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ABSTRACT

This study examines the results of a three year video mentoring program, the NASA Virtual Science Mentor (VSM) program, which paired 56 NASA mentor engineers and scientists with 56 middle school science teachers in seven Southwest Florida counties. The study sought to determine the impact on students, mentors, and teachers participating in the program. The paired teams met through a desktop video system. The mentors were involved in several activities such as lecturing, evaluating student projects, providing NASA resource materials, and responding to questions via email. Overall results showed that student progress significantly increased over the three year period in the following areas: class participation, critical thinking skills, teamwork, communication and participation in science projects. The majority of the teachers rated the program as excellent and a majority of the NASA mentors rated the program at least satisfactory. (Author)

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Distance Mentoring in the NASA/Kennedy Space Center Virtual Science Mentor Program

by

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Abstract

This study examines the results of a three-year video mentoring program, the NASA Virtual Science Mentor (VSM) program, which paired 56 NASA mentor engineers and scientists with 56 middle school science teachers in seven Southwest Florida counties. The study sought to determine the impact on students, mentors, and teachers participating in the program. The paired teams "met" through a desktop video system. The mentors were involved in several activities such as lecturing, evaluating student projects, providing NASA resource materials, and responding to questions via e-mail. Overall results showed that student progress significantly increased over the three-year period in the following areas: class participation, critical thinking skills, teamwork, communication and participation in science projects. The majority of the teachers rated the program as excellent and a majority of the NASA mentors rated the program at least satisfactory.

Distance Mentoring Based in the NASA/Kennedy Space Center Virtual Science Mentor Program

We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.
(NASA Implementation Plan for Education, p. 3)

What if you could take the expertise and enthusiasm of NASA engineers and scientists and bring it into the classroom to provide students direct access to that expertise? Mentoring students has long been known as a beneficial practice, yielding greater student insight into real world applications of their academic study. Now, with available technology, the potential to provide student access to professionals in the field is greatly expanded.

This paper presents the results of one such program, the Virtual Science Mentor Program. The Virtual Science Mentor (VSM) program was established by NASA at the Kennedy Space Center in partnership with the State of Florida and the Florida Gulf Coast University. The program operated from January, 1997- April 2000. The basic concept paired 56 engineers and scientists from the space coast area as mentors with 56 middle school science teachers in seven Southwest Florida counties. The paired teams "met" using a desktop video system produced by Intel.

This study focused on the results of the program after three years. The central research question was, "does a mentoring program effect middle school student progress?" In addition, in order to gain an integrated analysis of this program, additional research questions pertaining to the impact on teachers, mentors, and program administration were considered. Finally, it was hypothesized that mentors and teachers will have different levels of satisfaction with the program and that the more mentoring that takes place, the greater satisfaction there will be. Research on video mentoring is limited and it is hoped that this study will add to the literature in this area.

Review of Literature

This literature review summarizes previous work related to the definition of mentoring, the impact of mentoring and the use of communications technology to create mentoring relationships in an educational setting. While a great deal of work has been done on face-to-face mentoring and tele-mentoring, there is limited literature on video mentoring.

Mentoring Defined

Although mentoring has been practiced throughout the ages, there is no universally accepted definition of mentoring. Webster's New Collegiate Dictionary defines a mentor as, "a trusted counselor or guide" (1973, p.718).

Bronfenbrenner (as cited by Struchen & Porta, 1997) defined mentoring as a one-to-one relationship between a pair of unrelated individuals, usually of different ages, which is developmental in nature. A mentor is usually an older, more experienced person who seeks to further the development of character and competence in a younger person. Guidance may take many forms, including demonstration, instruction, challenge, and encouragement on a more or less regular basis over an extended period of time.

Struchen and Porta (1997) indicated that Levinson's 1978 study on mentoring described the complexity of the mentoring relationship. The mentor relationship is one of the most complex and developmentally important a man can have in early childhood.

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The mentor is ordinarily several years older, a person of greater experience and seniority in the world the young person is entering. Mentoring is not defined in terms of formal roles but in terms of the character of the relationship and the functions, it serves. The relationship needs to be examined closely to discover the amount and kind of mentoring it provides.

Redman (1990) found that in most cultures, wiser or more experienced persons have played significant and respected roles in guiding the personal and professional decisions of those younger and less experienced. Most of these relationships develop naturally through association. However, businesses are increasingly interested in providing mentors to students. For example, David Merenda, president of the National Association of Partners in Education (as cited in Mathews, 2000) stated that education institutions are witnessing an explosion of corporate mentors available to students.

Struchen and Porta (1997) indicated that, generally, the classical concept of mentoring has three common elements. First, mentors foster their protégé's achievement. Second, mentors act to help nurture their proteges to adulthood by teaching them specific skills. Finally, mentoring relationships are positive, usually intergenerational, and characterized by the voluntary assumption of responsibility for members of the next generation.

Face-to-Face Mentoring

In an investigative study which sought to determine the effects of mentoring programs for economically disadvantaged students in all grades, Lee (1999) found that economically disadvantaged students obtained academic, psychosocial, and career benefits from participating in formal mentoring programs. The findings also indicated that participation of economically disadvantaged students in a formal mentoring program improved their aspiration for achievement. More specifically, it was found that students mentored for more than one year had significantly higher aspirations than students did on the waiting list. The findings revealed that there seems to be a critical length of time that a relationship must exist before there is a significant improvement in students' aspirations. This study suggests that mentors need to make commitments to the relationship with their mentees for at least one year to make a significant difference. This study indicated that ideal mentoring evolves as a natural process but there is educational and personal growth even when mentoring relationships are externally established through formal programs.

Roper-Davis (1999) summarized three studies outlining the benefits of mentoring. A Louis Harris Poll in 1989 reported that 73% of mentored children show higher goals and expectations, while 59% show grade improvements. Another study by the Center of Intergenerational learning concluded that young people involved in an intergenerational mentoring program had less negative classroom behaviors, attended school more regularly, improved relationships and had positive changes in knowledge and attitudes. Similarly, a 1988 Proctor and Gamble study stated that mentored young people stayed in school, achieved more, and aspired to better grades.

One of the benefits of mentoring programs is improved student performance. In a study by Stephenson (1997), alumni mentors were assigned to students in an introductory programming class. Attrition by those students in the program decreased and grades increased. In this mentoring program, students progressed when they might have failed and alumni mentors were able to keep in touch with and support their alma mater.

A study by Holm and Dynak (1994) explored how strong mentoring relationships are developed between university and high school students. The focus of the study was on the interpersonal and cultural aspects of the mentoring relationship as opposed to the mostly academic and operational emphasis of previous research. It looked at the benefits of the program for both the mentor and the mentee. It found that both mentor and mentee benefited. The mentor learned to reject the stereotypes of student behavior as lazy and disruptive and instead formed an understanding of the students and their lives. Mentoring provides an avenue for pre-service teachers to learn to work with students from cultural backgrounds different from their own. The mentees considered the mentoring experience worthwhile.

Tele-mentoring

Eisenman and Thornton (1999) defined tele-mentoring as the use of e-mail or computer conferencing systems to support a mentoring relationship when a face-to-face relationship would be impractical. Often traditional mentoring programs failed in part due to disrupting work routines of the participants.

Moore's (1991) study of fifth-graders' literature–centered electronic dialogues with educators enrolled in a graduate-level educational computing course showed that students and teachers reaped benefits from the interaction similar to what has been reported for the use of paper—based dialogue journals. Specifically, patterns of effective questioning, response modeling, and student-centered discussion in authentic contexts were strengthened by online dialogue.

Ruedas' (1992) study of online discourse between students with learning disabilities in grades four through six and their teachers in seven special education classrooms showed that although there was a high level of interactivity, communication was dominated by teachers. The results of this study indicated that a conversational style of interaction produced higher levels of student participation and more complex interaction patterns online than "questions-only" or "statements-only" styles of teacher talk.

Mather (1997) describes other electronic programs which exist that match mentors with students via email. One such program is the Hewlett-Packard E-Mail Mentor Program. This program pairs students and professionals at the company and has worked well. Another email mentor program is the Electronic Emissary Project at the University of Texas at Austin. In this program, a subject matter expert matches up with a class of students.

Mentoring then is recognized as a valuable mechanism to develop younger members of society. These relationships may take many forms, from discussion to instruction to encouragement. Mentors foster their protégées achievement, skills, and self-concept. Mentors also learn from the mentoring experience. Electronic as well as face-to-face mentoring is beneficial. Finally, businesses are willing to supply mentors to educational institutions.

Methodology

The procedure used in this program was for teachers and mentors to communicate over the Intel Pro-share Desktop System. This system is PC-based and allows full interaction: audio, video, sharing data, software and Internet access.

Communication was over a dedicated Integrated Service Digital Network (ISDN) line or through a Transmission Control Protocol/Internet Protocol (TCP/IP) address on the Internet. A high-speed digital network line (T1) from the Kennedy Space Center to Florida's educational technology network, Florida Information Resource Network (FIRN), was used to reduce the number of "hops" the TCP/IP transmission experienced. This improved communication dramatically.

Pairing of mentors and teachers was done as much as possible by matching common interests of the mentor and teacher. Where no common interests were matched, mentors were assigned to teachers. Teachers and mentors in the program were volunteers. Teachers were selected through a competitive application process; mentors by responding to an organization-wide announcement at KSC.

The teams were given a chance to meet during a summer institute. At the institute, training was provided on the Intel Pro-share software, using the Internet, and accessing space program materials. Mentors and teachers discussed curriculum and job duties and planned a course of action.

Specific interaction between the mentor and teacher varied in each pairing. Some teachers exposed all their classes to the mentor, some only certain classes. Mentors provided a variety of activity: lecturing, judging student projects, providing NASA materials to the class, and answering questions.

Florida Gulf Coast University, located in Ft. Myers, Florida, was responsible for selecting the teachers, working with the school boards of the counties involved and installing equipment in the teachers' classrooms. Dr. Donna Price-Henry was the principal investigator. The State of Florida, through the Technological Research and

Development Authority (TRDA), and Intel Corporation provided funding and technical assistance in establishing and maintaining the program. The Kennedy Space Center was responsible for identifying mentors, installing equipment at their workstations, and co-management of the program. Technical and security issues at the Center were also addressed.

Several public activities were held to demonstrate the program. A desktop video broadcast was done from the State Capital building in Tallahassee, Florida to the Kennedy Space Center. NASA Deputy Director James Jennings and former Florida Education Commissioner Frank Brogan participated in an evening open house at Okeechobee Middle School. Some of the mentors were able to travel to their schools and meet face-to-face with their students.

Data was collected for this study by surveying mentors and teachers to determine the impact of the program. There were fifty-six pairs of mentors and teachers in the program. Surveys were sent to each. A professional educational consultant hired by the State of Florida developed the survey and collected the data. NASA had input to the questions ask, but the data collection process was independent from NASA. Nineteen (34%) of the mentors returned the survey and 32 (57%) of the teachers. Mentors/teachers were in the program 1,2, or 3 years. Mentors averaged 2.57 years of participation, teachers 2.3 years.

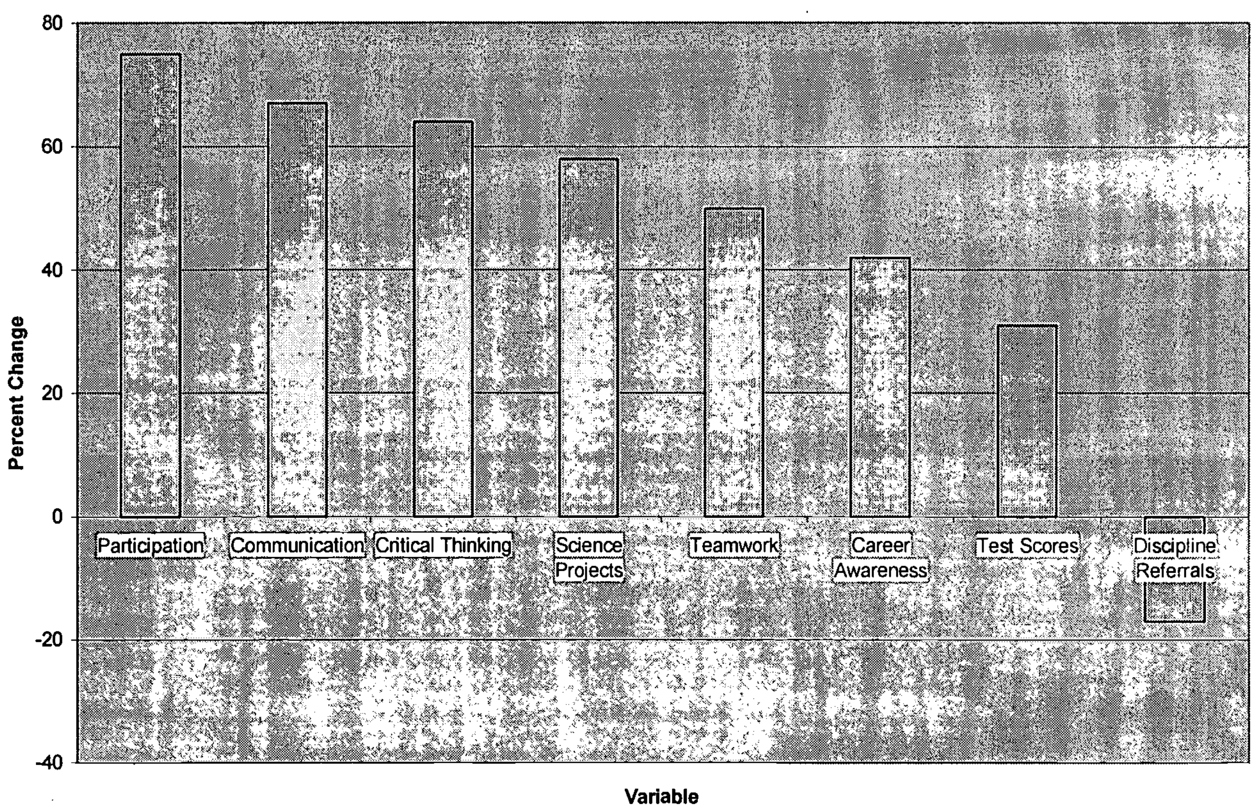
Questions were asked of both the mentors and teachers on such topics as satisfaction with the program, student participation rates, and other variables. The survey responses were generally treated as scale level of measurement data. Twenty questions were asked of the teachers, 13 of the mentors.

Results and Discussion

Impact to Students

The central research question revolved around the impact to students who participated in the program. The results indicate a very positive impact on participating students. Seventy-five percent of the teachers reported an increase in student participation since the inception of the program, while 26% of the mentors reported an increase in student participation. Approximately 42% of the mentors also reported an increase in the number of individual students participating. Additionally, Figure 1 illustrates the increase in other variables related to student performance. This result concurs with past research (Lee, 1999; Moore, 1991; Roper-Davis, 1999; Stephenson, 1997).

Figure 1. Changes in Student Performance as Reported by Teachers



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Impact to Mentor

An additional research question dealt with the impact to the mentor. This aspect of mentoring programs is reported less frequently. The results indicate mentors had positive feelings about the program. Fifty-three percent of the mentors had been in the program for three years, while only one had been in just one year. Thus, a majority of mentors participated in the entire length of the program. A majority of mentors stated they were satisfied with the program: 52% were satisfied or very satisfied, 42% somewhat satisfied and 5% reported no satisfaction. Finally, 69% of the mentors said they definitely would participate in a similar program in the future, with another 26% stating they probably would participate again. This finding corroborates studies such as the one by Holm and Dynak (1994) that also found mentors valued the experience of participating in such a program.

The results also indicate that although mentors were somewhat constrained for time to participate, they felt good about their performance and thought the program achieved key goals. Approximately 68% of the mentors reported they were satisfied or very satisfied with the work they did in the program. They felt this way even though 52% of them reported either not having enough time to work on the program or being constrained in the amount of time they had. Almost half, however, 47% felt they did have enough time to fully participate. None of the research reviewed for this paper reported the specific impact to a mentor's time involvement in a mentoring program. Finally, few mentors reported that they worked on curriculum development. Approximately 90% of the mentors reported they seldom or never worked on curriculum development. Some of the studies reviewed for this paper indicated that mentors did participate in planning, while others stated mentors conversations were more general in nature. More research in this area would be useful to determine the exact nature of the mentor's contribution.

Impact to Teachers

Teachers served as the middle person in this program, arranging contact and content between the mentor and the students. An important research question involves their observations of the program. Forty-two percent of the teachers had been in the program for three years while 33% were in two years and 14% one year. The results show that nearly three of five teachers rated the program as excellent. Approximately 58% of the teachers rated the VSM program as excellent, 19% as good, 8% as average and 3% as poor. Eighty percent of the teachers were teaching in the middle school grades. One third were teaching a general science course, 17% physical sciences, 14% comprehensive science, and 11% integrated science. The benefit for teachers of participating included additional curriculum resources from NASA, a potentially upgraded computer system, and re-certification credits.

Additional observations by the teachers indicate other benefits of the program. Teachers reported the greatest impact of participation on them was having the opportunity to learn and use new technology in the classroom (39%). Twenty-two percent cited the improved curriculum as a result of working with a mentor and 17% cited the professional development as the greatest benefit. Also, 67% of the teachers were satisfied or very satisfied with the program's ability to show a connection for students between their academic learning and real applications of the concepts. Sixty-one percent of the teachers were able to relate VSM activities to the Florida Sunshine

State Standards. These findings support the study by Moore (1991) that reported an increase in enriched student-centered discussion using authentic contexts.

Program Administration Issues

One final research question involved the issue of program administration. Few, if any, of the sources cited discussed the administration of such a mentoring program. Survey results indicated some very positive steps were taken in the implementation of this program that would be useful knowledge for establishing other such programs. Forty-seven percent of the mentors agreed that the summer institute provided enough time for planning with their teacher. Sixty-one percent of the teachers were satisfied with the summer institute. This indicates bringing the teachers and mentors together face-to-face at the beginning of the program was valuable. Matching the mentors by their interests also seemed to work well as seventy-two percent of the teachers rated their mentor as good or excellent. Finally, having a support system for the teachers was important. Fully 70% of the teachers rated the support they received from Florida Gulf Coast University as very satisfying.

As in any technology program, concerns about new technology functioning properly are valid. Fully 58% of the mentors reported they were able to connect electronically at least most of the time. While this connect rate is lower than hoped, it does not appeared to have effected satisfaction with the program as reported earlier. Seventy-five percent of the teachers rated their experience with the technology as satisfying or very satisfying.

<u>Teachers vs. Mentors Observations</u>

It was hypothesized that teachers would be more satisfied with the program than mentors because they were receiving resources, while being a mentor was added work. There was a statistically significant difference between mentors and teachers regarding satisfaction with the program ($t = 2.4$, $df = 49$, $p = .02$). The mean for the mentors was 2.4 and for teachers 1.6; both, however, indicating good satisfaction.

There was also a statistically significant difference between teachers and mentors with regard to perceived class participation ($t = 4.1$, $df = 19.6$, $p < .01$, unequal variances were found). The mean for mentors was 1.7 and the mean for teachers was 1.1. This is probably due to substantially more contact between the teachers and students than the students and mentors. They would have more time to observe the students' behavior. Both however, perceived an increase in student participation from the program.

Finally, it was hypothesized that the more mentors and teachers were able to connect the more program satisfaction would increase. There was a statistically significant correlation between mentor program satisfaction and having a regular contact time with the class ($r^2 = .54$, $p < .01$). This is an important observation for a technology-based program that may have technical trouble connecting the participants.

Conclusion

The results of the Virtual Science Mentor Program support the extension of traditional face-to-face mentoring to mentoring through new technologies as they become available. As indicated by the mentors, mentoring through technology was satisfying even with some associated technical difficulties. Teachers were also very interested in learning about this new technology.

Benefits of traditional, face-to-face mentoring also transferred to video mentoring. Benefits such as nurturing achievement, developing specific skills, and creating positive relationships were present in the video mentoring. Students' performance improved in a number of key areas: participation, communication, teamwork, critical thinking, and involvement in science projects.

The administration of such a program is an important component of program success. Providing support for the use of new technology was important as was arranging for mentors and teachers to meet. Providing enough time for mentors to fully participate needs to be carefully considered and emphasized. Despite some constraints on time, the mentors were satisfied with the program and the teachers were even more satisfied.

Additional research is needed in this newly emerging use of educational technology. Determining the best content for use between mentors and students is important. Assessing the various methods to present the content and interact with the students also requires more investigation.

As noted, businesses are taking an increased interest in providing mentors for students. Programs such as Virtual Science Mentor and organizations such as NASA can make a difference in students' lives by using technology to communicate with students and serve as mentors to students. Bringing the real world to students by professionals in the field is now more than ever, a possibility and an asset for educators.

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Appendix A

Mentor Survey

1. How long have you been a mentor in the Virtual Science Mentor Program?
2. Please describe your overall level of satisfaction with the Virtual Science Mentor Program. (v. sat-sat-somewhat-not very-not at all)
3. Please describe your level of satisfaction with the work you have done with your assigned teacher and students. (v. sat-sat-somewhat-not very-not at all)
4. Please indicate your level of agreement with the following statements:
   a) There was sufficient time allocated in the summer institute for planning with my assigned teacher. (Agree-somewhat A- disagree)
   b) The expectations of a mentor in the VSM program were clearly articulated to me at the beginning of the program. (Agree-somewhat A- disagree)
5. Were you able to schedule, on a regular basis, video-conferencing time with your assigned class? (yes, no, most of the time)
6. Overall, did you have adequate time to spend as a program mentor? (yes, no, somewhat constrained by work)
7. In your role as a Virtual Science Mentor please assess your participation in curriculum development activities. (freq., seldom, not at all)
8. During scheduled classroom video conferencing sessions, please assess your assigned class as a whole as the year progressed. (inc., dec., same)
9. Based on your overall mentor experiences with your assigned class, please gauge the number of individual students that participated in all VSM activities throughout the year. (more ind. students part., fewer..., same)
10. Based on your interaction with students, please assess the success of the program in meeting the goal of increased student awareness of science career opportunities. (exceeded, met, somewhat met, failed to meet the goal)
11. Time permitting, would you consider participating in similar programs in the future? (definitely, maybe, probably not)
12. If you think the VSM Program could be improved or enhanced – what would you recommend? (open ended)

Teacher Survey

1. How long have you been a participant in the VSM program? (1-2-3)
2. What single aspect of the program has had the greatest impact on you as a classroom teacher? (tech.— prof del. – improv. curriculum – other)
3. Based on your experience (in the VSM program) please describe the success of the VSM Program in impacting these targeted skill areas:
   a) student skills for communication (inc-dec-same)
   b) student teamwork skills
   c) student critical thinking skills
4. Please indicate the level of student awareness in science related career opportunities as a result of participating in the VSM program. (much greater, increased somewhat, no change)
5. Based on your classroom experience, please respond to the following:
   a) please describe any impact the VSM Program has had on test scores of participating classes. (scores increased, dec., about the same)
   b) please describe any impact the VSM Program has had on student attendance of participating classes. (att. inc., att. dec., same)
   c) please describe any impact the VSM Program has had on class participation since inception of the program. (inc., dec., same)
   d) please describe any impact the VSM Program has had on student involvement in science related projects since inception of the program. (inc., dec., same)
   e) please describe any impact the VSM Program has had on disciplinary referrals of students participating in the program. (inc., dec., same)
6. Please indicate your level of satisfaction with the VSM Program in showing students the connection between science learned in the classroom and the application of that science in industry. (v. sat, sat., somewhat sat., not very sat.)
7. Please rate the level of success in matching VSM Program activities to the Sunshine State Standards. (v. successful, successful, somewhat successful, not very successful)
8. Please rate your overall experience (both learning and using) with the technology provided in the VSM Program. (v. successful, successful, somewhat successful, not very successful)
9. Please rate your overall experience with your scientist/engineer mentor. (Excel., good, ave., fair, poor)
10. Based on your overall experiences, please rate the summer institutes. (excel., good, ave., fair, poor)
11. Please rate your overall experience with the Virtual Science Mentor Program. (excel., good, ave., fair, poor)
12. Please rate your level of satisfaction with the support provided by Florida Gulf Coast University throughout the year. (v. sat., sat., somewhat sat., not very sat.)
13. What one recommendation would you make to improve or enhance the VSM program (open ended)
14. Grade level of students participating in the program? (fill in the blank)
15. Course description of participating students (i.e. physical science, botany etc.)

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