to the team members.
7. One strong observation is the eleven teachers who indicate they have implemented ocean science courses at their high schools as a result of participation as a coach in NOSB.
8. The coaches indicated that the practice questions provided by the CORE office were by far the most helpful source of information in preparing and guiding their teams to participate.
9. A strong majority of coaches perceived the NOSB as providing good career information to students, noting print materials distributed at the regional and national events, opportunities to visit college campuses and research laboratories, and opportunities to interact with professional role models, i.e. scientists, researchers, graduate students, and other similar ocean related personnel.

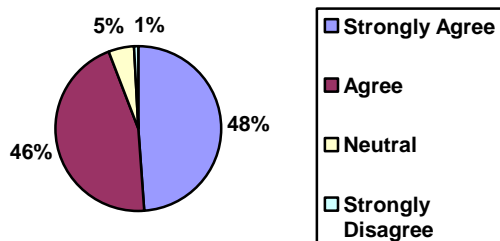


Figure 3. Coaches' responses regarding belief that the NOSB greatly increased students' awareness of ocean science careers.

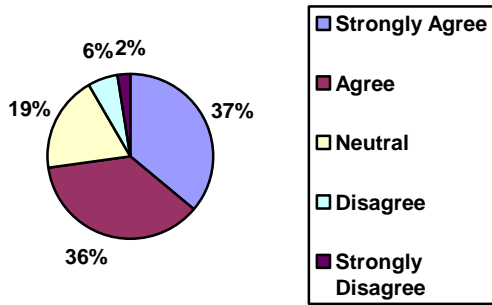


Figure 4. Coaches' responses to the statement that participating has increased their infusion of ocean sciences content into their classrooms.

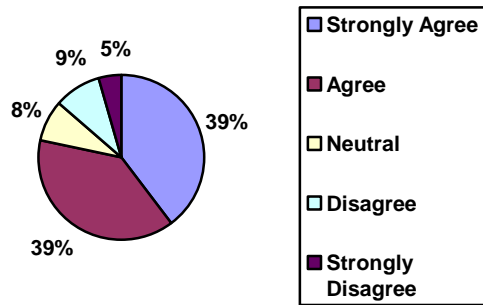


Figure 5. Coaches' responses to the statement that the addition of the Team Challenge Question was an improvement to the NOSB competition.

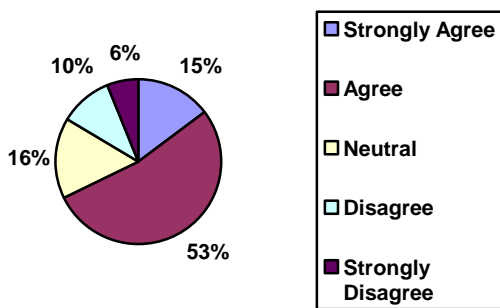


Figure 6. Coaches' responses to the statement that the difficulty level of the Team Challenge Questions at the regional competition was appropriate to the students' knowledge levels.

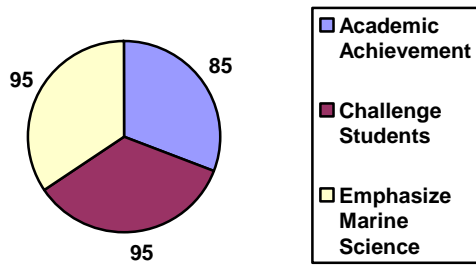


Figure 7. Number of responses in each category for Coaches' Reasons for Participating in the NOSB Competition. It should be noted that this item allowed for multiple responses from individuals.

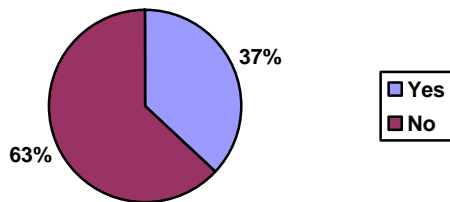


Figure 8. Coaches' respond that 63% did not perceive they encountered any barriers to participation in the NOSB program. The barriers which were reported by the 37% in that category are disaggregated in the following figure.

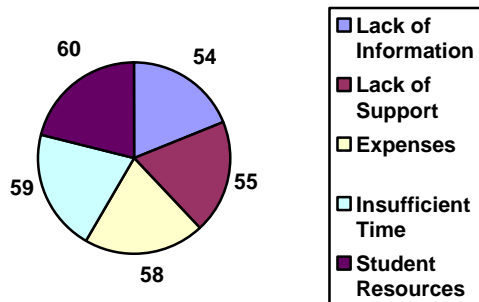


Figure 9. Coaches who reported barriers to participating in the NOSB competition identify those barriers in these five categories. The data are reported by number of responses, and no individual category appears to be more significant than others. It should be noted the item allowed multiple responses by coaches.

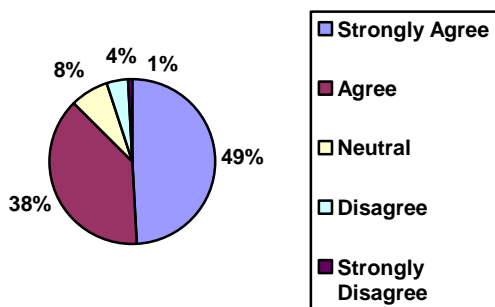


Figure 10. Coaches’ responses to the statement “My students and I received sufficient information about the NOSB and participation requirements to prepare for the competition. This selected response item is supported in the narrative analysis sections.

Past Participant Data

Analyses of the surveys completed by the thirty-two identified past participants have been included below. Additionally, members of the research team interviewed several past participants either at site visits, or electronically during an electronic forum posted to the www in fall 2003.

1. When looking back at your NOSB participation, what were the benefits you received which continue to be relevant to your college or career path?

Both college choices and career choices appear to have been influenced by past participation in the NOSB. Academically, participants reported improving science interest, working with their teachers, learning how to study and overall improved academics. “The NOSB was an opportunity to get to know my science teacher better: she has been a mentor ever since.” One participant indicated, “It gave me an idea about what to do with my life. It was inspiration on a large scale. “Leadership development skills were one of the dominant themes reported by past participants in the NOSB as they

related it to their careers. Survey respondents reported that they developed confidence in leadership skills, teamwork capabilities, and networking with experts in the field.

2. What part(s) of the overall NOSB experience (from preparation activities through the competition weekend itself) were the most enjoyable?

The competition itself was the most enjoyable aspect of the NOSB as reported by past participant survey respondents. Students had fun. They enjoyed the team environment and competing in an area of interest to them. They also enjoyed the opportunity to travel to popular destinations (Hawaii and Washington D.C.) .

3. What experience or activities other than NOSB during your high school years influenced your selection of career or college major?

In addition to NOSB, past participants reported several factors that influence their choices. NOSB participants reported that they have been very involved with philanthropic and community service work through scouting, camps and other volunteer activities. These activities, in combination with the influence of excellent teachers supported their choices of college major and subsequently their careers.

4. Why did you participate in NOSB?

Past participants listed several reasons for their participation in NOSB. The top five reasons, in order of prevalence were Oceanography; liked the competitions; excelled in the topic; and the influence of their teachers and friends. Other reasons included career interests; potential college scholarship opportunities, prizes and the overall experience.

5. What skills did you practice or develop through NOSB that have been helpful to college or career activities?

Past participants reported that they acquired and refined several skills through participation. These included team building, critical and “outside the box” thinking; organization and time management, and listening skills.

6. When you evaluate a potential career, what issues are important to you?

Participants reported a number of critical factors when examining characteristics of a career that were important to them. The predominant reasons included intellectually stimulating; quality of life and flexibility; societal importance; reputation/prestige; and self-fulfillment. Pay was also reported as a factor, but was not a predominant reason.

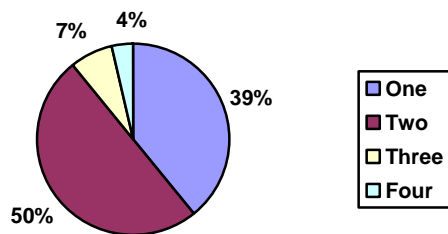


Figure 11. Past Participant Survey respondents indicate number of years in which they participated in the NOSB (n=28 responses to item).

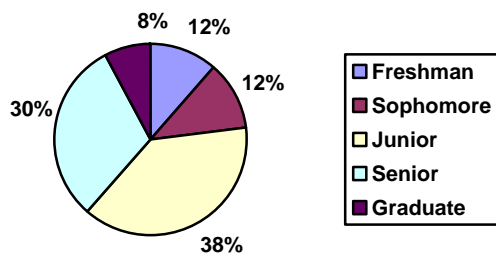


Figure 12. Past Participants indicate year in college in which they are currently enrolled (n=26 responses to item).

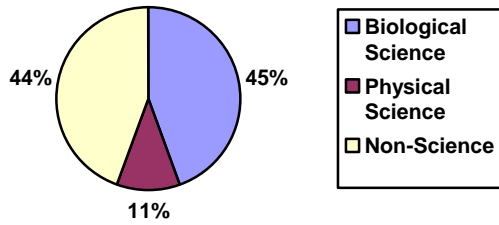


Figure 13. Past Participants indicate 56% have selected a science major in college (n=27 responses to item).

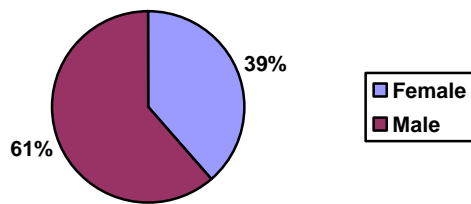


Figure 14. Past Participants indicate gender (n=26 responses to item).

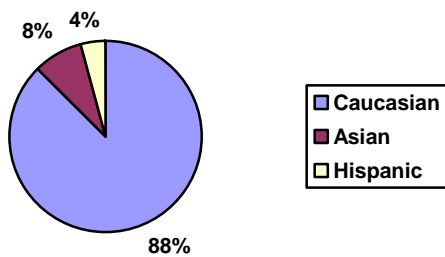


Figure 15. Past Participants indicate race or ethnicity (n=24 responses to item).

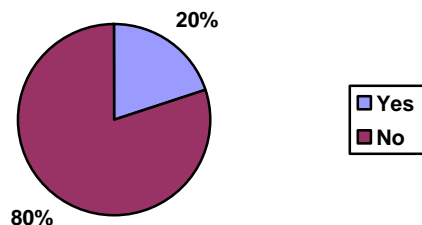


Figure 16. Past Participants indicate whether they have returned to their regional NOSB competitions as volunteers after graduation (n=25 responses to item).

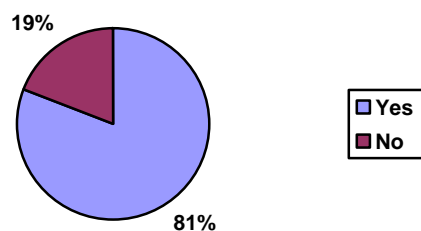


Figure 17. Past Participants indicate the majority have maintained communications with their former high school teachers/NOSB coaches (n=26 responses to item).

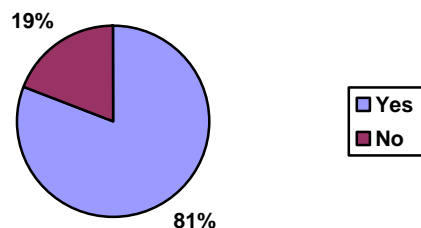


Figure 18. Past Participants indicate they have maintained communications with NOSB teammates since graduation from high school.

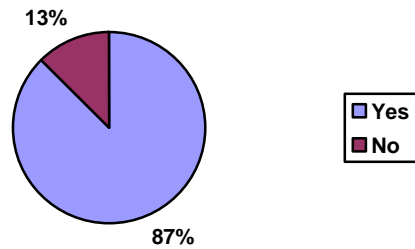


Figure 19. Past Participants overwhelmingly report that they had met individuals who had jobs of interest in the ocean science community through NOSB participation (n=24 responses to item).

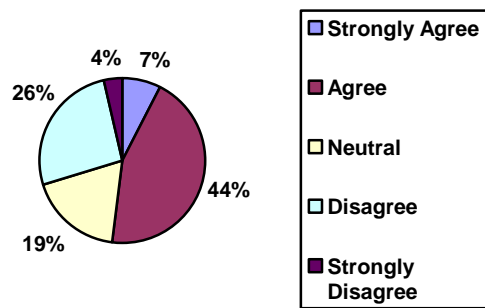


Figure 20. Past Participants' responses to item "Participating in the NOSB influenced my choice of career (n=27).

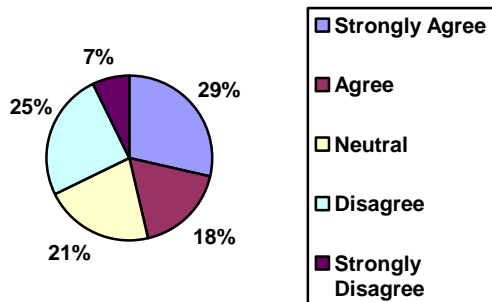


Figure 21. Past Participants' responses to item "Participating in the NOSB influenced my selection of a college (n=28).

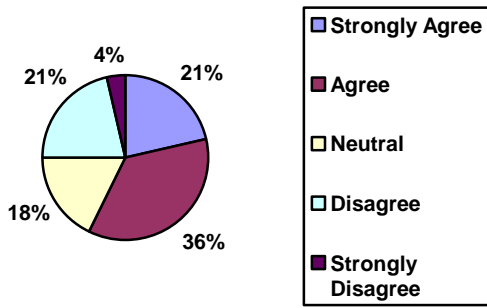


Figure 22. Past Participants’ responses to item “Participating in the NOSB influenced my choice of college major” (n=28).

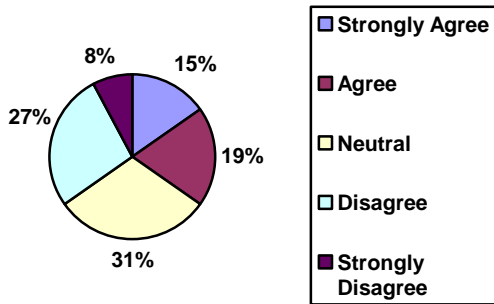


Figure 23. Past Participants’ responses to item “The NOSB provided me useful career information which influenced my career selection” (n=26).

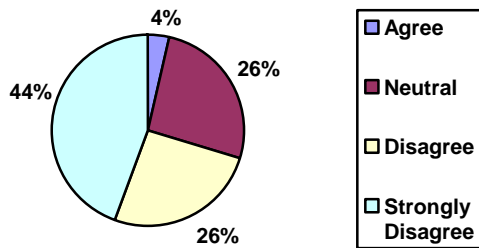


Figure 24. Past Participants’ responses to the item “My parents were the MOST significant factor in my selection of career or college major” (n=27).

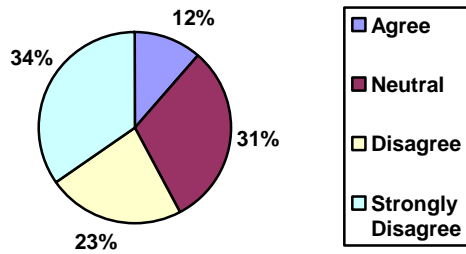


Figure 25. Past Participants’ responses to the item “My NOSB coach/high school teacher was the MOST significant factor in my selection of a career or college” (n=26).

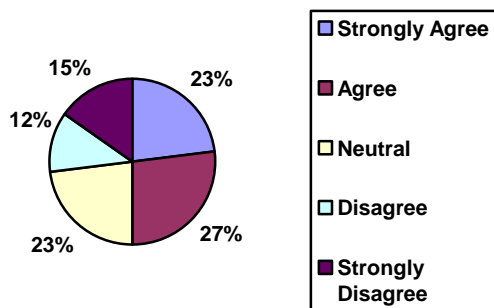


Figure 26. Past Participants’ responses to the item “Taking a marine science course has affected my career plans” (N=26).

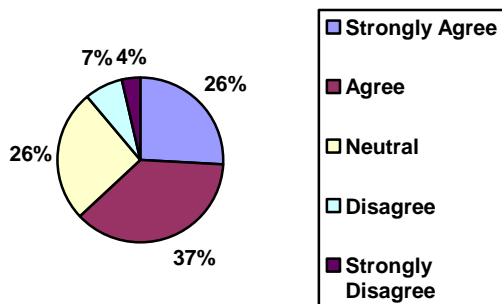


Figure 27. Past Participants’ responses to the item “The NOSB encouraged my participation in conservation and community service related activities” (n=27).

Volunteer Survey

Two hundred and fifty volunteers responded to the post competition survey, which again was administered electronically, with regional coordinators distributing the

URL to volunteers from each region. The respondents were from geographically dispersed regional NOSB sites. Summaries of the volunteer narrative by item and theme among responses are as follows.

1. “Fostering marine science education” was the predominant reason respondents gave for volunteering at the NOSB. Prevalent among the responses was a desire to foster continued excellence in marine science education and educators. In addition, many of the respondents indicated that they felt a strong social responsibility of giving back to the community in their professional discipline. In the purely intrinsic arena, many respondents indicated that they “enjoyed working with bright students;” and that it was personally rewarding. Several respondents indicated that they were volunteering simply as part of their job.
2. There were twenty-seven different volunteer jobs reported at the regionals. These jobs comprised six different roles including: Competition Logistics; Judging; Experts; Hospitality; Marketing; and Site Set-up. The primary volunteer role was competition logistics. Forty eight percent (148) of the respondents indicated that they filled this role as scorekeeper; timekeeper; runner; team challenge grader; and a number of other miscellaneous assignments. The second most prevalent role for volunteers was judging. Thirty percent of the respondents (93) were judges: science, rules and sportsmanship. Experts comprised thirteen percent (41) of the respondent volunteers.
3. The majority indicated that the biggest benefit from volunteering is seeing these “really bright kids in competition.” The students are there to “fulfill their goals.” The volunteers are there to further the interest in marine science. Respondents indicated it made them feel good and that it was fun. They get real “pleasure from volunteering.”

4. NOSB provides an excellent avenue for networking with both current professionals and educational institutions in the field; as well as with rising marine science stars. It also allows institutions and agencies to “showcase what they have to offer to participants, parents and educators.” These themes represent the main rewards highlighted by volunteers from participating educational institutions and agencies. Volunteers also felt that it was an important avenue for minority advancement in the marine science field. In addition, many of the institutions indicated that it was a great recruiting tool for universities. Participation also brings “prestige and recognition” to the university. Volunteers from the agencies reiterated the theme that it provides an excellent opportunity for the students to see possible future employment opportunities as well as other offerings of the agencies.
5. The NOSB provides the students with an opportunity to see the link between our society and the aquatic environment. It also enhances their opportunities to make connections with “role models” and mentors in the marine science field. It provides a “great start for their higher education and science career. Volunteers also felt that the NOSB provides the students with the opportunity to build their self-confidence; public speaking skills; and team building skills. The academic bowl provides an environment where bright students can work together as a team to recognize each other’s contribution and the power of a team effort.

Parent Interviews

Members of the research team visited ten of the NOSB Regional Competitions to observe programmatic activities and to implement interviews with select parents and volunteers. Interviews with parents proved difficult due to the fact, as with many

secondary student events, parents were not generally in attendance. Nevertheless, twenty-four parents were interviewed to ascertain data for cross-comparisons with other data sets in the study. The parent responses are summarized below. (Note: parent statements are in quotation marks; researchers' summaries or interpretations are in brackets.)

1. What benefits does your child obtain from NOSB?

“It gives them a way to use their abilities in a competitive way. It encourages an understanding about science and the environment. It is a strong academic challenge to my daughter and I think that is good for her in preparing for college. This program is outstanding in developing an understanding of teamwork among a group of students who don't frequently have the opportunity to work on a team. My child has a strong interest in science, and this supports that interest. It really builds confidence [from numerous respondents.] Reinforces study skills. This program brings excitement to learning about ocean sciences that you wouldn't have in the classroom. It helps kids think under pressure. It is a positive learning experience.”

2. Why does your child participate?

“The teacher encouraged this. She loves science, and has enjoyed the social interaction of the group. He enjoys the academic challenge. The thrill of the competition. I think the students enjoy the preparation for the competition as much as the competition itself. It helps with confidence, study skills, and leadership abilities/working with a team.”

[Numerous responses about “students love science, are interested in science.” Some comments discussed the need for extracurricular activities on the resume' preparing for college and in the search for scholarships.]

3. Do you get adequate information about the program?

[Strong responses that the teacher and the students get a good bit of information, but very little to the parents. There appears to be a consensus that information provided to teachers makes it to students on a “need to know” basis.] “This information is not making it to parents—but this is not different from any other program. Students are not terribly proficient at “getting material home.”

4. How will the NOSB influence your student’s career and college choices?

“She knows a lot more about the jobs people really do when they work in ocean sciences. There aren’t any role models in our community—or jobs for that matter—so he gets to meet people at NOSB who really do this. I don’t think it will, there is no money for a B.S. degree—you have to have a doctorate. I think she would rather be involved with the ocean as a hobby or for relaxation. The NOSB has really developed the leadership skills necessary for whatever job he does, so I guess that is the way.”

Cross-Set Analyses of Data

Following analyses and summarization of the individual data sets derived from the various instruments and audiences, the researchers re-analyzed the data by comparing the sets to identify and discuss emergent themes and categories representing similarities that were observed in the individual sets. The narrative data were analyzed using a constant comparative procedure and heuristic coding following Patton (1990) and Walcott (1994), and with categorical cluster analysis procedures described by Merriam (1990) from Guba and Lincoln (1981). Further, the researcher followed procedures for grounded theory development outlined by Creswell (2002), and concept evaluation and structuring procedures described by Novak (1998) and Novak and Gowin (1994).

The cross-set analyses utilized each of the data sets, as well as the factors describing effective competitions, the factors describing career-path decision making among secondary students, as well as re-combinations of these with new factors that emerged during the analyses. Chart 2 below is a linear concept map which presents all of the related factors and data sources used in the remaining research findings and summary sections in this document. This map is presented in non-linear format further in the paper to illustrate the emerging relationships in the data which describe the impacts and accomplishments of the NOSB as an educational system.

Affective Impacts of NOSB Participation on Students

Narrative analyses of the data sets individually provide useful information for NOSB management as it pertains to programmatic elements and program

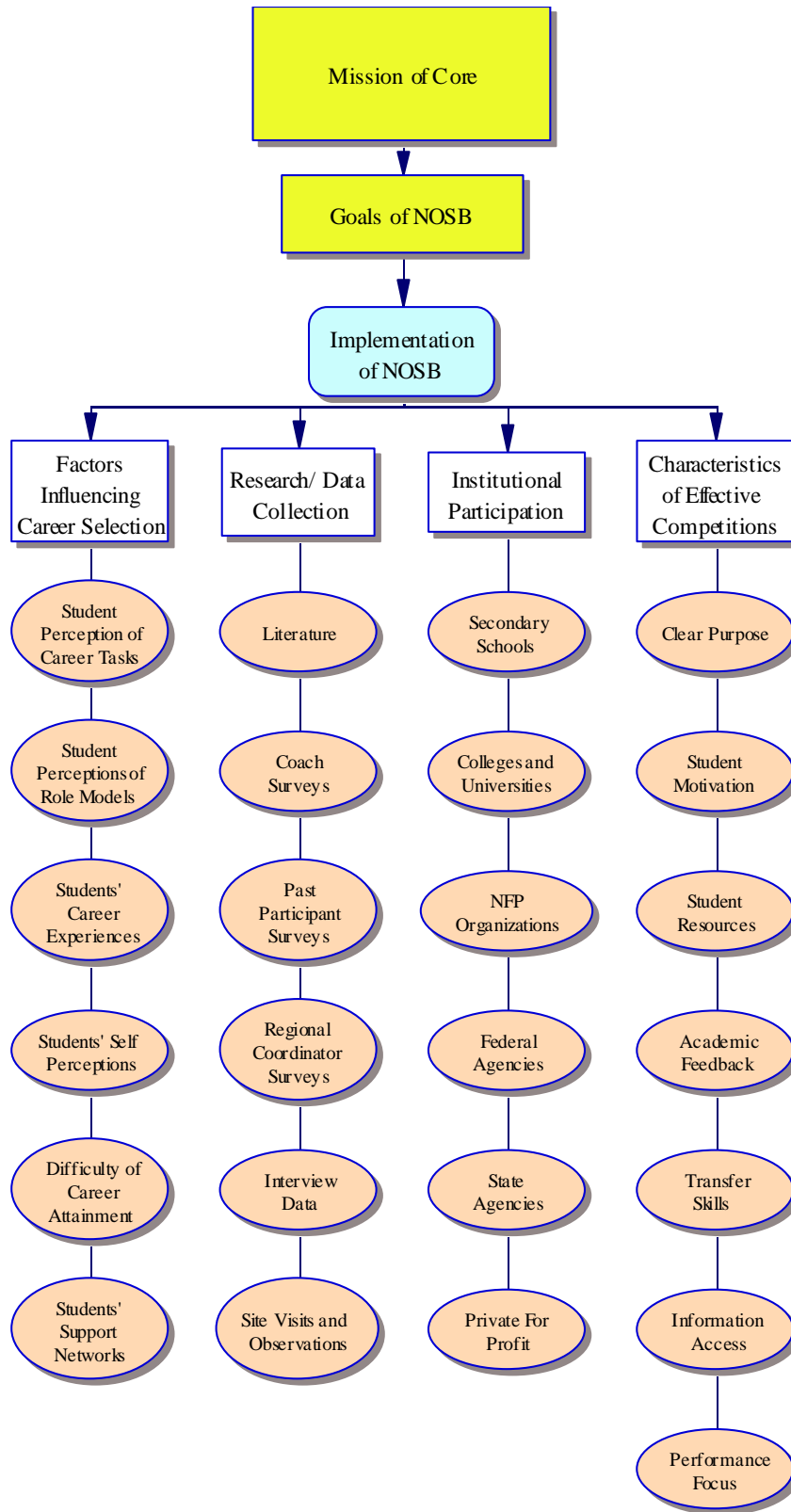


Chart 2. Linear Concept Map for NOSB Impact Assessment Study.

improvement on an annual basis. It is important, however, to move toward cross-set analyses of the data to leverage the potential of observing important impacts of the program, i.e. leveraging the explanatory power of the data by utilizing multiple points-of-view to describe and discuss the accomplishments and impacts of the NOSB. This analysis is accomplished by using narrative from multiple data sets within a unifying theme. This approach reveals a significant observation of student affective dimensions within program participation, as illustrated in figure twenty-seven and discussed in this section.

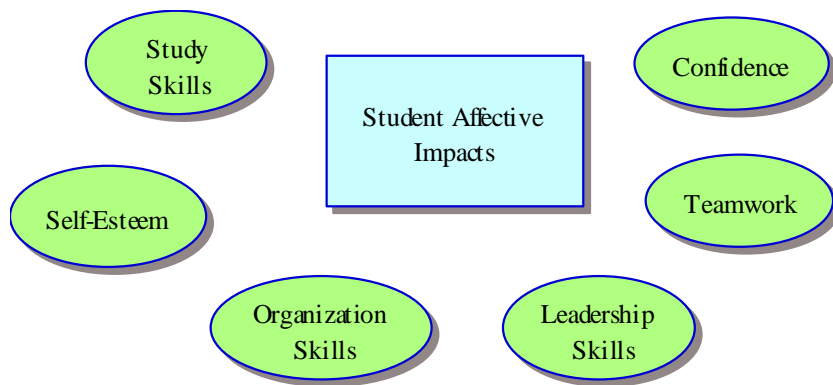


Figure 27. NOSB affective impacts on students are revealed by cross-dataset analyses.

Emerging Themes and Categories Associated with Affective Student Impact and Leadership Development

Following summarization of the data sets individually, the data were re-coded for emergent themes and categories across the different sets of data, i.e. surveys for regional coordinators, coaches, volunteers, past participants; parent and volunteer interviews, and site visit observations. A number of themes and categories emerged from these cross-set comparisons.

Teamwork/Cooperative Skills

One of the most prevalent comments or observations made by respondents was that participation in the NOSB fostered a meaningful understanding of teamwork, as well as contributing to a set of process skills (to be discussed later in the report) for implementing team-based learning and competition. Teamwork was viewed as a skill, something that could be learned, practiced, and incorporated in practical effort. Teamwork was viewed as a benefit, opportunity, and a value to be inculcated among young people, as well as an important goal of a program. Based on a view of teamwork as being comprised of a defined skill set, team effort was seen as more or less proficient based on practice—consequently, NOSB participation in and of itself, without regard for winning, was valuable as a mechanism for fostering teamwork. Teamwork was viewed as enhancing the affective dimensions of humanity, as a positive value and a life skill. Additionally, team efforts seemed to signify a higher level of difficulty, and therefore a trait more worthy of respect and reward. Numerous comments reflect that the individual, short answer questions in the NOSB competition were not valued to the degree that the team responses were—which would be a consistent observation with the esteem afforded teamwork. Further inter-thematic comparisons between the Teamwork category and the Social category reveal a view that the students who participate in NOSB are characterized by a high degree of individuality, perhaps in part due to acculturation through individual academic success in a school system intrinsically oriented to individualized reward structures. Data in the following, bulleted list are selected from the sets of data and are quoted material:

- Learning teamwork
- Sense of teamwork
- Learn teamwork
- To use teamwork

- Learn teamwork
- team membership
- team skills
- working with others
- development of team/group working
- children learn and grow in teams
- team collaboration
- teams working together
- teamsmanship
- opportunity to learn and work together
- working as a team
- to work as a team
- sense of teamwork
- learn about themselves and team members
- teamwork
- working as a team
- feeling of being part of a team
- the value of teamwork and fair competition
- team building team building
- team confidence
- benefit of learning to work as a close knit team
- teamwork
- encourage teamwork
- teamwork
- experience team work
- participate as part of a team effort
- learn about teamwork, discipline and goals
- learn to work as a team
- teamwork
- learned teamwork and strategy
- skills in team participation
- learn to act as a member of a team
- learn teamwork
- its really about being a team
- learning how to work as a team
- kids learn teamwork goes a long ways
- opportunity to work together on their team
- teamwork
- teamwork skills
- they learn teamwork
- learn from other teams
- teamwork
- they got to work as a team
- they learned how to work as a team
- to work as a team
- the practice of working as a team
- learn to work as a team
- teamwork
- how to work in team structure
- teamwork
- part of a team
- teamwork is useful
- helps them to bond with teammates
- have fun in team competition
- benefits of teamwork
- challenge and thrill of teamwork
- the camaraderie of working on a team
- teamwork
- working together as a team
- sense of teamwork
- establishing teamwork
- learn teamwork
- teamwork
- teambuilding
- teamwork
- good to get to know team members
- how to do teamwork
- teamwork skills
- working in teams
- team building
- teamwork, working together as a team
- working with teams
- work with teams
- work as a team
- being part of a team
- team competition

- team skills
- group or team cooperation skills
- studied and worked with teams
- Teamwork
- Teamwork
- Work as a team
- Travel with the team
- Teamwork
- Team work
- Teamwork
- Teamwork
- Working in teams
- Team work
- Working as a team
- How to work well together
- How to work as a team
- Excellent for teamwork
- A non-athletic experience where team outweighs individual interests
- Collaborative skills
- Working with a team
- Working with others
- To work cooperatively for the good of the team
- Working as a team
- Life skills by being part of a team
- Cooperation How to work with others in a group
- Teamwork
- Working with a group
- Team work
- Team work and sharing
- Sense of responsibility to the team
- Experience working on a team
- Being a team player
- Cooperative skills
- Benefit from the team concept
- Team skills
- Teamwork
- Team spirit
- Cooperation skills
- Team spirit
- Team skills
- Teamwork
- Habits of cooperation and communication
- Team building
- Teamwork
- Learn how to work as a team
- Learn to work as a team
- Team building skills
- Team unity
- Team work
- To work as a team
- They become part of a team
- Team working
- Team skills
- Teamwork
- Work as a team socially
- Team work
- Group aspect is irreplaceable
- Teamwork
- Work on team support and not trying to be a star
- Team spirit
- To work as a team
- Teamwork
- Teamwork
- working together
- learn about competition and teamwork
- experience in building teamwork
- learn gamesmanship and teamwork
- Commitment to a group
- The value of teamwork

Competitive Dimension

A second theme which emerges from the cross-set data analyses is the Competitive Dimensions of the NOSB program. Respondents hold a highly positive

view of competition as both a vehicle for learning and development, and as a skill-set which is valuable and pertinent to both academic and professional success. Additionally, there seems to be a dimensionalized view of competition as being comprised of a subset of skills such that competition can be practiced, learned, and engaged in to greater or lesser success as the skills are applied. Finally, competition is clearly not exclusive of social relationships across lines of associations. Students initiate, develop and enjoy social relationships with fellow NOSB participants with whom they directly compete.

Given the paucity of empirical research aimed at understanding the effect of competition among secondary, high ability students, competition is generally viewed as healthy, beneficial, and an important component of academics and like-skill development. Competition, and the winning or losing associated therewith, contributes to emotional and social grace, to a sense of balance in winning and losing, and to a meaningful conception of “how life really works” for these students. Students should learn how to compete, how to win and lose, how to behave socially while competing—which seems to further include the capability of enjoying friendships with co-competitors. Further, competition is an activity to be desired because it results in confidence, enjoyment and zest in living, a thrill. Competition is viewed developmentally for personal growth, skills development, social development, academic development, and as a vehicle for maturity. Competition almost assumes existential proportions—it is sensed, it is experienced, it thrills, we handle it, we love it, it adds an edge to life. Selected quotations from the data sets are bulleted as follows:

- Enjoy competition
- Exposure to competition
- Experience in competition
- Competitive strategies
- competition
- competition
- personnel growth in competitive challenge

- ability to win and lose graciously
- competition
- competition
- understanding of competition
- competition of any kind feeds a need people inherently have
- healthy competition
- camaraderie of spirit of friendly competition
- competition experience
- competition experience
- experience of competing
- to compete in a non-threatening environment
- learn through the competition
- healthy competition with peers
- competition may help them
- competition
- competition gives a powerful incentive
- practice for competition
- good competition behavior
- competition seems to make us all a little keener to work hard
- personal growth through competition
- enjoy healthy competition
- opportunity to be competitive in a healthy, constructive way
- competition skills
- the value of competition and sportsmanship
- learn the meaning of competition
- fun competing
- good experience in healthy competition
- exposure to competitions early on
- competition helps build self confidence
- competition
- competition
- competition is good
- the competition factor
- a chance to be competitive
- introduction to academic competition
- thrill of competition
- the experience of the competition
- competitive experience
- confidence in competition
- competing in this format
- how to compete under pressure
- thrill of competition
- participation in this competition
- efforts of competition
- any competitive event is good experience
- he has learned a great deal about competition
- handle competition
- sense of competition
- exposure to academic competition
- exposure to academic competition
- The competition is good
- Enjoy the challenge of the competition
- The simple act of going to the competition
- The desire to compete
- They enjoy the competition itself
- Academic students like the competition
- The love of competition
- Enjoy the competition
- The excitement of competing
- They enjoy competition
- The competitive academic adventure is the driving force
- Competition is good
- An academic competitive edge
- Competitive skills
- Learn to win and lose graciously
- Cooperative competition
- Friendly competition
- Competitive spirit and drive
- Competition in a friendly atmosphere
- Academic competition

- Competitive skills
- Competition is always great
- Competitive edge
- Compete in high-pressure situation
- Foster sense of competition
- learn to gracefully compete
- motivation
- challenge themselves
- striving for a goal
- motivation
- sense of determination

Social Relationships

While the *competitive dimensions* of the NOSB were clearly for and by the participants, equally significant were the opportunities to enhance and expand *social relationships* through the regional and national competitions. A significant theme which runs across responses in each data set is that the students who participate in NOSB have a need to interact with other students who are similar to themselves in academic ability and orientation. Many respondents note that for some high ability students, there is a relative isolation from peers, perhaps due to limited pools of “these types of students” in local school settings. Many NOSB participants meet peers at the competitions who similarly excel in academic challenges and share similar personality and vocational interests. These relationships not only develop through the competitions, but are pursued and maintained outside of the competition setting. One dimension of this social interaction is the opportunity to realistically gauge one’s own capabilities and performance in a context where the individual is no longer necessarily the most intelligent, most driven, or hardest working. For many students, the NOSB competition provides this unique view of self.

A second social theme which emerges from the data is the interactions with adults. The opportunity to meet, talk with, and share ideas with scientists, graduate students, sponsoring organization staff members, and even on a deeper level with their high school teachers produces a lasting affect on the NOSB participants. Some participants who are particularly focused on career goals find that the opportunity to

interact with college students and professionals at later stages toward these same goals is an important aspect of the NOSB.

A final social theme which emerges in the narrative associated with social dimensions is that of diversity. There is a strong perspective that personal experiences have not provided adequate social and geographic diversity for these high ability students in view of the potential they have for growth. The NOSB provides opportunities to meet people who are different from you—from different schools, parts of the state, different states and regions, different ethnicities, and with different preparation pathways leading to the competition. This exposure to such a broad group is viewed as highly positive by the audiences responding in the different data sets. Data associated with the Social

Dimensions are as follows:

- lots of fun
- they have fun
- camaraderie
- new friends
- comradeship
- opportunity to travel and meet new people
- opportunity to interact socially
- interaction with peers
- to see scientists
- interaction with community and professionals
- friendships
- shows social development
- interaction with people
- social growth
- meet new people
- collaborative and competitive atmosphere fosters friendships
- student interaction
- connections with people
- meeting people
- great group interactive experience
- meet people
- great social time
- to meet many different people
- a sense of belonging
- exposure to other students
- networking
- experts and students could freely speak to each other
- meet other students
- opportunities to interact with scientists
- socialization
- great social interactions with others
- meet new people
- meet peers
- social stimulation
- meeting a wider range of people
- meeting fellow students
- opportunity to meet like-minded peers
- interacting with real scientists
- exposure to their peers

- they get to mix with students from all over the state
- they got to meet other students
- opportunity of meeting students
- to enjoy competition as well as to meet other similar students
- chance to socialize with peers
- visiting with other students
- interact with other motivated and bright students
- great fellowship
- exposure to others of like mind
- social
- chance to meet other students
- chance to meet and interact with professionals in the field
- mingled with peers their own age
- meet people in the profession
- interact with students from other areas
- social learning experiences
- socialize with other students with the same interests
- interaction with other students
- getting to know different kids
- made new friends
- friendship
- get to know other students
- bonding with teachers
- meet other students with like interests
- friendships
- being around other kids who enjoy science, realizing there are others like her
- social skills
- group settings
- ability to meet and compete with peers from other schools
- both have met students and adults from other communities
- meeting other people from the state
- Meeting people of the same interest
- An idea of the level of education of my peers
- Opportunity to get to know my science teacher better
- To network with researchers and other students
- I met a lot of people who have the same interests
- Group participation
- Feedback from other students/peers
- Acquaintances with like-minded, high achieving students
- Talking with students from other schools
- Working together
- How to interact with peers
- Socializing with other teams
- To form new friends
- Learn to help each other
- Help students to learn to mix with others of like interest
- Interactions with other students
- To interact with students from other places
- Interactive skills
- Feeling of comradery
- Meeting students from other schools
- Interaction with other teams
- Meet new friends
- Creating social bonds based upon common interests
- Interaction with other high achieving students
- Positive interactions with students from other schools
- Exposure to other students
- Interact with lots of different people
- Collaboration
- Interaction with other similar students
- Meeting, socializing, and competing with other students
- Meet other students

- Networking
- Social courtesy
- Interactions with other very bright students
- Opportunity to meet other students
- Meeting new people
- To make new friends
- Interaction with adult role models
- To meet and compete with strong academic students from other schools so they get a sense of how well other students have prepared
- Interactions with other students and scientists
- affirmation of peer based interest
- working and belonging to a group
- gains experience working with others
- many life scenarios involve ability to work together
- Meeting others interested in the field
- Interact with students from different backgrounds

Study Skills

A large number of process skills are noted across the data sets which can be associated to both academic settings and generalized to life skills, vocational, or leadership settings. Looking specifically at academic settings, a strong theme emerges from the coaches, parents, volunteers, and regional coordinators, as well as the past participants, that participating in the NOSB provided reinforcement for overall academic success. These skills were viewed as either required to prepare one's self or one's team for the academic competition of NOSB, or were practiced in the competition itself. It is clear that even for high ability students, there is a strong perception that a degree of rigor and polish remains—that these kids have not acquired a mature or full set of academic skills and are in need of further development. A strong view emerges from the data that the NOSB meets these needs.

Among the academic related process skills that emerge most clearly are undifferentiated study skills—approaching, organizing, and mastering a collection of new content. Linked to this is an ability to individualize learning, to engage with mastery of

material without coercion or close direction from adult instruction or supervision. More specific process skills related to academic success and which arise through NOSB participation are critical thinking, reasoning, communication skills, i.e. writing, thinking, speaking, and listening, and problem solving. A number of respondents indicated that NOSB participation is strongly related to developing a mindset for lifelong, self-directed learning, and is highly motivational—as well as conducive to personal intellectual discipline. Data related to academic facets of student development include:

- Study skills
- Study habits
- Independent study skills
- Critical thinking skills and responsibility
- improved study habits
- intellectual challenge and satisfaction
- Digesting and organizing large quantities of information
- practice answering in public
- learning to look at things more completely
- Cooperative learning skills
- Lifelong learning
- Independent learning
- Oral and written presentation skills
- Life-long learning
- Independent learning
- Study skills
- it motivates them academically
- learn how to study
- listening skills
- speaking skills
- quick thinking skills
- good study skills
- she is learning valuable study skills
- Study skills
- Reinforcement of academic study
- wonderful thinking skills
- helps students with analytical thinking
- helps with study skills
- study skills for college
- Independent study
- To study for detail
- Study skills
- study discipline
- study skills
- cooperative learning skills
- quick thinking
- study skills
- reasoning
- critical thinking
- develop problem solving skills
- greatly increased her interest in science
- I learned a lot about studying
- Learning how to study
- Valuable study habits
- Studying
- Group studying
- Communication abilities and independent study skills
- Academic skills
- Problem solving
- develop public speaking and recall skills
- mental training
- learn problem solving skills
- academic challenge

- to prepare for deadlines
- having their interest sparked
- builds enthusiasm

Sportsmanship

One characteristic of competition which seems important as a virtue for adolescents is basic fairness in participation in competitive activities. This is expressed across the data sets as sportsmanship. While this theme could perhaps be associated with and combined with the overall theme of competition which emerged and was discussed previously, there were a substantive number of comments in the narrative which separated the two as constructs. Respondents perceive that a positive dimension of NOSB participation is that students, through winning and losing, are required to comply with a rule structure that is absolute, and that this is a benefit to these students. Select data used for identification of this theme include:

- Sportsmanship
- Learn to follow rules
- Learn how to be good winners/losers
- good sportsmanship
- good sportsmanship
- learn to win and lose
- how to accept defeat
- sportsmanship
- learn a little sportsmanship
- sportsmanship
- learned how to win and lose gracefully
- learn sportsmanship
- sportsmanship
- sportsmanship
- sportsmanship
- fair play
- Sportsman like behavior
- Good sportsmanship
- Sportsmanship
- Sportsmanship
- They learn that things don't always go their way
- Sportsmanship
- Sportsmanship
- Fair play
- Sportsman-like behavior
- Sportsmanship
- Sportsmanship
- Sportsmanship
- Sportsmanship
- Sportsmanship
- Sportsmanship
- Students learn you can't always be the best
- To accept that someone can be better

Leadership and Confidence

An important goal for CORE through the NOSB is the development of leadership or leadership potential for the ocean sciences by impacting high ability students who possess an interest in the ocean sciences. Literature for leadership studies would support the identification of a theme for leadership development based on the data provided in the surveys and interviews. The various respondents discuss the teambuilding, preparation, and participation activities associated with the NOSB develop within students a confidence in their abilities to self-direct study and social structures toward accomplishment of a goal. Numerous responses highlight that students have an enhanced perception of themselves and their potential as leaders through practice of process skills necessary for success in the broader arenas of college and career.

- Stronger confidence
- building their confidence
- To become better citizens
- Leadership
- Leadership
- confidence
- self confidence
- confidence
- self confidence
- it builds confidence
- confidence
- self-confidence
- build their confidence
- confidence
- confident in their studies
- self-confidence
- confidence
- self-confidence
- leadership skills
- build confidence
- self-confidence
- confidence
- increased self-confidence
- leadership
- self confidence
- leadership skills build confidence
- The leadership opportunity
- Confidence
- Confidence
- Leadership
- Leadership
- It builds self confidence
- To have confidence in themselves
- Self confidence
- Become more assertive
- Confidence building
- Leadership
- Leadership
- Leadership
- Self confidence
- Builds confidence
- Leadership
- Increased self-confidence
- Develops self-confidence

Self-Esteem

The literature related to adolescent development is clear with respect to a student’s perception of self. As a student perceives his or herself as more capable and competent in an endeavor, that student is more likely to continue efforts in that area (Rabinowitz and Glaser, 1985). In that respect, the NOSB, from the narrative data, is producing lasting impact on students’ self-esteem. Respondents view the NOSB as contributing positively to students’ growth and development, sense of personal satisfaction and accomplishment, pride in their abilities—and that these enhancements are based on authentic accomplishments through hard work.

- Sense of accomplishment
- Sense of pride
- sense of accomplishment
- sense of accomplishment
- personal satisfaction
- growth, self-satisfaction
- Improved self-esteem
- self esteem
- self esteem
- self esteem
- sense of achievement and pride
- sense of pride
- increase self esteem
- pride
- learn to challenge themselves
- Self pride
- pride in accomplishments
- increased self-esteem
- self-esteem building from learning
- self esteem
- both have improved self-esteem

Managing Pressure

Psychological research and literature describes stress as both positive and negative—without positive, motivational stress and personal experience with managing, learning from, and reacting constructively to stress, individuals will fail to develop an important, life skill that relates to long-term success in difficult career and personal activities. The respondents in the NOSB evaluation note that the NOSB is a sufficiently difficult and engaging activity for the students that they choose to “push themselves” and genuinely enjoy and appreciate—and learn from—this pressure. Pressure is viewed as an

external force through which students need to “think and learn” and apply specific management skills. Performance under stress, thinking and working under pressure, and “handling themselves” are all valuable experiences viewed as connected to future educational, career, and life activities. There is a perception that external pressure while in adolescent developmental stages is strongly positive and provided by the NOSB program. Select data related to these concepts follows:

- Learn to think under pressure
- Helps kids think under pressure
- Experience with pressure situations
- to handle themselves under pressure
- how to handle pressure
- perform under pressure
- experience in stressful situations
- to perform under stress
- learn to act under pressure
- poise under pressure
- adaptation to pressure, quick thinking
- working under pressure
- thinking under pressure
- handle stress taking risks
- learning to react quickly
- helps kids think under pressure
- experience thinking under pressure
- to keep a cool head under pressure
- How to deal with multiple stressful situations
- Dealing with stress and tension
- Answering questions under pressure
- How to think more quickly on their feet
- How they work under pressure
- Thinking on your feet
- Working under pressure
- Learn to think under pressure
- Responding under pressure

Process Skills

Respondents from each constituency were asked through survey items or in interviews to identify skills which NOSB participation directly required, taught, or communicated indirectly to students. Many of these skills are associated through research literature to success in school, career, and life and cluster around thinking skills, communication skills, and generalized personality traits. Thinking skills include critical thinking and analysis, deductive thought, problem solving capability, planning and attention to detail. Communications skills include listening, public speaking, writing, and

social poise. Generalized personality traits include dedication, commitment, responsibility, patience, organization, perseverance, and risk taking. Respondents across the data sets reinforce that these characteristics, skills, or traits are reinforced by participation in the NOSB. Select data in this area include:

- Organization
- Communication
- Organization
- Quick thinking
- Problem solving
- Self discipline
- Responsibility
- Collegiality
- Dedication
- To dedicate time to a goal
- Problem solving
- Responsibility
- Dedication
- Problem solving
- Patience
- Problem solving skills
- Attention to detail
- helping them with decision-making
- independent decision-making
- problem solving skills
- thinks faster
- sharing responsibility
- problem solving skills
- discipline and responsibility
- Critical thinking skills
- Make decisions quickly
- Perseverance
- Quick thinking
- Quick thinking
- Deductive reasoning
- Being confident
- Quick decisions
- Listening and paying close attention
- Assertiveness
- To think quickly
- Quick decision-making
- Better attention span
- Planning skills
- Communication skills
- Thinking critically
- Being good communicators
- Public speaking skills
- Risk taking
- Social skills, like eating out in a restaurant
- Public speaking
- poise

Values/Ethics

While not as dominant in the data, it appears there is a theme of Values and Ethics that emerges from the perspectives regarding benefits of the NOSB. High ability students need to learn—in the view of many respondents—to be responsible, to value independence, to take joy from academic achievement and competition. Others report that students learn the value of a work ethic, that hard work pays off—if not in winning

then in enhanced knowledge and social relationships. Select data reinforcing the

construct of values and ethics include:

- Fun and academic encouragement
- Enjoyment
- Learn to value intelligence
- sparks interest in future careers development as citizens gives them something to stay out of trouble
- It looks good on college applications
- Responsibility
- Independence
- Hard work does pay off in the end
- That it is okay to be a science nut
- Trying your best
- Commitment and sacrifice
- Realizing they are not always the best and the brightest
- Good social manners
- Decision making
- Cooperation
- Public speaking
- Organization
- Time management
- Critical thinking skills
- Shared decision making
- Perseverance
- Hard work

Agency and Institutional Participation & System-level Emergent Themes

The NOSB can be viewed under a systems theory model of organizational dynamics. Such a view reveals operational features and programmatic impacts not possible in a more linear model. Figure twenty-eight indicates the types of organizations found to participate in the NOSB regionally and nationally, with the following discussion clarifying the benefits which accrue to the organizations and their personnel.

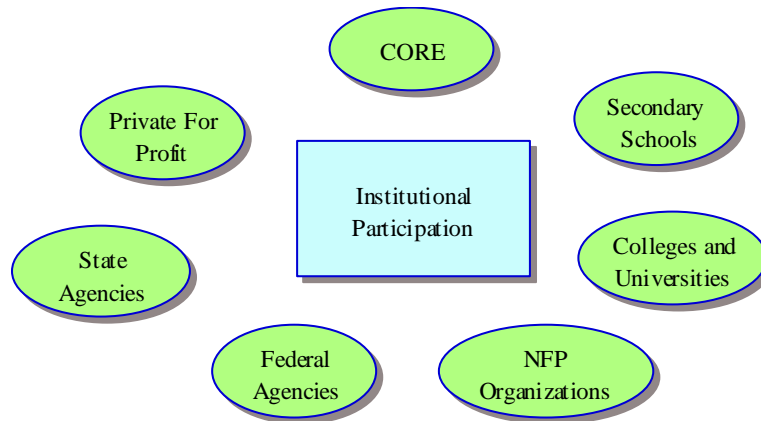


Figure 28. Numerous agencies and institutions partner to implement NOSB, revealing the NOSB to be a system organized for a coherent purpose.

Volunteers at the NOSB regional sites were asked to complete a survey designed to capture the rationales for participation. These data were coded using the methodology previously discussed. Analyses of these narratives indicates slightly different perceived benefits accruing for the individual than for their respective employers.

Individuals perceive they are benefited from participating as an NOSB volunteer through a sense of personal satisfaction and fulfillment. They express a perception that they are contributing to a social good or need by giving their time to the NOSB regional competition—and in particular that they are helping to diffuse ocean sciences content and information to the people they interact with at the competitions. They are personally

challenged by the excellence they observe among the students who participate. They perceive that they are considered a part of the social network that is comprised by the NOSB regional program.

Volunteers were asked to describe the benefits they believe their respective employers derive from having representation at the NOSB regional competitions in a volunteer role. Respondents associated with colleges or universities noted the prestige generated for their programs in the communities by associating with the NOSB, and through the public relations impact of having the competition held at their facilities. Numerous respondents noted that having high ability secondary students connect with their institutions was part of their overall recruitment programs, and that these students were “just the sort of motivated learners” they wished to contact. Volunteers associated with agencies suggested these [students] were the types of employees they would like to recruit—well-grounded in science, motivated, team-players, and energetic. Numerous respondents highlighted the community service and public relations benefits of volunteering with such a high quality program as the NOSB. Further respondents indicated that participation in the NOSB helps fulfill their own agency missions to provide education in the community—it “reinforces and makes public our commitment to innovative learning and intellectual excellence.” Other respondents discussed their mission to “encourage the students to consider careers in math and science fields.” This secondary mission fulfillment seems to be an important element in drawing volunteers and sponsors, and could be a communications element worth exploring further.

Correlation of Career Selection Factors with Narrative Data

Eccles (1985) and Lupart (2000) identified six factors which seemed associated with secondary students identification and selection of careers or career preparatory paths. These factors were observed individually and in select combinations in other literature reviewed previously in this study. Further, these factors were operationalized through the survey instruments developed to collect data in this research study. One additional factor emerged from the data following cross-set analyses. These seven factors are summarized in figure twenty-nine below.

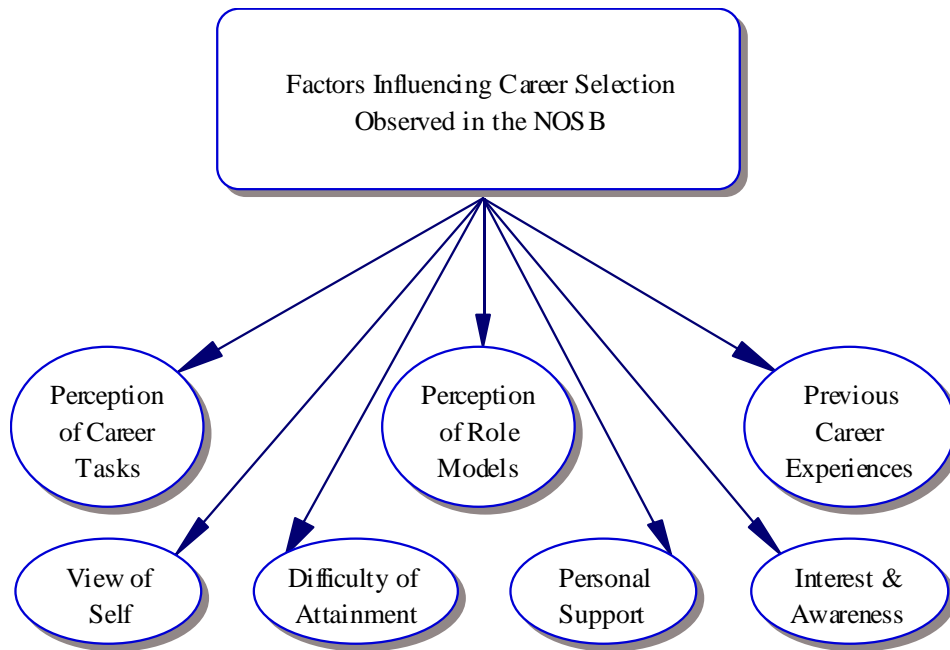


Figure 29. Factors Influencing Career Selection Identified in Literature and Instrumentalized in NOSB Research Study.

Compilation and analyses of the data across the sets, as previously discussed, allowed the researchers to observe the mechanisms through which the NOSB provides support for its student participants, and to conclude that the NOSB does provide support for its student participants to identify, clarify, and select career options and pathways—in

tangible ways associated with previously published literature in this area. The importance of the NOSB as a credible and important pathway for career selection for its participants could, on the basis of these findings, be highlighted in recruitment of other similar students, and should be viewed by the supporting agencies and institutions as an important contribution to ocean science education and the development of a professional career pipeline.

The six factors identified from the research literature were used in the development of the survey instruments to localize and organize respondents' thoughts to facilitate analyses. As with previous analyses in this study, the researchers used data management techniques from structural grounded theory and phenomenological inquiry to allow the data to be coded for the presence of the identified, six factors. The following summaries for each factor, with selections and quotations from the narrative data itself—and graphs summarizing selected response items from the instruments—indicate strong support for the credibility of these factors. Additionally, the narrative data suggest, as previously noted, that the NOSB is systematically addressing these factors through programmatic activities or incidental characteristics of the program itself.

Students Perception of Career Tasks

Students' typical views of careers are highly influenced by media portrayals and informal hearsay. Opportunities for in-depth analysis of specific career options for the high ability students associated with the NOSB are few and far between. A recent dissertation study (Stewart, 2004) in Ohio revealed that career studies in secondary schools associated to specific careers for high ability students—are almost non-existent. A view exists that high ability students are “tracking” toward career and college

success—even where data suggests these students are no more likely to have a firm view or choice of careers, and are as likely to change college majors as any other member of their age-cohort. Consequently, the opportunity for indepth analysis of a specific career or group of careers such as those associated with the ocean sciences, would be important and would address concerns raised in the literature regarding career path decision-making.

Respondents across all data sets in the current research study indicate that the NOSB as a context for career information is impacting the student participants in several distinct ways. The NOSB frequently, at the regional level, is a platform facilitating student interactions with colleges, universities, or ocean science research institutions and agencies. These interactions allow students insight into authentic jobs and job settings. Ocean science remains an atypical, applied field in which students—even in undergraduate programs—receive little orientation. The NOSB is viewed as a platform for authentic orientation and mentoring into the field of ocean sciences for the students who participate. The NOSB focuses specific attention on the variety of career options and specializations by the intentional breadth of its curriculum. The NOSB requires independent study and content mastery, similar to the career tasks associated with graduate school and careers in the field—while teaching students to link individual efforts in teams or cohorts of interested scholars and learners. The NOSB allows students to differentiate research, teaching, and vocational tasks and skills associated with the broader dimensions of involvement in the field, and to immediately link undergraduate and graduate fields of study to the career. Participants exit the NOSB with a perception of the interdisciplinary nature of an ocean science career, specific knowledge of the tasks

performed and differentiated across the field, and with an understanding of their own personal preferences should they choose to enter the field. Select narrative supporting these themes is as follows.

- Exposes kids to actual problems in the field.
- My students always have a great time, no matter how they do, so I enjoy bringing them for a great life experience. Also, teams that don't do well and sit out in the afternoon get to tour the graduate school of oceanography, which I feel gives them more experience in what it means to be a marine scientist.
- We live far from the ocean and this competition for three years has opened up access to oceanic studies, college majors and career options that these students would not normally receive.
- The NOSB exposes students to specific information about the field of oceanography that they would likely otherwise not see; they get more than a [name of television channel] understanding of what the study of the oceans is all about.
- Many of the team members have gone on to programs in marine science, and they have told me that their NOSB experience helped them to become more aware of opportunities and focus their interests.
- It also emphasizes (by example) the integrated nature of the various scientific disciplines (biology, chemistry, physics, etc.) as well as other disciplines (history, economics, geography, etc.)
- It helps make students aware of the oceans and fields of study.
- I have had students continue their Oceanographic studies at college level.
- Academically, many students have a stronger science grade because of the interest NOSB brings to them.
- They learn to think on their feet which will help them in college.
- [High School] offers no direct classes in Oceanography, so they have to get texts and read up on the subjects prior to the event. This is not dramatically different than what they will be required to do in scientific and engineering careers in life.
- The biggest academic thing that I think it did was to get the kids to recognize just how holistic science is today. To be a good oceanographer, you have to be a functional chemist, biologist, physicist, geologist, geographer, etc; and that applies to many fields today.
- All of my group are graduating except one. Some will be going into marine studies.
- We shared our work with both the scientific and political groups that will be making final decisions regarding building a trail through a coastal wildlife refuge.
- I have heard my students discuss some of the topics that they learned from NOSB in other classes, with visitors (guest speakers) and in their personal lives. They have been able to make many connections to what they learned to day to day life situations.
- It allows them to see that all jobs in science tend to move to an interdisciplinary mode. It helps to see why they take chemistry, physics, astronomy, and earth science.
- We have discussed the opportunities for research and teaching. One student is presently interested in working in an aquarium setting.

- Whenever I see scholarship information relating to the oceans or other opportunities for students interested in ocean science, I pass that along. We also specifically look at the kinds of things that scientists trained in ocean sciences can do for career choices.
- In the context of preparing for NOSB, students learn about different types of oceanographic study and employment. When they learn about something, they find out that “somebody” has to design instruments, collect data, or carry out the work. Most of the career related information they get comes in this manner, as a byproduct of study and participation in the contest.
- After the NOSB they do have an idea of the scope of marine science.
- I learned through NOSB to get involved in scholarly discussions with other competitors and university faculty.
- I think the practice and training these students receive in preparation for this event gives them an advantage in that they are exposed early to scientific method and the breadth of the field (marine science).
- Students obtain a solid basic understanding of the broad interdisciplinary aspects of oceanography. An appreciation of the importance the oceanographic science community places on the subject.
- I imagine it is eye opening to learn there are so many pursuits within the marine environment field. It is also likely that they learn a tremendous amount of information enriching their lives.
- The bowl presents an opportunity for students to explore an interest in ocean science that they would not otherwise have through their school curriculum. It allows them to see how various areas of science are integrally connected to studying the oceans. On a more limited basis, they are also exposed to various career “role models” in oceanography and aquatic sciences.

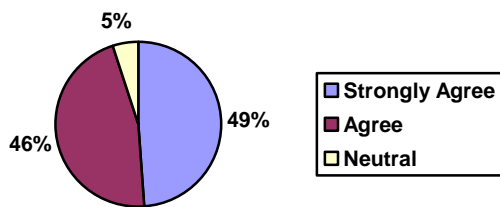


Figure 30. 95% of responding Coaches Strongly Agree or Agree that participation in NOSB has increased students’ awareness of ocean science careers.

Student Perceptions of Role Models

Respondents perceive an important feature of the NOSB is the opportunities it provides for contextualized interactions between the students and the ocean science professionals and pre-professionals, i.e. graduate students. These interactions allow the

NOSB students an opportunity to “put a real face on” the professions in ocean sciences. These students leave the event with a personal knowledge of an individual or several individuals who work at a specific university or research agency, and with whom they have had two-directional conversations, engaged in questioning and scholarly dialogue. The students perceive that there are ocean science professionals who would welcome them as new colleagues and as individuals who can contribute to the field. These interactions also result in an enhanced network of contacts and potential, future mentors—as well as an understanding and awareness of specific institutional locations where these NOSB students could find themselves post-secondary. Finally, the NOSB students, through the interactions with these professionals, are able to conceptualize the diversity of the pool of professionals engaged in the field—which allows each student an opportunity to “see someone who looks like themselves” engaged in authentic practice in a vocational context. Research supports that this personal, interactive engagement with individual members of a profession is a critical socializing factor in engaging students to enter this field of practice (Eccles, 1985; Stewart, 2004). Select data associating the NOSB with the provision of role models for the student participants includes:

- Interaction with professionals in the marine science field. More knowledge about the field because of answering questions and studying for the competition.
- They can see that we’re all not crazy scientists. They realize that there are both men and women in marine science.
- The NOSB is a terrific opportunity for students to get excited about science and meet scientists who are excited about what they do.
- The judges and moderators did such a great job of explaining the answers to the challenge questions. My students really learned a lot.
- The students are exposed to current events and research happening in the labs we visited. They meet scientists and program directors as people who are interested in them and with whom they can have a conversation. The whole experience was a very exciting and maturing event.
- It brings them into contact with experts in the area of Oceanography and related fields.

- The judges are great in encouraging my students and explaining how it was done.
- All of the judges, monitors, and volunteers during the competition were very nice and informative to our students. Many of them approached my students after a round and discussed some of the questions and the students' interest in science.
- It is significant that they meet professional scientists and others involved in working with the oceans. That those individuals see the contest as worth their time is significant to the students, and it encourages the students to work harder and keep participating.
- I have offered them opportunities to work in a marine lab under the guidance of marine science professors.
- Two professors from [college name] who helped us prepare also provided some information regarding ocean science careers.
- Any career information that they received would have been through contacts with the people at the regional science bowl or activities that they participated in at the regional and national ocean science bowl.
- The people at [college name] have sent many pamphlets about ocean science careers and their professors shared their knowledge with the kids when they were at [college].
- I have students involved in Robotics, Science Olympiad, Science Fairs, and Science Bowl. The students come in contact with scientists.
- I encourage them to call, email, or write biology and oceanography professors.
- I have served as mentor for several students on the team, assisting them in decision-making and writing letters of recommendation for them.
- Opportunities to discuss marine related careers with professionals who work in the field.
- We visit a research station on Lake Michigan and go out on a research vessel, we also have visited Shedd aquarium in Chicago as a NOSB team and asked a variety of individuals questions related to students' career interests.
- The opportunity to get to know my science teacher better, she has been a mentor ever since. Also, a glimpse of a college campus and oceanography professionals that lured me to the [name of university].
- Meeting oceanography professors at the [name of university] was the most enjoyable aspect of NOSB.
- Students learn more about oceanography and science to see if it interests them as a career. They get to meet individuals in the field who may be able to serve as mentors.
- Encouraged students to deepen their study of ocean science; NOSB exposed them to scientists in the field.
- Opportunity to interact with marine science professionals.
- Interaction with community professionals.
- Exposure to research as they head for careers. Two most powerful things for careers; having the most incredible teacher/mentor or a field experience; great experiences.
- I think having students, not only graduate, but undergraduate students, makes it more "relate-able" for the high schoolers. They see potentially where they can be in the next few years. It's not just a bunch of older professors and Ph.D.'s but kids closer to their age doing something they also love.

- They are coming in contact with numerous scientists and educators who would love the opportunity to give them advice and guidance in pursuing a marine-related career path.
- They gain much knowledge about ocean sciences in general as well as getting to interact with college students and professors that may be of great help in networking in the future.
- Great exposure to professors, and that they are real people. They find out what professions are available when volunteers introduce themselves. This gives them an idea of job opportunities in the field of science.
- The bowl presents an opportunity for students to explore an interest in ocean science that they would not otherwise have through their school curriculum. It allows them to see how various areas of science are integrally connected to studying the oceans. On a more limited basis, they are also exposed to various career “role models” in oceanography and aquatic sciences.
- They have exposure to real, practicing scientists and to a university setting. For some of them this is a first.
- I think they learn about oceanography, and see scientists (and learn that they aren’t middle-aged, white men—there are opportunities within science for women and minorities).
- I think they benefit from seeing so many active and interested volunteers, including professionals like me, and finding that we care how well their education goes.
- Opportunity to meet potential mentors from faculty participating in event.
- They get to see their coaches and scientists in a very personal role.
- They get to meet many professional oceanographers and visit an oceanographic institution. I’m confident it increases their appreciation of the importance of science and also increases the likelihood that they will continue learning science and consider a career in science.
- I would hope that their positive interactions with members of the “ocean sciences community”: researchers, faculty and graduate students, would encourage them to consider careers in the ocean sciences. More generally, I think that it is important for our community of high school students to have an appreciation of how ocean and atmospheric systems work and how they are impacted by decisions that governments, industries, and individuals make.
- Chance to interact with professional marine scientists, chance to get to know some for help choosing colleges, planning their career paths, scholastic and social learning experiences.

Students’ Previous Experiences with Career

Research indicates students who have authentic experiences with a career in the secondary years are more likely to actually consider those careers personally (Stewart, 2004). Respondent narrative indicates the NOSB is perceived by students, their coaches and parents, as an avenue for experiencing and studying the ocean science careers. There

is a perception that the interactions with the professionals at the regional competitions, the study of the various disciplines in preparation for the question-based portions of the competition, and the “real world” dimensions of the field-trips and laboratory visits constitutes career exploration. Several respondents, including past participants, indicate that the NOSB program facilitated students’ understanding of the careers in ocean sciences and directly contributed to actual student decisions. Select data which emerge in this thematic area include:

- NOSB did an excellent job of exposing students to opportunities in the science field. They talked with our students and explained many opportunities in college and beyond.
- It is great and helped me get the okay for the oceanography course to be offered at my school!! Several students want to go into ocean sciences.
- The NOSB program encourages students to take a look at marine sciences.
- It does a great job of making students familiar with the various fields within the study of oceanography.
- My students either have had an introduction to the field of oceanography and want to pursue it further, or would like to use the experience of NOSB to introduce them to the field.
- Career goals in marine biology
- Students are interested in Oceanography and may pursue a career in that field.
- It has opened the eyes of our students to different jobs in the science field.
- I think it built their confidence and let them see the connections between study and true success outside the classroom. It also got them interested in college and careers they had not thought about before. I am so pleased with the program.
- Many of the students look for summer placements in oceanographic fields. I still have some who would like to work with a scientist for part of the summer, but it is difficult to find professors. Some of the seniors are going into marine sciences as a major and I think that this helped them make their decision.
- Many go on to pursue fields in science where they normally would not have thought about a science or technology field. Many just say that they have an attitude change towards science concepts.
- One of my students has already accepted an internship at the [university name]. He will be working there for the summer and is seriously considering a career in Oceanography.
- We actually research many of the careers in preparing and I also push for them since I have my degree in marine biology.
- NOSB is the main source of career information for my students.
- The competition and the tour of the school of fisheries [were the most enjoyable aspects of the NOSB].

- Meeting oceanography professors at the [name of university] was the most enjoyable aspect of NOSB.
- I was exposed [in high school] to numerous medical settings and career opportunities so that’s why I pursued a major in the health field.
- Exposure to research as they head for careers. Two most powerful things for careers; having the most incredible teacher/mentor or a field experience; great experiences.
- NOSB is an important educational tool. It promotes public awareness of oceanographic education, encourages students to pursue it as a career, and it highlights current issues in a science-based format.
- Many are not always challenged by standard high school curricula. This opportunity affords them the vehicle to learn about oceanography and explore possible career choices prior to college.
- Certainly the winners get physical “perks,” but for many the accolades of their local heroes (i.e. practicing aquatic scientists) is a benefit. I think they see the value in terms of their longer-term career goals (these kids actually have serious longer-term goals).
- I think they learn a great deal about the oceans and begin to understand that they can be involved in oceanography coming from any background.
- As science becomes more interdisciplinary, this early exposure to oceanography prepares future scientists to be aware of problems in oceanography and enables them to apply techniques from other fields to potentially solve them.

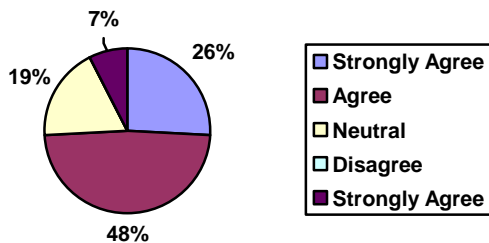


Figure 31. Past Participant responses to the item “The activities I undertook to prepare for the NOSB fostered skills helpful to success in college.”

Students’ View of Self

The current research highlights and supports the career selection factor of students’ views of self, with respect to competence, capability, skills, attitudes, abilities, and generalized identification of self with a potential for success in a given field. As NOSB contributes to students’ understanding of career tasks in ocean sciences generally,

and further allows the social interaction between students and professionals in the field of ocean sciences, it captures the significance of these features by simultaneously reinforcing students' views that they possess the generalized ability to "make it" in this profession. Selected response items associated with this research strand, i.e. view of self, indicate past participants viewed their own personal capabilities as the most significant factor in selecting their career (Figure thirty-two). Further, these past participants indicated the NOSB encouraged their development of ocean related hobbies (70% of respondents) which is associated with heightening interest and increasing the potential of a career selection. Finally, 63% of past participants indicate the NOSB encouraged their engagement with community service and conservation activities and value systems—characteristics also associated with career selection in the science disciplines.

Narrative data previously summarized in the *affective impacts* section of this research report are highly consistent across data sets in indicating that NOSB facilitates self-confidence, an awareness and enhanced capability in communications skills, team-building orientations and skills, and generalized leadership skills and understanding. Select narrative across sets in the area of students' view of self support and strengthen the credibility of this previous observation. Select narrative as follows describes how NOSB allows high school students the opportunity to relate to professionals and older students, i.e. undergraduate and graduate students—so as to "see" themselves fulfilling these roles. They are exposed to people and institutions that they see as winsome and potential destinations for themselves. Numerous parents report that NOSB has encouraged students to consider science-related and ocean-related careers where "there was no knowledge of" before participation.

- I think having students, not only graduate, but undergraduate students, makes it more “relate-able” for the high school students. They see potentially where they can be in the next few years. It’s not just a bunch of older professors and Ph.D.’s but kids closer to their age doing something they also love.
- Acknowledgement that there is reward (direct and indirect) for knowledge and education (they met volunteers who are evidence of this fact), encouragement to pursue a marine science education.
- Exposure to college pursuits.
- He has learned that the broader your learning the further you will go.
- Daughter is somewhat interested in considering this field. Never before was it ever thought of.

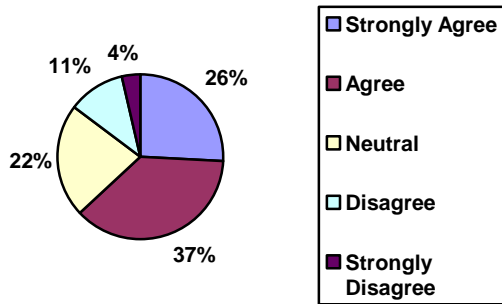


Figure 32. Past Participant responses to the item “My personal capabilities were the MOST significant factor in my selection of career of college major.”

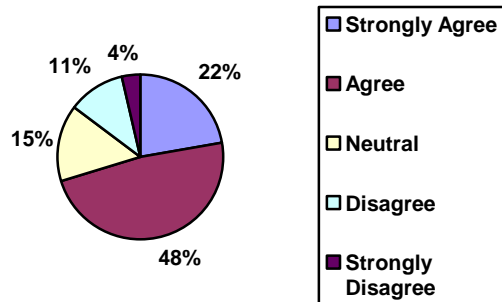


Figure 33. Past Participant responses to the item “Participating in the NOSB encouraged my developing hobbies related to the oceans.”

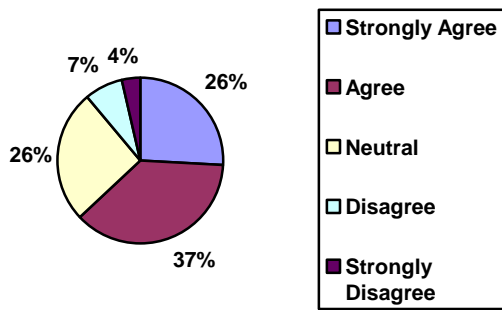


Figure 34. Past Participant responses to the item “Participating in the NOSB encouraged my participation in conservation and community service related to the ocean.”

Difficulty of Career Attainment

An additional factor associated with a realistic appraisal of the potentiality of a career by secondary students is the perceived difficulty of entrance and success in that field. Pearson and Dellman-Jenkins (1997) discuss the relationship of college and career that pervades many students’ thinking. Grant (2000) clarifies this relationship, however, by noting that many students, and particularly high ability and gifted students, enter college without a clear concept in mind for a given career—and ultimately change college majors numerous times. Eccles (1985) and Lupart (2000) describe this generalized perception of career attainment difficulty in a manner which was instrumented in the current research.

Selected response items in the surveys of past participants indicate 72% of these respondents considered the difficulty level of the academic requirements of the career path they ultimately chose, but far more respondents perceived that entry into their chosen profession would be easier than preparation requirements. This would suggest some factor, perhaps NOSB participation or other career study program or experience, has provided a personal association or perceived access to the profession of choice. In

this case, while the difficulty of entry to the field via challenging college coursework may be evident—socialization experiences in the career while at the secondary level could motivate students to attempt career entry regardless of difficulty. It is of note that the respondents were impacted by print materials from agencies and institutional partners of the NOSB—in that the recall receiving these materials and sharing them with other students. Such responses support the involvement of these agencies as is discussed elsewhere in this report. Select narrative data associated with career attainment is found here and under the section *Interest and Awareness* to follow.

- It provides an impetus to further their education
- The best indicator is the number of my participants that have gone on to study in fields related to marine sciences and other sciences...it piques their interest and they become lifelong learners.
- The regional competition has many career pathway resources. We also bring back the pamphlets to our freshwater bio class.
- We visit many ocean related sites both in the course and as part of ocean bowl...students also sent out on internet to find things and report on careers...also participated in the NOAA sponsored Deep East School of Discovery which beautifully showcased careers in web broadcasts.
- The support materials the Lake Sturgeon Bowl provided highlighted the many different possible courses of study and careers.
- I still remember most of the facts I memorized and learned. This knowledge is also applicable at my current internship at [name of aquarium]. It makes for less study time and less explaining that my supervisor needs to do for me.
- It gives kids an edge for going into marine science.
- This has helped him prepare for classes on a college level.

Students' Personal Support Network

Past participants were provided a series of narrative response items associated with career path selection—which for these individuals is now more relevant and clear as most have made college and college-major decisions. Important categories which emerged from these responses reflect that students were socialized and supported toward specific career selections or college professional preparatory activities by key, involved

and caring individuals who functioned as a supportive network as suggested by Eccles (1985), Lupart (2000), and others (Shymansky, 2000; Scherer, 2000; Stewart, 2004; and Olson, 1996).

The intense, personal nature of the NOSB program encouraged students to rely on adult mentors and leadership for academic support in a manner generally unnecessary for these high ability students. Transportation, meeting and practice spaces, coaching, and chaperoning trips were all vital—and allowed social interactions among the students and adults around academic knowledge and career potentiality. Further, the large pool of volunteers, officials, undergraduate and graduate students, professors, judges, and regional partnering agencies that hosted the NOSB competitions became an interactive social network to support these students in pursuing academic excellence and the consideration of eventual career and college selection. The data further suggest significant numbers of universities and agencies sought these relationships intentionally as they viewed the NOSB program as a channel for accessing a pool of potential students and professionals to meet their recruitment needs. The NOSB was then a vehicle for social networking desired by students, parents, teachers, and potential faculty members and agency employers.

Narrative data—and a significant amount of data emerges in this thematic area—suggest that students and teachers obtain basic information about a career field through individualized study and through materials collected or provided through NOSB. Individualized use of these materials and self-directed learning guided students to preferences based on individualized perceptions of self. Actual participation in NOSB allowed interactions between students and a broad network of interested adults, peers,

and pre-professional students. These social interactions resulted for many in identification of mentors and academic advisors—which resulted in selection of university programs by a number of participants. The data suggest that the pipeline for ocean sciences professionals has been enhanced or impacted by the NOSB indirectly at least, and directly for some students. Furthermore, the data support a conclusion that the NOSB is impacting students' career selections by providing an atmosphere which—according to the literature reviewed and the data—is highly conducive to career decision-making. Finally, the NOSB facilitates a system of support—socially and academically—for these young people. Select narrative in this area includes:

- Some of them are interested in attending the college where we have the competition so it gives them a chance to visit the college.
- I believe it might also help them decide on a college or part of the country to attend college by talking with other people.
- Academically, they learn another area and get great feedback on their analysis skills.
- Several are looking to major in an ocean science. Others have gotten opportunities to work with DNR or teachers developing coastal curricula.
- I have at least two former NOSB team members who are/will be studying marine sciences in college.
- Many of the students look for summer placements in oceanographic fields. I still have some who would like to work with a scientist for part of the summer, but it is difficult to find professors. Some of the seniors are going into marine sciences as a major and I think that this helped them make their decision.
- Students received information from our local university regarding the ocean sciences programs they offer, as well as the careers each program could lead to. In addition, the university arranged for our students to visit researchers so the students could see first-hand what they do.
- Flyers from host institutions, CDs from host institutions, posting of web sites and recruitment videos that our school and team received were shared with the students.
- Several universities have sent information related to ocean science programs. This information was given to NOSB participants.
- List of colleges in the U.S. that have ocean-science programs, and lists of careers related to the field are provided to all my students.
- We passed on a significant amount of information from the [school] school of ocean sciences.
- The NOSB materials have reinforced our school career lessons.

- Any career information that they received would have been through contacts with the people at the regional science bowl or activities that they participated in at the regional and national ocean science bowl.
- My students meet the people from the college we compete at and I have them discuss careers. Last year one of my students went to [college name] and is majoring in marine science.
- The people at [college name] have sent many pamphlets about ocean science careers and their professors shared their knowledge with the kids when they were at [college].
- The counselors have career sheets that give job descriptions and even colleges where it is available.
- [Name of college] did a great job relating careers to the oceanography department.
- I worked with students finding colleges that support the study of oceanography.
- Most of our students do research on their own about the career fields they are interested in. I try to pass along any opportunities sent my way about science related programs through various organizations.
- I have students involved in Robotics, Science Olympiad, Science Fairs, and Science Bowl. The students come in contact with scientists.
- I encourage them to call, email, or write biology and oceanography professors.
- This is something that I spend a lot of time talking about to team members, especially seniors, as they try to decide on which college to attend. And I am still in contact with some former team members now in college, talking with them about their majors.
- I have served as mentor for several students on the team, assisting them in decision-making and writing letters of recommendation for them.
- Opportunities to discuss marine related careers with professionals who work in the field.
- We visit a research station on Lake Michigan and go out on a research vessel, we also have visited Shedd aquarium in Chicago as a NOSB team and asked a variety of individuals questions related to students' career interests.
- The NOSB is a terrific opportunity for students to get excited about science and meet scientists who are excited about what they do.
- It gives my students a chance to see the ocean, visit the Texas State Aquarium, and interact with students & adults from various schools, occupations, and socio-economic backgrounds.
- It gives students the opportunity to travel to science institutions around the state and meet students from other schools interested in science.
- NOSB provided an environment with people of the same interests, and those who encouraged learning in marine science.
- The opportunity to get to know my science teacher better, she has been a mentor ever since. Also, a glimpse of a college campus and oceanography professionals that lured me to the [name of university].
- Meeting oceanography professors at the [name of university] was the most enjoyable aspect of NOSB.
- Having fantastic math and science teachers.
- Influential teachers.
- My teacher asked me to join the team.

- Exposure to different people.
- Hopefully a connection to a college or university where they will some day attend school.
- Encouraged students to deepen their study of ocean science; NOSB exposed them to scientists in the field.
- [Name of center] used ocean bowl to expose potential students to our program for recruitment.
- NOSB exposes students to a college campus.
- They get exposed to a university.
- Getting high school students who have marine interests involved in competition and give them exposure to marine scientists.
- Outreach for oceans, university, and community; stimulates students to come to university.
- Outreach to talented high school students—our future students.
- [Name of center] gains recognition from its participation and may eventually gain increased students from continuing participants in NOSB.
- Student recruitment.
- Good PR, exposure of our institution to high quality science students and teachers.
- Some students may decide to attend [name of institution].
- Visibility for prospective applicants farther down the road.
- Recruitment of students.
- Insight into university/college curriculum.
- Networking opportunities, exposure to college campus environment.
- Opportunity to talk to people working in their areas of interest.
- Interaction with professionals in the marine science field. More knowledge about the field because of answering questions and studying for the competition.
- Change to experience being on university campus.
- Touring of the campus.
- Opportunity to interact with marine science professionals.
- Interaction with community professionals.
- By participating in NOSB, students get to work with a champion or advisor who inspires them.
- The NOSB directly supports the educational efforts [institution] works to promote. It's a wonderful feeder system and succeeds in exposing kids to the marine world, at a time when they are making critical choices about their future studies and professional opportunities.
- Because it helps benefit the ocean science community to bring new students into the sciences.
- I participated in NOSB when I was in high school. It was critical in my decision to attend [name of university] and I thought the competition was incredibly fun. I love to help other students enjoy the science bowl as well as being available to answer questions that high school students might have about college.
- They are coming in contact with numerous scientists and educators who would love the opportunity to give them advice and guidance in pursuing a marine-related career path.

- Students are able to make connections with people in the fields of ocean sciences, which is a rare opportunity.
- Exposure to a university setting, meeting people who work in the marine field.
- They gain much knowledge about ocean sciences in general as well as getting to interact with college students and professors that may be of great help in networking in the future.
- They are exposed to a variety of specialists in the field.
- They see institutions that support their interests. It shows them a future for their interests.
- Exposure to staff and facilities of working institutions. Different perspectives on the subject matter that they have been studying. An improved ability to determine if they want to pursue a career in ocean sciences.
- They are able to meet professional scientists, and students within the oceanographic field.
- The competition may help them get their foot in the door with an oceanography or fisheries department at the university of their choice.
- Interacting with volunteers and leaders, many of whom have careers involving ocean science (gives kids ideas of what they could do someday!)
- They learned by preparing but also got to meet scientists and see the UWM campus. They could gain confidence in science.
- Opportunity to meet potential mentors from faculty participating in event.
- Encouragement for their interests; exposure to college faculty and facilities.
- Great, fun way to generate passions for science. Meet people in a field they are interested in. Information available for internships and volunteer opportunities.
- They have a chance to become involved in the community.
- Besides the accelerated learning in the field of oceanography, they get a chance to meet at the competition people who work at [names of institutions] and other marine related careers. This may provide opportunities in the future for internships with these places.
- They learn more marine science content; they interact one-on-one with marine science faculty and students at a marine science institution.
- Met new people (graduate students and professors), mingled with peers of their own age and learned a great deal, contacts for future endeavors.
- I would hope that their positive interactions with members of the “ocean sciences community”: researchers, faculty and graduate students, would encourage them to consider careers in the ocean sciences. More generally, I think that it is important for our community of high school students to have an appreciation of how ocean and atmospheric systems work and how they are impacted by decisions that governments, industries, and individuals make.
- Chance to interact with professional marine scientists, chance to get to know some for help choosing colleges, planning their career paths, scholastic and social learning experiences.
- They mingle with those working professionally in the sciences.
- She met people, professionals in the field.
- Exposure to NC State and the scholarship encouraged our son to go there.

- She's going to go here, [name of school], somewhat as a result of a bowl, very positive experience.

Interest in the Field/Awareness of the Field

Numerous researchers cited previously indicate that students' selection of a career path can be viewed as highly related to specific aspirations that emerge from knowledge of a career, interest in a career, and—at a very basic level—an awareness that the career exists supported by a social network that can accommodate this career and a vision of self engaged in this career (Wang and Staver, 2000; Plucker, 1998; Quaglia and Perry, 1995; Subotnik, 1993; and Stewart, 2004). Clearly, as noted in all of the data sets separately and in cross-set analyses—one of the dominant features of the NOSB is that it provides a mechanism which sparks interest in the oceans, not only as a field of study and knowledge, but also as a rewarding, engaging career.

Many former NOSB students responded that they had not previously considered themselves as potential researchers or professionals engaged with the ocean. This theme emerged from parent responses and from coaches—the NOSB allowed students the opportunity for a first-hand, close-up view of a science field and the diversity of people engaged in that field. It allowed them to see themselves and valued, key people in their lives, as engaged and involved in the field through the NOSB itself. This created an authentic, realistic awareness and reinforced a qualitative interest in the field—which researchers suggest is key to career selection (Eccles, 1985; and Lupart, 2000). Select narrative from cross-set analyses on this theme includes:

- I think it sparks an interest in many to actually pursue science careers or opt to take more science courses in high school
- It has certainly increased ocean awareness and spawned future interest and scholarly pursuit in my students.

- They are interested in the field of marine sciences, both how it is done and as a possible career.
- They are interested in the field of marine sciences, both how it is done and as a possible career.
- Increases interest in the subject.
- We do a careers unit with internet searches and class discussions.
- It provides students an exposure to ocean sciences.
- NOSB provided a heightened awareness of current ocean issues.
- I learned pertinent information about my major.
- I decided not to go into sciences, but I still feel like it was a very important experience in shaping my education.
- I learned about ocean sciences and considered a career in it for a time.
- It introduced me to oceanography.
- It gave me an idea of what to do with my life. It was inspiration on a large scale.
- NOSB gets potential students interested in college programs.
- Possibly increasing the pool of upcoming minority science candidates, which are underrepresented.
- I'm positive this is sparking interest for future careers and leaders in this field.
- Exposure to the world of oceanography and marine science.
- A great start for their college and science careers.
- They may help to determine a speciality to pursue for a career based on their studies.
- They learn much about the science of oceanography and in many cases develop a strong interest in it.
- An unforgettable experience that will keep oceanography and marine science as a potential interest or career in the future.
- Learning about potential future opportunities.
- This competition may also encourage high schoolers to later study ocean related sciences in college.
- I think they get a touch of the university life, goals, and ideals. Their preparation must entail gaining an appreciation for the role of science in establishing knowledge.
- Broadened their ideas about post-high-school careers and applications of generic class subjects to more exciting fields.
- Increased knowledge of the field.
- Increased knowledge of subject matter.
- Broadened her horizons, increased knowledge.
- She's been exposed to a college atmosphere
- Broadened her interests.
- A greater knowledge of oceanography and possible future plans in this field.
- Broadened her horizons.
- Interests and career opportunities for major; interest and work opportunities for career.

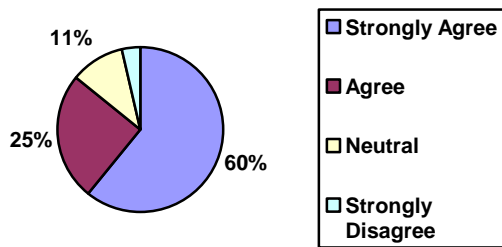


Figure 35. Past Participant responses to the item “Participating in NOSB encouraged my overall interest in the oceans.”

As indicated in figure 35 above, beyond the evidence that NOSB is directly or indirectly supporting the entry of past participants into the ocean sciences or science career pipeline as discussed previously, it is also evident that the NOSB is influencing interest in the oceans. This interest is integral to providing career related knowledge, in the event—as is highly likely—some of these students make career changes or college major changes “down the road.” Furthermore, this interest will certainly support enhanced stewardship for the oceans and its resources by this element of the U.S. citizenry.

Correlation of Effective Competition Indicators with Narrative Data

In a 1996 text, Tallent-Runnels provides a valuable framework—termed *effectiveness characteristics*—for evaluating the effectiveness of academic competitions, followed by a concise programmatic summary of approximately 80 regional or national academic competitions for students in the United States at the time of the writing of that text. These characteristics, cited in figure thirty-six below, were used as the organizing framework to evaluate the National Ocean Sciences Bowl as an academic competition program. A comprehensive literature review failed to identify another example of a systematic framework to evaluate competition-based programs. The researchers believe the Tallent-Runnels framework is in fact unique in its inclusiveness and its treatment of academic competition as a learning methodology.

Other literature, as summarized earlier, provided a variety of other perspectives on academic competition; however, characteristics suggested in these sources are substantively contained in the Tallent-Runnels framework. Diegmüller (1996) discusses the academic focus of competitions. Nifong (1996) describes or characterizes the pursuit of academic excellence and the benefits of winning and losing in character development. Many researchers see academic competition as a singular solution to mediocrity in secondary education (Diegmüller, 1996). Parker (1998) suggests a parallel between physical and academic competitions as opportunities for students to express personal excellence. Harp (1995) provides a view that academic competitions provide a degree of visibility to students on the basis of academic accomplishment—promoting learning as a valued characteristic of a successful student.

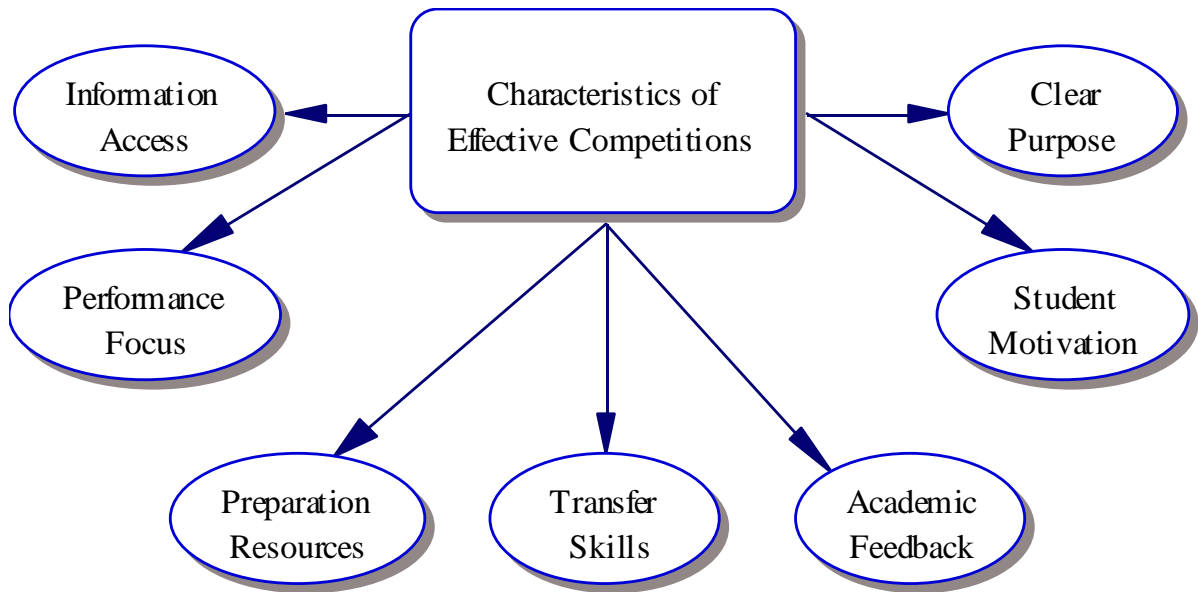


Figure 36. Research literature reveals seven characteristics of effective academic competitions, which were used as organizing themes for the cross-set data analyses.

As revealed in the cross-set analysis of the NOSB data on the theme of competition in the previous chapter on *Affective Impacts of the NOSB*, a uniform perception exists among the respondents to the various surveys and the interviews for the study that competition has resulted in strong, positive impacts on the student participants. Further, the past participants responding to surveys and interviews provide corroborating support for this perception of competition by offering personal experiential data as examples of the positive impacts—summarized in this report for that single data set.

This chapter re-codes and organizes the data from across the sets following the organizing framework suggested by Tallent-Runnels (1996) to identify how the NOSB functions programmatically in light of these effectiveness indicators. It should be noted that the transfer skills category suggested above will further include process skills, academic skills, communications skills, and leadership skills as discussed through the remainder of this report.

Information Access

The capability of students, parents, teachers, and related school officials to efficiently collect program information is viewed as an important indicator of overall program quality. The communications flow should be two-directional, as well as responsive to the needs of both returning participants and teachers, who have an enhanced understanding of program requirements, and novice participants who have little understanding of program requirements. Narrative responses with respect to obtaining information for fielding a team at NOSB indicates these features can be observed in the system. Teachers report regular communications with Regional Coordinators—who rely on email communications with CORE staff and frequently use “forward” features of email servers to directly connect teacher/coaches to pertinent information. Teachers and Regional Coordinators perceive the CORE staff as responsive and timely in communicating. Students and Teachers particularly appreciated programmatic and curricular support such as sample questions, web links, and textbook references. There also did seem to be a difference in information to prepare versus information about CORE and the NOSB program—suggesting a marketing problem (although this was seen more profoundly with volunteers and parents than with students and teachers). Select narrative which supports this category includes:

- Knows some of the national and regional sponsors.
- Familiar with regional sponsors.
- I have heard of CORE but don’t know much about them.
- The teacher who organized the school program is very knowledgeable and had distributed information well.
- I probably could have gotten more information if I had asked.
- I had very little information.
- Yes, it was wonderful and very supportive. We received textbooks and other materials to study from which helped. The love of oceanography was kindled.
- I think the opportunity to meet marine scientists is rare, and should be highlighted.

- Overall I think the program is excellent in the goals it has set. But there is a marketing problem. All regions I am familiar with have fewer schools and more teams per school.
- I am provided with a number of informative emails over the course of the year from our coordinators that have led me to opportunities to incorporate ocean sciences in my courses. By coaching this team, I am forced to keep abreast of new developments in ocean sciences and to constantly review. This knowledge and attitude keep me engaged and this filters over into my teaching.
- The program consistently supports its purpose by adequately supplying information and sources in helping each school develop its program.
- The materials provided to us and the practice sessions we were able to attend were helpful, and all of my students came away with at good feeling about the competition even though we came in 13th.
- The sample questions are great.
- It is extremely well organized and covers a broad range of oceanographic topics.
- My students and myself were adequately informed and therefore prepared for the competition.
- My marine science teacher encouraged me to put a team together, and we did.

Performance Focus

Tallent-Runnels (1996) differentiates the immediate “win or lose” feedback which highlights the performance orientation of competitions with a substantive, educational performance which highlights and encourages excellence. Narrative responses emerged which reinforce two different categories of performance—1) technical, skill application or process performance, and 2) cognitive or academic oriented performance, i.e. performance that demonstrated mastery of specific content. These latter ideas are summarized with example narrative in the following section.

This current section addresses the technical, skill application or process performance focus of the NOSB program. Past participants, parents, and coaches report that the competition provides an opportunity parallel to athletic competition: students invest substantive and disciplined effort in preparation for the event. At the event, they have an opportunity to “challenge themselves,” to “rise to their best level” and to demonstrate publicly they have worked hard. Students “like to show off” their

knowledge; they like the recognition for “being the best;” their skills are challenged and they are singled out for their “academic prowess.” The immediate gratification of competence *vis a vis* the quiz format is valued by the students. The NOSB also afforded students the opportunity to study content that was highly interesting to them, but which was not typically represented in secondary courses—in part due to a lack of academic content standards for the ocean sciences to support such infusion in the secondary curriculum.

- Reinforcement of interest in learning loads of knowledge.
- Broaden knowledge of marine science.
- In-depth exposure.
- My team members are usually students that have a fascination with and a desire to learn all they can about the ocean. They enjoy the learning process and love to share what they have learned about the seas.
- It is an excellent tool to get students motivated in marine sciences. Originally, NOSB had a major fault in that the students could win by just knowing the rules. The introduction of the team challenge illuminated that fault.
- Throughout this country, school ends and athletic competition begins. Students love competition, and to offer an academic competition where they can compete with what they know and have learned about the oceans is exciting. Success breeds success.
- Some participate because they like to show off what they know.
- They are students who love science (though many are academic underachievers) and enjoy the opportunity to compete and demonstrate their skill before an audience. There’s also the prizes!
- The personality and drive of the coach can encourage participation. The competition allows them to test their skills and knowledge, just as an athletic event does.
- I enjoyed being able to apply my knowledge about my interests.
- Recognition of hard work.
- Students get a chance to show off their knowledge.
- A greater level of understanding of global and oceanographic issues, an applied use of their scientific knowledge, a fun and interesting reason to work and study hard in a difficult field.
- They are able to showcase their knowledge and meet other students and educators in the field of marine science.
- Positive reinforcement that learning and the application of knowledge can be fun, both as an individual and a team member.
- The NOSB gives them a reason for studying ocean-related sciences. It gives them experience in applying their knowledge, and it rewards them for responding quickly and strategically in the quiz situations.

- They receive a wonderful opportunity to compete in a well organized event. Their skills are challenged and their excellence is rewarded in their field of interest.
- Recognition for their academic prowess, excitement, an opportunity to expand their knowledge and relationships with other schools.
- Students get the benefit of applying what they know and hearing the experts give analyses of their answer.
- Rewards and recognition for science knowledge. Scholarships and other prizes for performing well.
- Tremendous experience in learning, especially beneficial for lower performing groups to see what the higher performing groups can do, motivation.

Learning/Content Focus

As noted above, the second category emerging from the narrative with respect to performance focus is the area of performance as the basis for content mastery. Students, parents, coaches, volunteers, and regional coordinators report a linkage between the content curriculum associated with ocean sciences as an interdisciplinary field and participation in the competition itself. Students and teachers/coaches perceive that NOSB participation is a validating exercise for the students and teachers—and the schools themselves—that the curriculum studied was valuable and rich.

Student success in the competition or performance program supports the student personally with respect to “knowing that they learned something.” Students who previously knew nothing about the ocean have become fluent in discussing, arguing, and defending their knowledge of the nuances of recent research and scientific understanding. The knowledge surpasses that normally received in a typical high school class setting, and prepares students who are interested for initial success at the post-secondary level. The rewards in the NOSB are not based on “who you are” but “what you know.” This is fundamentally a meritocratic system based on external knowledge and content mastery, and is understood and received as such by participants. Select narrative in this category includes:

- Reinforcement of interest in learning loads of knowledge.
- Broaden knowledge of marine science.
- Good application of knowledge.
- The competition has raised her awareness of ocean sciences and the many areas of its specialties.
- They learned so much about oceanography, and it sparked their interests to learn more in the future.
- My team members are usually students that have a fascination with and a desire to learn all they can about the ocean. They enjoy the learning process and love to share what they have learned about the seas.
- Students who had had no previous knowledge or interest in oceans are now much more aware of the relationship.
- I think the NOSB program helps to jump start the process of getting students and educators interested in the future of our oceans.
- It encourages students to study Ocean Sciences, exposing them to areas not usually covered in most science classes. It also educates teachers about ocean sciences, which helps us to then include more in our curriculum.
- The NOSB program provides students an opportunity to engage in learning about the oceans and their relationship to people and other organisms. It gets students excited about learning, specifically about the sea.
- Students are exposed to more information than they would normally receive, and they are thrilled by the competition.
- It is an excellent program that involves intense study into very specific points of marine biology, marine geology, marine chemistry, and oceanography. Unfortunately, it has limited participation of involving only five students per team.
- The competitive academic adventure is the driving force.
- Learning information pertinent to my major.
- Those who encouraged learning in marine biology.
- I thought it would be a good way to go deeper into the information than just what we were covering in class.
- You got to be rewarded for your knowledge.
- A solid basic understanding of the broad intellectual aspects of oceanography. An appreciation of the importance the oceanographic science community places on the subject. Thanks and encouragement for all their hard work.
- I think that the team challenge questions are a huge improvement to the NOSB. It puts a greater emphasis on what the students know and less on the mere game/strategy of it all.
- They expand their knowledge of ocean sciences.
- Good academic experience.
- Oceanographic knowledge.
- Learn about science through studying.
- Demonstrated academic excellence.
- Gain experience in rigorous, intellectual challenge in public venue.
- The breadth of information that the students are exposed to in order to compete is relatively wide.

- It allows students that are more academically inclined the chance to enjoy competition as well as meet other students with similar interests.
- They learn a lot of natural sciences and they are rewarded emotionally for being good students.
- Increased knowledge through study/preparation.

Preparation Resources

While the lack of resources for students to use, according to Tallent-Runnels (1996, p. 4) does not automatically disqualify a competition as an “effective competition,” having these resources does “move the competition beyond the traditional image.” Having these resources suggests the orientation or motivation of the competition is not simply provision of the competitive program or environment—but further includes substantive educational concerns for the students’ development in skill or knowledge areas. There is clearly an overarching learning support structure for these students. The category or theme of preparation resources is readily discernible in the narrative from the different data sets.

These preparation resources included print materials and extensive web resources, as well as opportunities for interaction with scientists, professors, and researchers who gave time to assist with student study sessions or to host field trips. The web resources include practice questions, links to curricular materials, career information and linkages, scholarship opportunities, further educational opportunities, and parent resources—although parents seem to be detached from connecting to CORE and the NOSB through this mechanism. Coaches identified locations to visit with teams to provide contextual understanding of the broad field of ocean sciences. Questions posted to regional coordinators or to CORE personnel were answered promptly. There was an overall focus

on enhancing content understanding of all of the students—and a strong consensus that this in fact happened. Select narrative for this theme includes:

- My students and I were adequately informed and therefore prepared for the competition.
- I think the opportunity to meet marine scientists is rare, and should be highlighted.
- The program consistently supports its purpose by adequately supplying information and sources in helping each school develop its program.
- The materials provided to us and the practice sessions we were able to attend were helpful, and all of my students came away with at good feeling about the competition even though we came in 13th.
- The sample questions are great.
- Financially they have done a stellar job. It has also been quite easy to get academic help. Twice they came to [school name] for regional prep sessions, they've been at our state science teacher's meeting the last two years, and they commonly have given us resources like textbooks and articles to use.
- We receive a great deal of information and support from the regional leadership. Questions are answered promptly and adequately. I wish there was more help for coaches in determining and asking questions that would be helpful in practicing for the team challenge questions.
- All of the materials and field trips helped get the students involved.
- The support from the planners was so good. They answered so many of our questions and were so helpful and friendly in their support. The materials to study from were also great.
- We did a lot of outside activities which seemed to help a lot.
- The field trips my teacher took us on were most enjoyable.
- More intensive instruction, better instruction, more thorough learning, broader coverage of the field, expanded interest in ancillary sciences (physics, chemistry).
- They build up so much knowledge; they're provided so many resources for their learning by [regional sponsor].

Transfer Skills

The researchers have previously identified in the data numerous academic study skills, leadership skills, and process and communications skills which respondents report are accrued by students directly through competing or preparing to compete in the NOSB program. While that more extensive section certainly relates to this current theme, it is more actively associated to the students and not the programmatic characteristics of the competition itself—although that difference may be purely semantic. Within the Tallent-

Runnels framework, the effectiveness of a competition can be assessed on the basis of acquisition of long-term transfer skills which accrue to the students.

Narrative—different from that cited in the previous section—emerges specifically related to the NOSB in a more generalized view of student participation, which supports the acquisition of specific transferable skills as a result of competing. Students seem to obtain a capability for individualized, independent study which is widely viewed as characteristic of adult learners. Students seem to develop a generalized, global view of science knowledge through the interdisciplinary focus of the NOSB—somewhat of an earth system view of science and its related sub-disciplines. Students “learn how to learn,” learn how to meet new people, and develop relationships with them. Students learn how to synthesize knowledge and apply content to new, challenging and high pressure environments. The NOSB is viewed as a highly positive learning environment where all students—even the ones who don’t place—leave with a positive view of themselves and their capabilities. A large number of respondents, and particularly the responding past participants, report that NOSB participation sparked a life-long interest in, and in many cases hobbies or avocational pursuits related to the ocean. Select narrative in this area includes:

- The competition has raised her awareness of ocean sciences and the many areas of its specialties.
- He learns good study skills and prepares for college.
- Exposure to academic competition.
- Students get much out of practice and participation.
- The students need as many ways possible to try their strengths before they go out to the world.
- Very important experience in shaping my education.
- The knowledge that I gained from participating in NOSB has made my marine biology classes much easier, since I still remember most of the facts that I learned and memorized.
- I learned a lot about our planet and the oceans through independent studies.

- The feeling of accomplishment at all the information that I absorbed over that one year.
- Digesting and organizing large quantities of information.
- The amount of effort in the form of studying it took to do well in NOSB taught me valuable study habits.
- Learning material relevant to biology.
- NOSB participants challenge themselves to learn, develop public speaking and recall skills. Additionally, they may help determine a specialty to pursue for a career based on their studies. There are great perks and scholarships that help to encourage involvement as well.
- It teaches the students how to work as a team, how to synthesize and apply their knowledge of ocean issues in a challenging situation, and provides an opportunity for them to learn.
- Meet new people, learn a lot about oceanographic studies, learn more about opportunities in science.
- A greater level of understanding of global and oceanographic issues, an applied use of their scientific knowledge, a fun and interesting reason to work and study hard in a difficult field.
- It is an intellectually stimulating competitive environment.
- I think the students learn that science can be fun, that it isn't bad to be smart, that hard work pays off, that sometimes it's just the trying that counts.
- From my observation, the students clearly enjoy the experience that combines learning...time with friends, special support from their teachers, and a sense of accomplishment; all of which contribute to their growth and development as learners and citizens.
- They get an opportunity to challenge themselves to learn outside of the classroom, a glimpse of academia and post-high school life.
- They'll ace their first college-level intro to oceanography class.
- Aside from the increased knowledge of the subject matter, students experienced the benefits of teamwork competition, and problem solving. The positive atmosphere of the NOSB made participants feel like winners despite their overall scores.
- I believe that when they do well in competition, it makes them more confident in their studies. I believe when they do not do as well as they expect, it makes them try harder the next time. It's a win-win situation.
- It encourages them to get excited about science, and they get to see what is out there to do in the science world and what they may be interested in pursuing in their future careers.

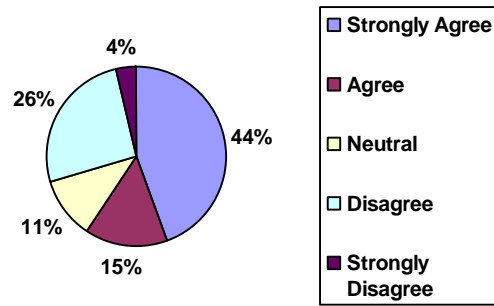


Figure 37. Past Participants responded that 59% had selected a career or college major based on an ocean or science related hobby—after 72% reported that NOSB participation had influenced the development of a hobby related to the ocean personally.

Academic Feedback

As noted previously, the performance orientation of the competition is essentially a system of immediate reinforcement or feedback. Unfortunately, and again as discussed by Tallent-Runnels (1996) this reinforcement frequently does not manifest itself constructively in the form of usable information to assist student improvement. The NOSB narrative does not support a conclusion that there is consistent, cross-regional and national attempts to build in specific academic feedback as the literature supports. There is narrative, particularly in the Coach surveys, that some select teams participate in a curricular driven “breakout” session with their coaches following participation. This seems especially true of teams which have participated or plan to persist in participation year to year. Site observations conducted by the research team further support an orientation among teams to the specific types and science categories of questions being asked in competition, followed by a reinvestment of study time to those areas—even during the day of competition. The students and coaches are attentive to the science content foci of the questions, to their own study predilections and materials, and seem oriented to redirecting or reorganizing their study strategies following competitions. The

following selections of narrative are the “best examples” of support for the presence of academic feedback as a characteristic of the NOSB—although the researchers do believe these selections are only marginally supportive at best. Select narrative in this area includes:

- The competition provides a good way to gain student interest in learning more about the marine sciences. And even though winning is emphasized, the Chesapeake Bay Bowl has come up with some excellent ways to reward teams who prepare and participate, but are not fortunate enough to win.
- We receive a great deal of information and support from the regional leadership. Questions are answered promptly and adequately. I wish there was more help for coaches in determining and asking questions that would be helpful in practicing for the team challenge questions.
- Some enjoy marine science and want to see what they know.
- To provide an “external” measure for students to gauge their progress and accomplishments.
- The feeling of accomplishment at all the information that I absorbed over that one year.
- You got to be rewarded for your knowledge.
- A solid basic understanding of the broad intellectual aspects of oceanography. An appreciation of the importance the oceanographic science community places on the subject. Thanks and encouragement for all their hard work.
- They have opportunities for scholarship, they get a sense of accomplishing something worthwhile, they get rewarded for having brains and using them wisely.
- Recognition of hard work.
- It also gives them a chance to see how much they know.
- They get recognition and rewards for learning about oceanography.
- They are able to showcase their knowledge and meet other students and educators in the field of marine science.
- Positive reinforcement that learning and the application of knowledge can be fun, both as an individual and a team member.
- The NOSB gives them a reason for studying ocean-related sciences. It gives them experience in applying their knowledge, and it rewards them for responding quickly and strategically in the quiz situations.
- They receive a wonderful opportunity to compete in a well organized event. Their skills are challenged and their excellence is rewarded in their field of interest.
- Recognition for their academic prowess, excitement, an opportunity to expand their knowledge and relationships with other schools.
- Students get the benefit of applying what they know and hearing the experts give analyses of their answer.
- They learn a lot of natural sciences and they are rewarded emotionally for being good students.

Student Motivation

The area of student motivation is clearly an exemplary characteristic of the NOSB program from the perspectives of the various survey respondent groups. The types and nature of the prizes, as well as the basic orientation toward competition itself among these types of students—are all viewed as essentially motivating features. Respondents refer to the positive reinforcement that occurs during the program. The teams become self-reinforcing as well. They develop internal cohesiveness and relationships with each other. NOSB provides students a rationale for studying the ocean science content areas. One teacher reported that students obtain benefit from having wrong answers explained and corrected by expert judges, who demonstrate a commitment to the program through long-term association [Note: this type of academic feedback was not consistent as evidenced in the data, as was previously discussed.]

The NOSB program is referred to as a tool, a support, a motivational activity, an opportunity for engagement, and a reason to study. Competition is viewed as an essential need for secondary students—and a fundamentally motivating force itself. Numerous references in the narrative address the prizes—which are viewed, even at the most basic or inexpensive level, as genuinely meaningful to students. There is an association made between the reward and the effort expended. Narrative in this thematic area includes:

- Aside from the increased knowledge of the subject matter, students experienced the benefits of teamwork competition, and problem solving. The positive atmosphere of the NOSB made participants feel like winners despite their overall scores.
- The competition motivates students to hone their knowledge and skills related to ocean sciences.
- Challenge to study and know more.
- He has learned that the broader your learning the further you will go.
- Academic discipline.
- Thinking on toes, critical thinking.

- NOSB is doing a fine job in meeting its stated purpose. The rewards that you give the student who participate and place in the top encourages students to want to learn about the oceans.
- They learned so much about oceanography, and it sparked their interests to learn more in the future.
- It was wonderful in supplying an opportunity outside our normal curriculum. It motivated students to explore peripheral topics within several curriculum we offer.
- The materials provided to us and the practice sessions we were able to attend were helpful, and all of my students came away with at good feeling about the competition even though we came in 13th.
- It think it does so, because every year more students are showing an interest in being part of the team, and that means also that more students are taking an interest in the field.
- The NOSB program provides students an opportunity to engage in learning about the oceans and their relationship to people and other organisms. It gets students excited about learning, specifically about the sea.
- The competition provides a good way to gain student interest in learning more about the marine sciences. And even though winning is emphasized, the Chesapeake Bay Bowl has come up with some excellent ways to reward teams who prepare and participate, but are not fortunate enough to win.
- My students come to life whenever there is competition at any level, within the classroom, between classes, and certainly between schools. Many who would not put in extra study effort do now because there is someone to beat. That may not always be healthy, but it seems characteristic of teenagers.
- NOSB supports students by getting them excited and involved in ocean sciences. It falls short by limiting the number of students that can participate.
- It's a great motivational activity. It inspires students to really work hard and excel in the field of study.
- It is an excellent tool to get students motivated in marine sciences. Originally, NOSB had a major fault in that the students could win by just knowing the rules. The introduction of the team challenge illuminated that fault.
- NOSB participants challenge themselves to learn, develop public speaking and recall skills. Additionally, they may help determine a specialty to pursue for a career based on their studies. There are great perks and scholarships that help to encourage involvement as well.
- Competition of any kind feeds the need people inherently have to do better. Challenges the students to learn more and more.
- The monetary and other awards are also really great—I was surprised by how much was donated to the NOSB—the scholarships given to the first and second place teams will no doubt be welcomed by the students (and their parents.)
- They'll have incentive to get to know more things and it may potentially influence their future career selection.
- Encouragement to learn about ocean sciences.

- A greater level of understanding of global and oceanographic issues, an applied use of their scientific knowledge, a fun and interesting reason to work and study hard in a difficult field.
- I think that NOSB turns a set of disciplines, that can be considered dull by some folks, into a fun, exciting competition. What's better than education and fun in the [same] room?
- They are having fun while they learn! And it is simply personal satisfaction for each person to be able to be part of this.
- The NOSB gives them a reason for studying ocean-related sciences. It gives them experience in applying their knowledge, and it rewards them for responding quickly and strategically in the quiz situations.
- They get an opportunity to challenge themselves to learn outside of the classroom, a glimpse of academia and post-high school life.
- This motivates them to do better in school as well as giving them something educational to do to stay out of trouble.
- It encourages them to get excited about science, and they get to see what is out there to do in the science world and what they may be interested in pursuing in their future careers.
- Tremendous experience in learning, especially beneficial for lower performing groups to see what the higher performing groups can do, motivation.
- This gives them a reason to learn. It shows them "science" outside their school.

Clear Purpose

The assessment framework used for the current study associates purposes in academic competitive events with clearly articulated content areas and the goals and objectives of the program. As such, the NOSB is clearly identified with the multi-disciplinary concerns of ocean sciences. One of the strongest characteristics to emerge in the narrative in the broader thematic area of effectiveness indicators is clarity of purpose, goals, and attainment of that purpose through programmatic components. The narrative across the sets underscores the emergence of this category among all respondents. A strong consensus exists that CORE has clearly articulated a purpose for the NOSB program, and has provided and supported a strong program to meet that purpose.

As such, the NOSB "provides an opportunity for many students to put a focus on the oceans that they would not have otherwise." The program "adequately supplies

information and sources in helping each school develop its program.” And, “every year more students are showing an interest in being part of the team, and that means also that more students are taking an interest in the field.” These comments suggest the program operates out of a clearly defined purpose which can be articulated by key participants—students, coaches, volunteers, parents, and regional coordinators. Select narrative in this area includes:

- The purpose is high school competition in the ocean sciences. I believe students enjoy the preparation, study, and participation in this competition.
- I feel the NOSB program instills an excitement in the students for ocean science, through preparing for and participating in competitions.
- NOSB is doing a fine job in meeting its stated purpose. The rewards that you give the student who participate and place in the top encourages students to want to learn about the oceans.
- Overall I think the program is excellent in the goals it has set. But there is a marketing problem. All regions I am familiar with have fewer schools and more teams per school.
- I think NOSB supports its purpose and provides an opportunity for many students to put a focus on the oceans that they would not have otherwise.
- The exposure that it provides for children is priceless.
- I speak from being very involved in NOSB since the beginning. NOSB more than achieves its purpose of promoting ocean sciences education in schools throughout the country.
- Yes, it adequately and consistently supports its stated purpose.
- NOSB has created interest in ocean science in the participating schools. Some schools have added classes as a result.
- The program consistently supports its purpose by adequately supplying information and sources in helping each school develop its program.
- It think it does so, because every year more students are showing an interest in being part of the team, and that means also that more students are taking an interest in the field.
- I assume that the purpose is to generate awareness and interest in the oceanographic sciences. I believe that this objective is well accomplished. The broader goal of awareness and interest in other NOAA areas is probably missed, but they appreciate the opportunity offered by NOAA in putting on the event.
- It is extremely well organized and covers a broad range of oceanographic topics.
- I think that its stated purpose is supported by the opportunities that the faculty and staff have given us.
- I'd need to review your stated purpose. I believe it has certainly increased ocean awareness and spawned future interest and scholarly pursuit in my students.

- It is great bringing exposure to ocean studies. The location was well done, the topics clear, and the overall program was strong.
- It does a good job of reaching its goals and purposes.

Access to Ocean Sciences

An additional thematic category which emerges from the data in support of program effectiveness is not contained in the Tallent-Runnels framework, but is nevertheless an important view of the NOSB. A substantive number of respondents—particularly the coaches/teachers—indicate that their schools are rural, low-income, or inland and typically do not have the resources to offer a full range of science courses for students. Consequently, a secondary course in marine biology or oceanography would be quite beyond the district’s capability or interest. The NOSB has become a curricular addition to these high schools—providing students the opportunity to engage in a highly interesting course of study at a very deep and intense level, without the district or school requirement of a formal course. Some teachers report that their own content knowledge has been enhanced through helping teams prepare, and that this enhanced content knowledge and student interest has been a precipitating event to begin a formal course in ocean sciences in their schools. In that vein, the NOSB has served as an important stimulus not only for reaching the individual students who participate directly—but for reaching students in the general population who may ultimately take a course that evolved out of a teacher’s enhanced understanding and comfort level. Select narrative in this area includes:

- I have tried to get team members interested in participating in summer programs that involve ocean science, because they get really excited during the competitions and want to learn more. However, the majority of programs that I have found for them cost too much money for their budgets, and also require sacrifices like missing out on work for their jobs.

- It was wonderful in supplying an opportunity outside our normal curriculum. It motivated students to explore peripheral topics within several curriculum we offer.
- It encourages students to study Ocean Sciences, exposing them to areas not usually covered in most science classes. It also educates teachers about ocean sciences, which helps us to then include more in our curriculum.
- I am provided with a number of informative emails over the course of the year from our coordinators that have led me to opportunities to incorporate ocean sciences in my courses. By coaching this team, I am forced to keep abreast of new developments in ocean sciences and to constantly review. This knowledge and attitude keep me engaged and this filters over into my teaching.
- NOSB has created interest in ocean science in the participating schools. Some schools have added classes as a result.
- The program consistently supports its purpose by adequately supplying information and sources in helping each school develop its program.
- This program has opened doors at our school that would not have been opened without a program like this. We are a small school that is looking for new ways to motivate students to think outside of a text. This program does that. We do not offer oceanography at this time due to its cost, this program allows the students to learn other sciences. Of the players on my first team all are now pursuing a course in science. This is a great program and does reach its goal with our school.
- We are a rural school far from the ocean. This program has surely increased the awareness of the ocean and its environment, chemistry, biology, etc. It has also added to my classes in biology and physics as the principles overlap material taught in those subjects. I do believe it is a good program and should be one that is continued.
- There are very few national science competitions similar to the NOSB. My students are not afforded the opportunity to study oceanography or marine biology; this competition provides an access point for those studies.
- The program is challenging and different from other programs at their school. It allows them to step out of the traditional box and explore other areas of science.
- I wanted to allow my students an experience that was out of the ordinary to their reality. We live in a small, sheltered, low-income community. There is not much for youth to do around here. I wanted the students to have a taste of what is out there to take part in.
- To give our students in our rural setting the feeling of success among schools much larger than ours.
- To provide a format for learning about the oceans that goes to a higher level than I can go in the class.
- This is the only opportunity that students in our school have to learn more about the marine sciences.

Summary

Assessing the Impact of the National Ocean Sciences Bowl: A Systems Approach was an ambitious, two-year, multi-tiered research study of a significant, national ocean science education program implemented in twenty-four regions throughout the nation, and annually at a national finals competition. Using four survey instruments, two interview protocols, site visits and observations at ten locations, a participant observer, and a limited, online discussion forum—the researchers collected a significant quantity of data. These data were analyzed separately to identify major thematic issues and clusters, and then re-analyzed cross-wise for consistency of view—both internally and in view of a significant body of literature reviewed to triangulate both the data and their interpretations.

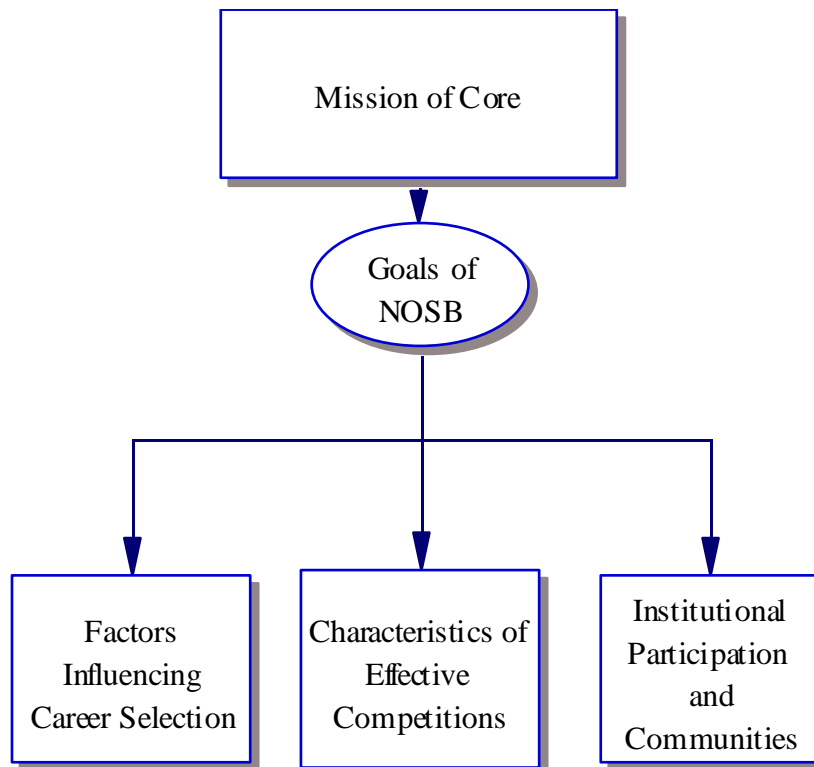


Figure 38. Overall tiers for Impact Assessment Study

Figure thirty-eight illustrates the two primary research tiers, i.e. *Factors Influencing Career Selection* and *Characteristics of Effective Competitions*, which were identified from literature as the basis for the research questions and factors, and to form the initial thematic categories to guide the data sorting (Eccles, 1985, 1998; Tallent-Runnels and Candler-Lotven, 1996; Merriam, 1988). The additional component of this figure highlights the importance of viewing the NOSB as a programmatic context, or community of audiences—each having a separate perspective on the potential impacts of this program. These audiences are the students themselves, the teachers who function as coaches, the parents, the volunteers who perform the tasks of judging, scorekeeping, organization and logistics, record keeping, and the myriad activities necessary for the successful implementation of the NOSB at both the regional and national levels. Additional audiences include the regional coordinators, the national CORE staff who invest significant effort into the success of this activity, the local, regional, and national fiscal partners, the local community, and school and agency leadership.

Survey instruments were created, piloted, and refined for each of the key audiences, and posted online for ease of response. Additionally, the research team visited ten of the regional sites to observe the program to formally interview members of each audience, and to collect anecdotal print materials. The instruments were piloted by one of the researchers in a previous 1999-2000 study of the NOSB program, and those initial instruments were revised in view of their performance during that study, and in light of the research literature and specific contextual needs of this current study.

Over 500 respondents or interviewees from the various audiences provided data for analyses. The data were found to be internally consistent, with perspectives shared by

the different audiences evidencing strong similarities when they were compared cross-wise, i.e. set to set comparisons. The number of past participants responding (n=37) was small

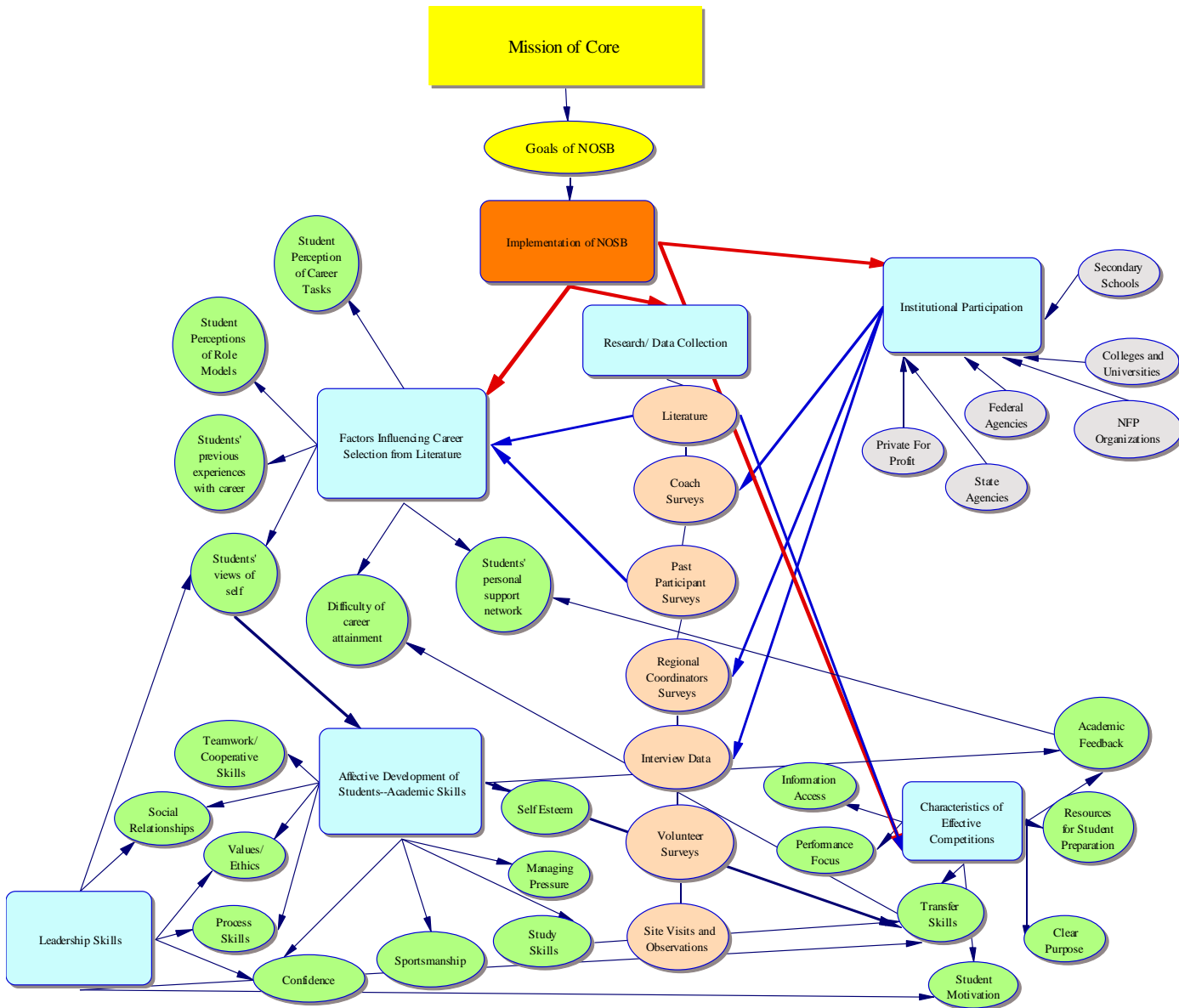


Figure 39. Non-Linear Study Model with Internal Conceptual Connections

for the overall pool of potential study participants—but in fact was comparable to a longitudinal study of a similar, national academic competition used as a comparison

index (Subotnik and Steiner, 1993). Themes and categories which emerged from the analyses included: the significance of teamwork and cooperative learning in the program; the value of the competitive dimension of NOSB to motivate participants; the importance of the social networks that develop for the students and other audiences; and the centrality of the academic, communications, and leadership skills that are developed among the participants.

Findings

The major findings of the research study are illustrated in Figure thirty-nine, as indicated by the directional lines used to connect the various graphical elements of this figure. The directional lines used in this figure provide graphical indicators for the primary and secondary connections which were created or which emerged through the development and implementation of the study. The thickest lines connect the header “Implementation of the NOSB” graphic with the two tiers of the study identified at the outset, i.e. Factors Influencing Career Selection and Characteristics of Effective Competition, and with the primary sources of data and primary audiences used in the study. The secondary connective lines indicate the primary literature source and data source for establishing the thematic categories (delineated as circle and oval shapes in the figure) and for triangulation to establish credibility. The tertiary level connective lines suggest initial linkages of the thematic categories to their dimensionalized, category cluster. The reader is directed to the analyses narrative sections earlier in this report for greater explication of the following findings and conclusions, and for selections from the narrative and quantitative data for support of these findings and conclusions.

Career Path Related Findings

The researchers find that sufficient data exist, with high internal consistency across the audiences of the study, to demonstrate the effectiveness of the NOSB program for creating social networks for the participating students necessary to influence those students' career path decisions. These networks include relationships among teammates, with other teams and from other schools, and emerging mentor relationships with coaches, college professors, researchers, undergraduate and graduate students. These relationships seem durable in view of the number of past participants and coaches who indicate they maintain follow-on communications with past NOSB team members. Further, literature associated with career development and decision-making with respect to college and careers indicates that these relationships are highly important in providing support for high ability students to negotiate the distractions of multi-potentiality in these decisions. Additionally, the development of these relationships, particularly with individuals associated with specific colleges and universities influences the decision of NOSB participants to eventually attend these institutions. Finally, it is noteworthy that for the past participants responding to the survey and online forum, the NOSB coach is more important and informative to the student in career and college decision-making than the parents are—supporting the literature that discusses the relevance of specific career information, and that parents frequently lack this information. A limitation of this finding and the study design is that parents were by and large underrepresented as a source of data due to a lack of attendance at the NOSB sites visited. It is recommended in a following section of this report that CORE implement a revised communications plan to involve parents in the NOSB event more substantively.

An additional career path finding relates to specific career information required for decision-making among high ability secondary students. In 1993, Subotnik and Steiner followed up a longitudinal study of a pool of previous, national award winning students in the Westinghouse competition. These researchers found that for students who had previously distinguished themselves on the basis of science knowledge and capability—a large number of these students, perceived as “the next generation of scientists” had in fact dropped out of the science pipeline. The reasons for this were found to be lack of specific information related to career preparation, types of activities performed “on the job,” and career entry and salary information. Further, many of these science “drop outs” reported that while science programs had been interesting and “hands on” in high school, science in the undergraduate curriculum was too frequently “memorization of facts.” This study pointed out the importance of highly specific career orientation and information for secondary students to ensure—if they are motivated to enter a career pipeline—that they stay in the science career pipeline. In the current NOSB study, the researchers find that CORE does provide significant linkages for students to career information, both generalized and in the programming itself through career-focused, specific questions during the competition. As with the issue of academic feedback, however, a broad range of exposure to this information, or lack of exposure, is observed across the different regions. Given CORE’s interest in influencing the career pipeline—this inconsistency in regional communication of career information to students should probably be a concern to program administrators.

Leadership Development Findings

A second major area of findings is related to a large cluster of themes which emerged across the data sets for *Leadership Skills*. While the students' views of self emerged from the literature as a factor for examination of career path decisions, this view of self seems far more complex in the data collected on the NOSB program.

Additionally, these leadership skills and this view of self further articulates with perceptions of career tasks and related vocational skills necessary for entry and success in the chosen career. Coaches, parents, volunteers, and past participants voice a strong theme that NOSB preparation and participation forces students to master a set of academic-related skills that transfer to success in college and in the career setting.

Further, a separate set of skills—labeled *Leadership Skills*—which includes the ability to express confidence, to plan and sequence complex tasks and studies, to create working relationships with colleagues, and to formulate a system of ethics and values associated with performance and winning or losing—is strong across all of the data sets. Clearly, whether the students won or lost at NOSB competition, they learned the skills necessary to lead and succeed in school and work settings.

These skill sets associate to the *Characteristics of Effective Competition* literature in that they are highly transferable—applicable to numerous contextual settings. Further, these skill sets serve to motivate students in school and career settings by providing a clarified view of self and by facilitating personal confidence in view of the difficult career and higher education goals these students frequently set for themselves.

Competition Effectiveness Findings

A third major set of findings is associated directly with the *Characteristics of Effective Competition* identified in the literature with respect to academically oriented competition programs. The researchers find that while the NOSB program demonstrates strong evidence of meeting the characteristics of clear purpose, student motivation, transfer skills, performance focus, and resources for student preparation—it appears from the data, the NOSB program could be strengthened in the areas of academic feedback to students and information access for the key audiences, particularly parents.

In the area of academic feedback, the literature suggests that the academic performance focus can best be sustained by immediate, constructive, and academic feedback to students closely associated in time to the event (Rabinowitz and Glaser, 1985; Eccles, 1998; Tallent-Runnels and Candler-Lotven, 1996). Data indicate that the program design for NOSB does not formalize this process, which could be viewed as a possible area for evaluation and program refinement. Survey respondents from several audiences do report incidental activities in this area—but the researchers conclude this does not rise to a level of consistency to satisfy the literature. A caveat in this finding should be the pragmatic issues of the intensity and pace of the competition in balance with the fiscal constraints which would limit the ability of CORE and the regional partners to expand the competition time table to accommodate this additional activity—and it may be that the finances and calendars simply will not support this change.

In the area of information access, additional discussion follows in a recommendation for parental involvement. However, it should be noted that among volunteers interviewed at the ten sites visited by the research team, a significant gap in

the knowledge of the volunteers and students at the regional level existed with respect to “what is CORE.” This gap is even more pronounced, it seems, with respect to parental involvement in the student participation decision and activities. Again, as noted below, the researchers are aware of the fact this is a typical pattern in secondary education—parents are generally absent from student educational activities. Nevertheless, the researchers find that CORE could improve its communications processes and control procedures by enhancing parent communications and volunteer orientation at the regions—if it remains a goal of CORE to, among many other objectives, have the NOSB serve as a conduit for public involvement in ocean sciences overall. Additionally, as one goal of the NOSB is to influence the career pipeline for ocean sciences, and the literature delineates parents as one key group of mentors in the career decision process of high ability secondary students, the need to close the gap with parents’ perceptions of NOSB and CORE seems critical. It is noted that the NOSB web site pays particular attention to parent resources, and does include informative and content specific information—however, it is unclear how parents are intentionally directed to use this site.

An additional finding with respect to the competitive aspects of the NOSB is in the area of competition in academic settings, as opposed to cooperative learning. The literature reviewed highlights this philosophical tension in pedagogical practices, and suggests that these approaches are typically viewed as exclusive to each other. The researchers find that the NOSB program—possibly because it is implemented as a team competition and not an individual student competition—avoids the negative characteristics of both these methodologies and provides a balanced outcome. Students are motivated by the “winning or losing” dynamic, and this results in the development of

performance strategies, ranking of performance, and an orientation toward “being the best.” Simultaneously, the data are clear that the students also learn group and team-building skills, and learn to value the contributions of peers and the concept of task specialization. Triangulation of the data highlighted internally consistent conclusions on this point: NOSB models authentic competition and authentic cooperation and social sensitivity simultaneously. From these data, the researchers suggest competition and cooperation can function within the same programmatic context such that students benefit from both aspects of the program.

System Level Findings

The fourth area of findings addresses the systems view of the NOSB program. The data are consistent in their description of the NOSB as a functional community, comprised of multiple populations or audiences with a variety of interrelated rationales for participation. Further, the different audiences express these different participation rationales in highly consistent ways as evidenced in the single-set data summaries. The data support a perspective that the NOSB has evolved from a one-dimensional, educational program, into a broad-reaching learning community. Teachers use the NOSB to update their own content information and as a source for content, activities, and resources to infuse in broader classroom teaching activities—and even as the basis to develop entirely new high school courses. Teachers and parents view the NOSB as a tool to teach a set of critically important skills to their high ability students: how to win and lose gracefully and to demonstrate sportsmanship; how to work as a team; how to lead a group; how to study on your own, and importantly, how to plan for the acquisition of a body of new information by critically structuring the personal learning environment and

schedule. Regional coordinators who are associated with institutions of higher learning—as well as the professors and university administrators at those institutions—clearly view the NOSB as a pipeline to identify, communicate with, and recruit students of high potential to their undergraduate and eventually graduate programs. Students choose to participate because they enjoy the competition, they enjoy recognition for their academic capabilities, they like to win—even at the risk of losing, and they like the social interaction with like-ability peers. Additionally, the NOSB is a powerful medium for building awareness of ocean sciences in students, coaches, and local community. As a network, it has become an informal science education program for the audiences beyond the scope of the competition itself. Finally, for all of these audiences, the NOSB represents a link to the increasingly significant ethic of environmental stewardship—these audiences want to see the Earth and its resources sustained and protected, and regularly choose to participate in activities that are “Earth friendly.”

A second systems level finding is the impact of the NOSB on the development of a community linking scientists and educators in a cooperative venture. Since the early 1980s, calls for greater involvement of scientists in education have emphasized the necessity of “bridging the gap” between the nation’s classrooms and the latest scientific research (Walker et al., 1992). Currently, several large scale policy and funding initiatives are seeking creative models to link scientists and their findings with educators in a way which directly and measurably impacts students at all levels. On several dimensions, the NOSB program provides a model for this type of linkage. The CORE staff utilizes scientists in developing the questions and curricular framework for the NOSB competition. At the regional level, coordinators engage scientists to provide

judges for the competitions. Many regional competitions provide opportunities for students to visit laboratories and research centers to interact with scientists. Many regions feature guest speakers to provide students with informative and interesting examples of not only science as it is practiced, but the people who practice science and their education and career paths. Such a model provides students with mentors and a network of contacts to assist and support their own career and college decisions, while providing opportunities for the scientists and researchers to present, explain, and showcase their own research in an informal, educational program-setting.

CORE and NOSB Mission and Goals Related Findings

The last area of findings concerns evidence from the data that the NOSB program is operating in a manner consistent with the overarching mission statement, goals and approaches of CORE, and consistent with its own stated purposes. While at first glance this statement may seem superficial—in fact it suggests a structural and foundational element important for the sustainability and development of this program in the future. The degree to which the program is internally consistent with institutional mission, goals, and approaches will influence the overall staffing stability and support for the program internally at CORE, and across the broader constituency of the CORE institutions.

At the mission level, CORE desires to “promote, encourage, develop and support efforts to advance knowledge and learning in the science of oceanography and to disseminate such knowledge to the scientific community and the public...[and to] promote the exchange of information and knowledge to create, foster and support cooperative efforts among members of CORE and other U.S. scientists, and federal, state, and local agencies.”

The data collected for this study consistently support that these activities are actively in view in the operation of the NOSB program at the regional and the national competitions. As noted previously, the data suggest NOSB has emerged as a broad-based, networked, and active learning community with an open exchange of information and ideas among scientists, researchers, college personnel, graduate and undergraduate students, agency personnel, secondary teachers, and secondary students. The regional sites have deep community support from the public and private sectors, and from typical science agencies and community service agencies alike. A clear academic focus and emphasis on student development supercedes the “win or lose” mentality of other competition-based programs reviewed in the literature. Communications structures have developed and are sustained throughout the year, which seem far more sophisticated and durable than would be expected for what, at face value, is a two-day weekend program. These observations hold for the goals and approaches identified by CORE to operationalized its mission, to the degree that they are applicable its the education program, with a caveat that CORE does address its mission through mechanisms other than education.

With respect to the specific goals of the NOSB program as excerpted from the CORE web page, the data consistently support a conclusion that the NOSB does possess a strong academic and content focus which “broadens students’ and teachers’ awareness of the latest scientific research on oceans.” Certainly, the NOSB does provide a vehicle for networking and connectivity within the regional oceanographic research communities where the program is located, and the program has intentionally reached out to under-represented populations of students to enhance the inclusivity of the ocean community. It

should be noted, the data are not strong with respect to the goal of helping teachers “use the oceans as an interdisciplinary vehicle for teaching.” Clearly, this has occurred in many of the regions, and the coaches who responded to the survey do indicate they have infused ocean science content into their general instruction. However, this seems to have occurred as an ancillary or side-benefit—and not particularly as a result of professional development for the teachers consistently across the regional locations. The researchers would reiterate here that the opportunity to expand programming for teachers seems not only practically important given the logistic structure already in place at the regional level—but as discussed in this current section—logically important with respect to this goal of the NOSB to work with and support teachers directly.

Recommendations

While this research study was conceptualized primarily as an assessment of the broader accomplishments and impacts of the NOSB more than a program evaluation *per se*, the data and analyses are substantial enough to suggest several areas wherein the program could be strengthened, improved, or logically expanded—given the overall goals and objectives for this program and for education under CORE generally. Consequently, the researchers perceive that the data, within the overall context of the NOSB and CORE, support the following recommendations.

1. Clearly, a communications issue exists with respect to parents. This is not unique to the NOSB program, but is a characteristic of secondary education in the United States generally. Nevertheless, the literature and the data from the past participant survey highlight the importance of parents as influences in career path decisions, as well as college selection among this population of students. In that light, to the degree that

the NOSB would like to impact the career pipeline in the ocean sciences community by encouraging the consideration of the field by these students—some greater sophistication should be attempted with respect to establishing a communications channel with parents. Select data from interviews and surveys suggests that parents may not understand the career path associated with ocean sciences, and may have negative or stereotypical views of career preparatory paths, salary structures, and the types of jobs available to students post-college. Some provision of this information to parents could ensure that parents “get on the same page” with the ocean sciences community in influencing their students. At the very least, the permission slips requiring parental signature could be formalized to include supplemental information about the purpose of the NOSB and links to contact information, career information, or college information for their students—to get this information “in front of” the parents at least once, at the point they sign the form. It is noted by the researchers that the NOSB web page includes significant information and a specific parent communication section; however, this form of communications is evidently not reaching the majority of the parents as inferred from the study data.

2. Data from the interviews and volunteer surveys which can be associated to science agency personnel suggest that the NOSB could be marketed more effectively to the science community as an opportunity for involvement in educational programming. Many respondents were unsure of the overall organizational affiliation of the NOSB, i.e. CORE. It seems this represents an untapped audience who could become constituencies for NOSB and CORE through their agencies, but who are not “getting the message.” The pace of the activities at the regional competitions does not lend

itself to much communications beyond “surviving the day,” and this is unlikely to change. However, as recommended later, greater sophistication in the development of a database to include registering volunteers to facilitate follow-up communications after the fact could be highly beneficial to CORE. As a specific idea, perhaps a pre-event information packet could be provided for all volunteers from CORE to supplement materials provided by the regional coordinators. Additionally, a more sophisticated national database to include registration information for all volunteers could facilitate a listserv to include these individuals.

3. Data suggest that a teacher who participates in NOSB as a coach is likely to infuse ocean sciences content and activities in his or her broader curriculum for other students. Additionally, eleven current or past coaches have indicated that they ultimately planned, obtained approval, and implemented ocean sciences high school courses as a direct result of participating in the competition. This characteristic of NOSB—an infusion of ocean sciences beyond the team itself to the broader school environment, even in a limited sense, is very powerful. It is recommended that CORE leverage this characteristic by formalizing the data collection process to collect and maintain the anecdotal and quantitative data for infusion activities over time. Additionally, a portfolio of ideas and case examples for whole school infusion of activities could be provided to coaches to encourage this expansion of ocean sciences for other students and teachers, and would demonstrate a powerful impact and leveraging of the NOSB program well beyond that which is currently documented. Additionally, these data would represent a powerful tool for ongoing reporting to CORE members institutions and for NOSB fund-raising annually.

4. As reported in the pilot study in 2000, the coaches who participate in the NOSB program represent a pool of approximately 400-500 teachers who obtain most of their content knowledge training secondarily, from coaching their team. There is a need to formalize the training in terms of knowledge depth and instructional activities with this pool of teachers to assist their efforts with their team. Additionally, this pool of teachers represents a significantly “untapped” audience for professional development that would constitute a highly related educational program for CORE in conjunction with the NOSB—but in many ways, a very different educational program. The network of regional sponsors, with their pools of science judges drawn from long-term partners in the regional communities clearly represents a delivery system for this professional development program, and with the audience already identified, i.e. the NOSB coaches, and a curricular schema—the ocean science categories used in NOSB—all that seems lacking is a funding stream. Should CORE consider offering professional development at the regional sites, this could be opened up for other teachers as a recruitment tool for prospective coaches.
5. Both the data collected and the research literature highlight the important relationships that can occur between secondary students and undergraduate and graduate students in career path decision-making. While some of the regional sites structure intentional interactions between these groups of students, this facet is by and large informal due to different regional contexts. Simultaneously, many of the colleges and universities who participate in NOSB report that they do so primarily in hopes of recruiting students. It is therefore recommended that some examination of a formalization and expansion of the role of undergraduate and graduate students—and

particularly past participants in NOSB—be undertaken by CORE and the regional coordinators. Again, a best practices guide could be collected via survey of this small group of people, and then shared annually, and with new coordinators particularly.

6. The data collected from the various audiences point to a widely held perspective that one of the most valuable impacts of the NOSB for the participants is the opportunity to develop and practice leadership skills. Past participants and coaches provide numerous examples of student development and growth in this domain. These leadership skills also surface in the literature associated with effective competitions, and in the literature associated with students' career path decisions. As the participants and coaches suggest strongly that this is one of the most important characteristics of the NOSB, it is recommended that this leadership component be expanded and formalized to include opportunities for students to possibly demonstrate leadership through environmental service projects associated in some way with the regional or national competition, and/or with the opportunity to view contextualized leadership by a greater emphasis in the questions on the biographies of men and women who have provided key leadership in the ocean sciences, and historical items associated with key events, milestones, and discoveries—as is already emphasized. Additionally, marketing and public relations for the NOSB—and potentially even fund-raising at the national level—could emphasize the leadership dimensions of participation, particularly with some foundations who support activities in that area.

7. There is a significant need to formalize the databases of the NOSB to facilitate a number of potential communications issues. The researchers remain of the opinion a number of additional educational programming and research opportunities exist within the NOSB structure—yet no national level database including names and contact information for all volunteers, coaches, students, sponsors, and even parents of potential “ocean science recruits” exists. Long term research and communications needs, fund-raising, data collection for program evaluation, and potential education program expansion are only a few rationales for initiating a robust database system to manage NOSB and CORE’s broader education concerns.
8. A number of current innovations and initiatives in the broader ocean sciences education community in the United States are attempting to foster the growth of the ocean sciences community both numerically, and with respect to functionality, consistency of goals, policy, and curricular frameworks. Additionally, the importance of linking scientists and educators has been discussed under a number of auspices. *The NOSB is a highly functional model of exactly such a program.* Using a curriculum which has been developed with significant input from both scientists and science educators—and with ongoing analysis through the technical advisory component—the program at the regional and national level is implemented cooperatively by numerous state, federal, and private partners, and by scientists and science educators cooperatively. The best of “both worlds,” i.e. science and education, have been combined to benefit not only the students, but the institutional and agency partners alike. And, on a secondary level, while the program is directly targeted to reach high ability secondary students, data suggest that the ocean sciences

curriculum is being infused into a much broader array of classroom settings. Indeed, the NOSB has directly resulted in the establishment of ocean science courses in multiple high schools which are regularly reaching far greater numbers of students than which actually participate in the bowl itself. It is recommended that effort be expended to formalize the use of the NOSB as a case study within ocean sciences of the type of scientist-educator linkage being explored and created under NSF-COSEE and other initiatives.

9. The current federal and state level education emphases in this country are being driven by the *No Child Left Behind* legislation that, by and large, are highly focused on education *in the classroom*. The NOSB makes an excellent case for consideration of the importance of non-formal and informal science education and its importance in this country—which has perhaps been de-centralized or even lost in current conversations about education due to *No Child Left Behind*. Given its national platform, it is recommended that CORE better refine and circulate its position with respect to informal education and the important contributions to scientific learning made by the NOSB, its regional partners, and other similar informal education practices. Additionally, CORE and the NOSB could refine and circulate its position with respect to the manner in which academic competitions can contribute to the formal and informal science education and general development of secondary students.
10. Finally, because of the large number of partnerships evident at the various regional ocean sciences bowls—as the regional sponsors have “reached out” to develop the volunteer, judging, and fiscal partners—CORE has developed, if not the largest, then

certainly one of the largest constituencies in the ocean sciences community. Viewing the NOSB regional and national partners as a community suggests that this large group could become an additional programming venue for CORE, more so than simply program support. Some consideration of a “partner’s conference” as a strand or sub-conference at one of the major national or international ocean sciences conferences could create additional momentum and sponsorship for NOSB, as well as highlighting this significant accomplishment of CORE across that part of its constituency that tends to be less involved in pre-college education.

Program Effectiveness and Logistics Recommendations for the NOSB

Comparing the literature review of competition as a motivational strategy for high ability secondary students with the data collected under that area suggests two possible recommendations for strengthening the NOSB. The first falls in the area of academic feedback to students. The second is in the area of communication of transfer skills to participants and audiences.

First, the literature for effective academic competitions suggests that the most effective programs provide immediate, academically focused feedback to participants to assist them in future preparation for participation or to improve academic deficiencies. While some respondents to the various surveys describe how judges took time to provide correct answers to missed questions, and some coaches took time to meet with students after competition to review deficiencies—in the main, these seem to lack consistency across the regions due to time constraints. The pace and duration of the program at both the regional and national levels does not lend itself to much additional time to work with students in this area. Nevertheless, the literature is clear with respect to the importance of

this characteristic (Tallent-Runnels and Candler-Lotven, 1996). Perhaps some consideration could be given to sequencing the questions by categories and using scoring sheets to indicate which categories were the academic deficiencies for students as a means of, at least initially, enhancing the degree to which all students are provided specific, academic feedback close to the time of competition. Alternatively, the scoring procedures could be revised such that the scorekeeper not only tracks correct and incorrect answers and points accrued, but also tracks the categories in which the questions were asked.

The second characteristic which could be enhanced within the NOSB in respect to the literature and data is in the area of communication of transfer skills obtained through participation. The data and analyses presented earlier summarize and catalog a number of specific academic, leadership, and career skills which are developed by NOSB participants as a result of preparing for and participating in the competition. This information would be highly valuable if translated into recruitment and fund-raising information. Further, these skills could be highlighted in documentation for both parents and coaches who report needs for fund-raising at the local school level to accommodate participation costs. It is clear from the data that these skills are highly valuable and are transferable to the college setting—as such, this information could also serve as important recruitment information for the colleges and universities which comprise the CORE membership, and would perhaps be of great interest to those institutions which have significantly supported the NOSB.

Career Path Development Recommendations for the NOSB

One strong picture which emerges from the career path items in the coach and past participant surveys, and in the interviews with parents, is the perception that there are few entry level jobs and there is little “money to be made” in ocean sciences.

However, while these observations are likely accurate in many contexts, there is also a strong perception among past participants and the other audiences that the ocean sciences offer the opportunity for enriching and satisfying engagement in a field which contributes to greater stewardship and preservation of this planet and its resources—and that this deep sense of personal satisfaction is important to the population of students drawn to NOSB. Among the past participants who responded to the survey or the online forum, approximately half indicated they had selected career paths or college majors in the sciences, while nearly all suggested they had chosen paths based on personal values and a sense of purpose in life. Interestingly, 57% of past participants indicated the NOSB participation had influenced their selection of a major—science or otherwise.

Additionally, a significant number of students reported that their NOSB Coach was more important to their ultimate career path decision than their parents had been—pointing out the importance of a mentor who provides purposive and clear information, which parents often do not have. Of note, however, is that a smaller number of students reported that they had received specific career path information from the NOSB program—indicating that what is communicated with the NOSB participants is perhaps attributable more to NOSB coaches and the personal relationships than to specific NOSB programmatic elements.

In that view, it is recommended that the NOSB should consider mechanisms to build in the types of specific career information reported by students, teachers, and parents as most critical to decision-making. These include specific undergraduate and graduate schools where students can attend; specific jobs that are available linked to degree emphasis; case examples of a diverse group of young professionals, graduate and undergraduate students who are following typical career preparatory or career paths; and sources of financial support for undergraduate degree programs linked to institutions. As a starting point, perhaps the CORE member universities could provide links to a standardized, searchable ocean career “clearinghouse.” This could be viewed as an additional benefit to CORE membership by these institutions. It is noted that, while links to the CORE members are located on the CORE web page, these links are highly inconsistent—leading sometimes to marine research programs and sometimes to university index pages. The inconsistency of these links denigrates their value as a “single source” for career information.

As previously discussed, it is also recommended, based on literature associated with mentoring and adolescent development, as well as select data and analyses from this report, that the NOSB formalize the role and involvement of undergraduate and graduate students at each regional and national event, and consider possible mechanisms to link these individuals with NOSB participants in social networks and relationships. The potential of a student selecting an undergraduate program seems related to that student’s knowledge of a key individual already in that program—either a student, a professor, or a “trusted adult” who is an alumnus of that college program such as a parent or teacher.

Finally, the literature in career decision-making suggests that specific career exploration experiences are vital to the decision path of secondary students. Activities such as internships, job shadowing, job-site visitation, and guest speakers make a difference for many students. A number of coaches responded that some of the best opportunities at the regional events were afforded the “losers” who, while waiting for the final competitions to conclude, were provided opportunities to visit laboratories, tour research facilities, and meet with professors. These programmatic components, if they could be enhanced and multiplied, would enhance the capability of the NOSB to influence the career pipeline in the ocean sciences.

Future Directions in Research for the NOSB

Given the scale at which the NOSB is implemented, i.e. nationally, with a very large regional base, with large sub-populations of secondary students, teachers, undergraduate and graduate science majors, university personnel, and science agency personnel—the NOSB is clearly a highly favorable structure or environment for further research designed to clarify ongoing and emerging questions in the science education arena. Among these are greater refinement of the understanding of how high ability students navigate the transition from secondary to undergraduate institutions; how emerging science knowledge is infused from laboratory to classroom; how to maintain multi-audience programming over broad geographic regions; the possibility for recruitment of minorities into typically underrepresented employment fields; and the use of innovative instructional and communications technologies to build education programs and to leverage limited fiscal resources. Based on the current NOSB impact study, and

the previous pilot study, the researchers recommend the following research strands be considered as the most immediately promising:

1. Case studies should be developed of the eleven teachers who indicated they had established ocean science related courses in their high schools as a result of participating in the NOSB competition. This body of research should also pursue the various infusion models for ocean sciences which have occurred through the NOSB—from the coach using select activities with all students in all classes, to working only with the team. There seems to be a wide variety of examples of how the ocean sciences content has been infused to other students who have never participated in NOSB. This research could further develop case studies on the models through which the NOSB is implemented at the various schools, from team selection to preparation activities, to linkages in the core curricula.
2. Broader research should be conducted on current, high school students to expand the understanding of career path decision-making among high ability secondary students. While numerous agencies have expressed interest in contributing to the science pipeline, and to recruitment of particular demographics to that pipeline—there is little consensus beyond anecdotal data as to how these students make their decisions.
3. During the time this impact study was implemented, NOSB piloted a project in California to increase the number of ethnic minority students who participate. This pilot project was implemented beyond the scope of the impact study reported here, but clearly represents an important effort which should be contextualized and analyzed.

4. Teacher professional development as an academic research area has struggled with understanding how content knowledge is linked to professional practice. The NOSB program is a model worthy of examination, as teachers who primarily *do not have academic degrees* in ocean sciences have lead students to significant levels of performance and knowledge through facilitative control of the educational process. The role and function of individualized learning in professional development associated with implementing the NOSB seems to possess a success level worthy of understanding and emulation.
5. The discussions in this country with respect to the inclusion of the ocean sciences in the science education frameworks and standards documents have achieved a higher level of importance with the release of the preliminary report of the U.S. Ocean Commission. When, how, by what processes, and under whose auspices these standards are developed remain key questions—although numerous agencies and institutions are addressing select components of these questions. The NOSB can perhaps be viewed as a model or testing ground for these standards on several dimensions: it possesses clearly defined and articulated content areas which have been selected and refined with broad involvement of both science educators and research scientists; the refinement of the pools of questions, the development of the team challenge questions, and the broad selection of activities utilized at the regional sites can be viewed as field testing of this *de facto* ocean curriculum; data support a conclusion that the NOSB curricular framework has been infused broadly in the secondary curriculum, and is within the content and conceptual capabilities of a general population of secondary teachers—and this infusion ranges in scale and

sophistication from select activities in single classes, to the development and implementation of entire curricula and new courses. At the very least, CORE should undertake an internal analysis of the degree to which the NOSB and its curricular framework could inform the ocean standards discussion.

Conclusions

The National Ocean Sciences Bowl is a significant, regional and national ocean sciences education program that provides a context to inspire and motivate students toward leadership and involvement in ocean sciences and toward a greater sensitivity toward environmental stewardship. It contributes to these students' career path and college decision-making by engaging them in a social network that provides specific, contextualized information about careers and entry pathways to those careers. It contributes to the generalized development of these students by facilitating the development of leadership and academic-focused skills that are highly transferable to other academic and vocational settings. It meets a widely perceived need for high ability students to compete with, engage with, and share experientially with other students of similar ability levels. All of the audiences reporting for this impact study conclude that the act of competition is singularly important as a motivational strategy to engage these students' "best performance" skills in both academic and interpersonal domains.

The National Ocean Sciences Bowl is also a dynamic social system. It is comprised of numerous sub-populations who satisfy and sustain some dimension of their individualized personal, professional, or institutional identity through articulation with the NOSB program. Students address their social identities. Teachers address their professional learning and engagement identities, as well as curricular and science content

enhancement needs. College and university personnel address their recruitment needs. Scientists and researchers address their needs to engage with educational programs and to recruit high ability and interested students to their fields. Numerous agencies, institutions, and businesses meet their needs for community involvement, support of youth programming and education, and public relations.

In final analysis, the researchers conclude that the NOSB is significantly more complex and substantive than “just a competition.” This complexity is difficult to ascertain and describe “in the trenches”—particularly during the incredibly fast-paced and dense, weekend schedule. This view is an important contribution of this impact assessment, and the researchers believe this view will and should support continued refinement and programmatic development within the NOSB—and through the NOSB, within CORE.

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APPENDIXES