Research Report 2: The Impact of the Advanced Technological Education Program

Findings from the Targeted Research Grant: Assessing the Impact and Sustainability of the Advanced Technological Education Program (NSF Grant Number 0832874).

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The Advanced Technological Education (ATE) program, funded by the National Science Foundation (NSF), is designed to improve the education of technicians in high-technology fields such as bio-, advanced manufacturing-, and aerospace technologies. The program makes grants to projects and centers, usually at the community college level, to achieve this goal. It began in 1994 and more than 1,000 awards have been made including several for research and evaluation studies. An ATE research award provided the funding for the study reported here.

The research findings are presented in two reports. Report 1 was a description of the study methodology and sustainability findings. The impact findings are presented in this report, called Report 2.

A list of the people who assisted with the research is found in the acknowledgement page of Report 1. Again, thanks to each of you.

I. Introduction and Purpose

The purpose of this research was to assess the impact (effect or influence) of Advanced Technological Education (ATE) grants. Report 1 was a detailed description of the research process and the sustainability findings. This report presents general findings on the impact of ATE grants along with additional details about the survey development and the selection of the sample. These two reports are intended to fulfill NSF reporting requirements. In addition, additional funding is being sought to carry out and publish several research studies using the existing ATE database. One article has already been submitted and is in the process of being revised following reviewer comments (Welch & Barlau, 2010).

The purpose of Report 2 is to answer the question, "What was the impact on people and institutions who received and implemented ATE grants?"

II. Methodology

The accepted procedures for developing an instrument to measure sustainability were followed during the implementation of this research (Borg & Gall, 1983). These steps are listed below and are described in Report 1. (Welch W. W., A Study of the Sustainability of the Advanced Technological Education Program, 2101).

     A. Identify the thing that is to be measured.

     B. Define the elements of the object sometimes called the domain of content.

     C. Develop measures of the elements of the content domain.

     D. Review and pilot test the surveys.

     E. Select an appropriate research population.

     F. Distribute the survey to the research subjects and conduct follow-up activities to obtain a reasonable response rate.

     G. Process and check the data for accuracy.

     H. Analyze the data

     I. Report the findings

Appendix B of this report contains additional information on the survey development, Steps B, C, and D above, and selecting the study population Step E.[1] This technical information helps establish the content validity of the survey and describes the research population in detail. Both steps are essential for effective survey development.

The data analysis process for the impact study was the same as for the sustainability survey described in Report 1. A nonresponse bias study was carried out for the total survey. The study

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[1] These additional details are included in part because of the interest at the WMU Evaluation Center to develop a checklist and/or a webinar on survey development for ATE evaluators.

is summarized Report 1 and a full description of the study is found in a paper by Welch & Barlau (2010). The paper was submitted for publication and is currently under revision.

As mentioned above, the purpose of this part of the research was to determine the impact of an ATE grant on the elements or aspects of a grantee site. A description of these elements, called the domain of content, is found in Appendix B along with a description of the process used to create it. Briefly, there are three main headings, People, Programs, and Organizations. These are further subdivided as follows.

I. People: Faculty, Students, Administrators, ATE PIs/Staff

II. Program: Curriculum, Instruction, Educational Materials

III. Organizations: Colleges, Schools, Business/Industry, Communities

This is not an exclusive or exhaustive list. It is a guideline to direct the survey development and to report findings. There is at least one statement on the survey related to each of the 11 elements.

Current PIs and others familiar with the program were asked to describe the effects of implementing an ATE project or center. Their statements were quoted and put on a survey for other ATE PIs to judge if the statements described their own situation. This kind of survey was named a Peer-Generated Likert Scale because respondents are asked to rate their opinions using a five-point Likert scale that ranged from "strongly agree" to "strongly disagree". There was also an option to circle "not applicable" if the statement in question was not part of their grant work.

The responses of 216 returned surveys were used in this analysis. The percent choosing each option was calculated. If the statement was positive, those responding agree or strongly agree were combined and are reported in the table below. If the statements were negatively worded, for example, "our grant had little impact on us", then the percentage of disagree and strongly disagree were combined and used for this analysis.

The sample size varied among the items because some of the statements were not applicable for their situation. The net item sample size is shown in the parentheses following the statement. There were a few missing values that lowered the net sample size, but this occurred in only 21 cases.

III. Findings

The findings of this analysis are presented in Table 1. The statements are grouped by the three main categories of the domain of content, People, Programs, and Organizations, and their attendant sub-categories.

The number shown proceeding the statement is its item number on the impact survey. The statements were scattered across the survey in no particular order. However, in Table 1, they are ordered by the three main categories of the domain.

Table 1: Percent of Respondents Expressing Agreement or Disagreement with Peer Statements about Impact

Statements About the Impact of ATE Grants	Percent Agree or Strongly Agree	Percent Disagree or Strongly Disagree
Impact on People (Students, Faculty, PIs, Administrators)		
9. "Our faculty has improved their teaching style because of their involvement in our ATE grant." (n=198)	82.3	
4. "Faculty members who have no colleagues in their specialty on our campus really appreciate the community they have created through this project." (n=157)	78.4	
2. "Persistence of students recruited through our project is lower than the college's average persistence." (n=171)		67.3
6. "Student interest in technology careers has increased because of our ATE grant." (n=201)	82.6	
14. "We have data-based evidence that our program improved the workforce skills of our graduates." (n=188)	62.2	
23. "We have evidence that the career awareness materials we distributed have influenced the career choices of potential students." (n=187)	63.2	
24. "We use measures of student achievement to assess the impact of our technology education program." (n=187)	76.5	
25. "Our ATE grant has helped us produce more science and engineering technicians than we would have done without the grant." (n=190)	72.1	
30. "Most of our effort was devoted to exposing students to the opportunities provided by our ATE grant." (n=194)	40.2	44.3[2]
1. "Our administration has supported our ATE efforts." (n=214)	87.4	
3. "Our NSF grant has given us the confidence to seek and obtain funding from other sources." (n=211)	88.6	
12. "Our ATE project/center is isolated from the rest of our college." (n=191)		76.5

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[2] The responses to this item were similar for those agreeing and disagreeing.

15. "The ATE grant has increased our sense of worth by being a part of this national effort." (n=212)	86.3	
Impact on Programs (Curriculum, Instruction, Educational Materials)		
27. "We were able to survive the substantial budget cuts implemented by our college because of our ATE grant." (n=160)	58.8	
18. "We have been able to make available an educational program that was previously not offered as an option for people in our area." (n=200)	86.0	
20. "We were not able to develop all the curriculum materials that we had planned to do." (n=200)		60.5
19. "We have little evidence that our professional development program has improved the teaching skills of our instructors." (p=198)		71.2
28. "The grant has permitted us to develop educational materials that otherwise would not be available." (n=203)	85.1	
13. "We would not have been able to introduce a new technology or program and/or make significant changes to our technician education program without the ATE grant." (n=199)	81.4	
Impact on Organizations (Colleges, Schools, Business & Industry, Communities)		
5. "Our NSF/ATE grant has had little long-term impact on our college." (n = 201)		78.7
16. "One impact of our grant has been a decrease in communication between our academic and technician departments." (n=187)		88.3
8. "The ATE grant helped us to establish relationships with professionals from four-year colleges that will continue in the future." (n=208)	86.5	
10."We have people who use our curriculum products in ways other than the way they were intended." (n=192)		14.0
22. "More K-12 teachers are integrating engineering and technology content into their classrooms because of the in-service workshops we have offered." (n=172)	71.5	

29. "People use our curriculum products in ways other than the way they were intended to be used." *(n=194)*		15.5
7. "Businesses in our area have benefited from having a more qualified pool of job candidates from which to choose." *(n=191)*	74.8	
11. "Because of our grant, local industries are more willing to ask us to provide technological education for their workforce." *(n=182)*	66.5	
21. "The standards and certifications we have developed are recognized and endorsed by our industrial partners." *(n=142)*	78.2	
26. "The grant provided the catalyst to establish and/or strengthen collaborations with business and industry partners." *(n=209)*	88.9	
17. "Our project/center was instrumental in helping our local educators and employers understand the need for further science technology, engineering, and mathematics education." *(n=205)*	81.0	

IV. Discussion of Findings.

A. A Different Way to View Five of the Statements

While these findings were being considered, I realized that a few of them were indirect measures of impact but they also described a characteristic of the grant site. For example, consider the statement, "*Our administration has supported our ATE efforts*". In the parlance of educational research, they could be used as predictor variables as well as criterion or outcome variables.

Predictor variables are similar to other grouping categories such as project versus center or active versus expired grants. One may determine the extent to which grant type, grant status or administrative support are related to the criterion variables of sustainability and impact.

Five items might be used as predictor variables. These are:

1. "Our administration has supported our ATE efforts."

10. "People use our curriculum products in ways other than the way they were intended to be used."

12. "Our ATE project/center is isolated from the rest of our college."

20. "We were not able to develop all the curriculum materials that we had planned to do."

30. "Most of our effort was devoted to exposing students to the opportunities provided by our ATE grant."

The responses to these items are shown in Table 1 and included in the findings; however, one also could compute an overall sustainability score for the sites and determine if the replies to the above predictor variables were related to those scores. For example, is sustainability (or perhaps impact) related to administrative support or project/center isolation?

B. Summary of Survey Responses

Overall, the findings suggest that receiving and implementing an ATE grant has had a large impact on the people, programs, and organizations involved with the award. Sixty percent of the statements had impact percentages that equaled or exceeded 75% agree or strongly agree. (For the negatively worded items, it was 75% disagree or strongly disagree.) Another nine had response percentages between 50% and 74%. One might label these as "Strong Impact" and "Moderate" impact. Given the nature of the survey, responses less than 50% should probably be viewed as "some" impact.

The results are presented according to the three main categories of impact, people, program, and organizations. In the remainder of this report, the term "agree" will be used to mean the sum of the percent agreeing and the percent strongly agreeing. Similarly, "disagree" means the sum of the percent disagreeing and strongly disagreeing.

1. Impact on People

Our respondents report that their involvement in ATE has strongly influenced their faculty in several ways. These include improved teaching, the creation of new collegial networks, enhanced grant seeking confidence, and an increased sense of worth by being part of a national effort.

Several statements about the ATE students suggest they have been influenced as well. The respondents believe that student interest in technological careers has increased, and to a lesser extent, an increase in retention rates, and more technicians have been produced. Those statements about the availability of data to support the belief that student workforce skills and career choices have been influenced are positive, but only in the 60% range.

Several PIs comments were made during the early part of this study about considerable effort being spent in exposing students to the opportunities provided by their ATE grant. However, the responses to this item were evenly split between those agreeing and those disagreeing.

2. Impact on Programs

The ATE projects and centers have had the greatest impact, according to our respondents, by making it possible to change or develop new programs and create materials that otherwise would not have been possible. They also report having evidence that the professional development programs have been effective. To a lesser extent, the ATE award helped some institutions survive despite large budget cuts.

3. Impact on Organizations

The respondents believe that having an ATE grant has had a long-term impact on their colleges and this has occurred without jeopardizing the communication between the academic and technician departments.

They report that useful collaborations have been established with business and industry partners, with schools, and with professionals in four-year colleges. In addition, the grants have provided an increase in the pool of qualified job candidates and have helped industry through the development of endorsed standards and certifications.

During the item development stage, a few PIs expressed concern about the lack of quality control when their materials and programs were given to others to use. However, this concern was not widespread with only about 15% percent reporting it was a problem.

As mentioned above, five items turned out to be candidates for predictor variables, however, the responses to the statements do provide information about the ATE program. The responses to these items are:

> 1. *Our administration has supported our ATE efforts. (*87% agree)

> 30. *Most of our effort was devoted to exposing students to the opportunities provided by our ATE grant.* (40.2% agree; 44.3% disagree)

> 12. *Our ATE project/center is isolated from the rest of our college.* (76.5% disagree)

> 20. *We were not able to develop all the curriculum materials that we had planned to do.* (60.5% disagree)

> 10. *People use our curriculum products in ways other than the way they were intended to be used.* (14% disagree)

C. Reliability and validity of the survey

One way to address validity concerns of a test or a survey is to determine the reliability of an instrument. Reliability coefficients provide an estimate of the consistency of responses either across time, across people, or a combination of both. Establishing acceptable levels of reliability does not prove validity but it can reduce one of the possible threats to validity.

One reliability study compared the responses of the 216 subjects to the same item appearing twice on the survey.[3] They were items 10 and 29 placed on different pages of the survey. The responses of the judges were correlated and an inter-rater reliability coefficient[4] of 0.84 was found using the SPSS program. The coefficient is the same that one would get if using the more familiar Cronbach alpha often used to calculate the reliability of achievement tests. This level of consistency is considered very good for analyses of this kind. It lends support to the validity of the survey.

There were four instances where two responses were received from an ATE grantee. This occurred three times when the PI was away from the site and a program manager or someone else replied to the survey. When the PI returned, he/she later returned a second copy of the survey. In one case, the PI returned two copies of the survey apparently forgetting that one had already been returned.

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[3] Actually, this was a mistake during survey development but it turned out to be a fortuitous one.
[4] SPSS calls this the "average measures interclass reliability".

These situations permitted a triangulation of the analysis. One could calculate the consistency between a pair of responders each rating the same project or center. There are several ways to compare these responses such as Pearson's correlation, Spearman rho, and Kendell's tau-b. The choice depends on the assumptions one makes about normally distributed data and whether they are ordinal or interval. In addition, one could use the Kappa statistic to measure the level of agreement. These options will be examined in a later report. However, for this initial report, the familiar Pearson r correlation is reported.

The first computed correlation was 0.85, which is considered high and was between a PI and a program manager rating the same project. Triangulation is a method of cross-checking data from multiple sources to search for regularities. Subsequent analysis on another project and a center yielded correlation coefficients of 0.89 and 0.83, also considered high. These findings suggest a consistency in the responses.

A fourth comparison was done which produced a correlation between the raters of 0.61, a moderate value. This raised the question of why one pair of raters should be less consistent than the other three. The data were checked for errors and none found. Further investigation revealed that one survey had been returned by a college administrator within two weeks of the mailing and a second returned six weeks later by the PI.

It is clear when comparing the responses that these two people had different perceptions of the impact of the grant. For example, the administrator thought the grant had a strong impact on the college while the PI did not. In general, the view of the impact the grant had on the college was higher for the administrator than for the PI faculty member.

While this comparison did not yield information regarding the consistency of responses, it does illustrate the differing views sometime held by faculty and administrators. A similar finding was found in a prior study by the author and a colleague (Reineke & Welch, 1975)[5]

The study compared 492 pairs of high school science and math teachers and their principals randomly selected from five states. The research was part of an evaluation of NSF's Comprensive Teacher Education Program. They found, "It is apparent that principals possess a more positive view of teaching conditions than do science and mathematics teachers. Four of the five comparisons were significant at the $p < .05$ level. These perceptual differences were for teaching load, curriculum materials, effectiveness, and facilities. No differences were found for perceived support." (p. 231).

It seems likely that the lack of consistency for the administrator and the PI is not a function of the survey itself, but a difference in perception between administrators and faculty. Reineke and Welch hypothesized that the differences might arise from control and responsibility issues or from different perspectives of administrators and employees. Perhaps this is what is occuring in this study.

Two of the other correlations were between PIs and program managers and were generally consistent with correlation coefficients of 0 .83 and 0.85. In the third case, it was the same person answering twice. Here the correlation was 0.89 indicating a great deal of consistency when replying to the survey.[6]

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[5] Reineke, R. A., & Welch, W. W. (1975). Adequacy of science teaching conditions as perceived by administrators and teachers. *Science Education*, 229-233.
[6] These correlations were computed for all (53) impact and sustainability items.

Another threat to validity is developing a survey that does not measure the key elements of the object that is being measured. This is called content validity. An instrument has content validity when it measures the construct of interest, in this case, ATE impact. The procedures that were followed to ensure content validity are explained in Appendix B.

V. Concluding Remarks

Several things have been learned from the implementation and findings of this research that may be useful for the National Science Foundation, its grantees, and prospective ATE researchers. These are listed below.

1. The respondents reported their ATE experience had a significant impact on them, their programs, and their institutions. The areas of impact included faculty, students, programs, educational materials, and collaborations with business, industry, and four-year colleges. Several findings suggest a change in the collegial environment at community colleges. For example, they report an enhanced sense of worth, more grant seeking confidence, and the formation of new faculty networks.

The ATE/NSF program appears to have been an effective change agent at the community college level in addition to increasing the nation's hi-tech workforce.[7] While this may not be an expressed goal of the program, it should be useful information for accountability to Congress and in seeking continued support of the program.

2. The database of information about the ATE program provides several opportunities for secondary analysis. Secondary analysis is "Any further analysis of an existing data set that presents interpretations, conclusions, or knowledge additional to, or different from, those presented in the first report on the data collection and its results". (Marshall, 1998).

One such study carried out was an evaluation of the NSF/ATE program using selected items from the impact survey. Congress established the program in 1992 "to improve scientific and technical education at associate-degree-granting institutions" (Committee on Science, Space, and Technology, 1992, p. 4). The Act listed the following objectives for the program (p. 5).

> A. develop model curricula and instructional programs
> B. provide faculty enrichment
> C. develop and disseminate model instructional materials
> D. purchase or lease state-of-the-art instrumentation
> E. stimulate partnerships between educational institutions and the private sector

The survey items[8] were examined to determine whether they were evaluative in nature. This means the responses would provide a judgment of merit or worth of the program. Approximately a dozen met this criterion and at least one was found for each of the objectives listed above. Two were found that addressed the overall goal of the ATE program. The items that most closely matched the program's goals and objectives were selected for this analysis.

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[7] This conclusion has been documented by several reports from Gullickson and Wingate at the WMU evaluation center.

[8] Actually, they are statements but when put on the survey, they become items. Both terms are used in this report.

They are shown in Table 2. Column 1 contains the objectives of the 1992 Act. The second column lists a relevant item for that objective and the PI responses are presented in the third column.

Table 2: Evidence that the ATE Legislative Objectives and Goals are Being Achieved

Program Objective from Congressional Act of 1992	Relevant Item from Impact Survey	Agree or Strongly Agree
"develop model curricula and instructional programs"	*We would not have been able to introduce a new technology or program and/or make significant changes to our technician education program without the ATE grant.*	81%
"provide faculty enrichment"	*Our faculty has improved their teaching style because of their involvement in our ATE grant.*	82%
"develop and disseminate model instructional materials"	The grant has permitted us to develop educational materials that otherwise would not be available	85%
"purchase or lease state-of-the-art instrumentation"	*The instrumentation and equipment we secured as part of our ATE grant will have little use by the college after the grant ends.*	94% Disagree
"stimulate partnerships between educational institutions and the private sector"	*The grant provided the catalyst to establish and/or strengthen collaborations with business and industry partners*	89%
Overall goal: "to improve scientific and technical education at associate-degree-granting institutions"	*First item: Our ATE grant has helped us produce more science and engineering technicians than we would have done without the grant.*	72%
	Second item: We have data-based evidence that our program improved the workforce skills of our graduates	62%

The statements about program objective all had favorable response rates above 80% indicating that a strong majority of this group of PIs believes the program objectives are being achieved. The two items that addressed the program goal had lower response rates but still indicate that the program is producing more and better-prepared technicians.

The latter two items each had about 30 replies of Not Applicable. This may mean that while they think that the number and quality has improved, they do not have hard evidence that this is the case. Further investigation would be necessary to examine this possibility.

Although an evaluation of the program was not the goal of the current research, the above results suggest that ATE is successfully achieving its goals and objectives. However, caution is advised until further analysis is carried out. One must be cognizant of the possibility of respondent yea saying or acquiescence. This was addressed by wording the statements so that concurring with the statement would require a "disagree" response. In addition, the PIs were responding to statements made by their peers. Whether this adequately reduced possible response bias will require additional study.

3. Several other secondary analysis studies could be conducted using the survey database. Some of the research questions that might be addressed are listed below.

      A. What are the differences in the responses to the survey items for projects compared to centers? What factors are related to the differences if some are discovered?

      B. What, if any, are the differences in the responses for active vs expired grants? Again, what are possible reasons if differences are found?

      C. Several survey statements were identified above that could be used as predictor variables. For example, administrative support and project/center isolation from the rest of the college. The research questions would be of the type, "Are these variables related to ATE impact or sustainability. Many authors state that administrative support is necessary for the effective implementation of the grant. The data could be analyzed to determine if such a relationship exists.

      D. What is the relationship between the impact or influence of a grant and the degree to which it was sustainable?

      E. Is it possible to develop an "impact score" by adding together the impact item scores or conducting a factor analysis of the responses? In addition, does the factor analysis support the categorization of responses used in this report, that is, impact on people, programs, and organizations.

      F. This study reported a simple correlational procedure to obtain reliability evidence for the survey. However, further investigation is necessary to determine the proper method for computing the degree of consistency among raters judging the same project or center. Spearman's rho, Kendell's tau-b, the Kappa estimate of agreement, and other indices are procedures that may be more appropriate for this database.

These and other research questions are being considered for a proposal to NSF to obtain funding for the secondary analysis of the impact and sustainability database.

Bibliography

Altman, D. (1991). *Practical Statistics for Medical Research.* London, England: Chapman and Hall.

Committee on Science, Space, and Technology. (1992). *Scientific and Technical Education Act of 1992.* Washington, D.C.: U. S. House of Representatives.

Converse, P. D., Wolfe, E. W., Huang, X., & Oswald, F. L. (2008). Response Rates for Mixed-Mode Surveys Using Mail and E-mail/Web. *American Journal of Evaluation* , 99-107.

Marshall, G. (1998). *"secondary analysis.".* Retrieved January 1, 2011, from A Dictionary of Sociology: http://www.encyclopedia.com

Reineke, R. A., & Welch, W. W. (1975). Adequacy of science teaching conditions as perceived by administrators and teachers. *Science Education* , 229-233.

Welch, W. W. (2011). *A Study of the Sustainability of the Advanced Technological Education Program.* Boulder, CO: http://www.colorado.edu/ibs/decaproject/.

Welch, W. W., & Barlau, A. (2010). *Selection of Sites for the ATE Impact and Sustainment Research Study.* wwelch@umn.edu.

Welch, Wayne W.; Barlau, Ashly N. (2010). Addressing Survey Nonresponse Issues in Evaluating National Science Programs. wwelch@umn.edu

Welch, W. W., & Walberg, H. J. (1972). A national experiment in curriculum evaluation. *American Educational Research Journal* , 373-383.

Welch, W. W., Lindbloom, D., & Flahaven, M. (1973). *An Evaluation of the White Bear Lake High School.* Washington, D.C.: ERIC Clearinghouse on Tests, Measurement and Evaluation. Document ED 069 656.

Worthen, B. R., & Sanders, J. R. (1987). *Educational Evaluation: Alternative Approaches and Practical Guidelines.* New York: Longman Inc.

Appendix A: Cover Page and First Six Items on the Impact Survey

Members of the leadership teams of ATE projects and centers were asked to write about the impact and sustainability of their grant(s). We asked what impact the grant had on them, their institutions, and those involved in their programs. We also asked about programs and activities that will be or have continued (sustained) after their grant ends. We have selected about a third of their statements, mostly direct quotations, and are interested in whether you agree or disagree with their statements.

Please read each statement and then indicate the extent to which you Disagree or Agree with using the following response scale. (Circle the response option at the right of the page that best represents your opinion.)

AA	*Strongly Agree with the statement*
A	*Agree with the statement*
U	*Uncertain on whether I agree or disagree*
D	*Disagree with the statement*
DD	*Strongly Disagree with the statement*
NA	*Not applicable*

Part I of the survey is about Impact and Part II is about Sustainability. Please answer all questions and return your survey in the enclosed, stamped return-addressed envelope.

Thank you for your help.

Part I: Impact	*Circle the option that best represents your opinion.*
1. "Our administration has supported our ATE efforts."	AA A U D DD NA
2. "Persistence of students recruited through our project is lower than the college's average persistence."	AA A U D DD NA
3. "Our NSF grant has given us the confidence to seek and obtain funding from other sources."	AA A U D DD NA
4. "Faculty members who have no colleagues in their specialty on our campus really appreciate the community they have created through this project."	AA A U D DD NA
5. "Our NSF/ATE grant has had little long-term impact on our college."	AA A U D DD NA
6. "Student interest in technology careers has increased because of our ATE grant."	AA A U D DD NA

Appendix B. Additional Information on Survey Development and Sample Selection

Several data gathering procedures were considered including questionnaires, telephone interviews, and site visits. A survey was chosen because it is more economical than interviews or site visits. A mailed rather than an online survey was used because it was a more familiar process, the process could be controlled locally, and it was thought to be more user-friendly for the intended audience. Subsequent literature reviews also indicate that despite some earlier successes, response rates are lower for online surveys (Converse, Wolfe, Huang, & Oswald, 2008).

The survey consisted of Likert-type items, a type of rating scale. It consists of a series of statements to which the respondents specify their level of agreement. In this case, the respondents are ATE principal investigators (PIs).

The usual methods of item generation for surveys are subject interviews, focus groups, or content experts. The survey developer writes items based on what he/she learns during this process. However, this study departed from the norm in the way the questions were developed. Statements about impact were written by the peers of the target group, ATE team leaders and people familiar with the ATE program. The survey respondents were then asked to rate their level of agreement with these statements using a Likert-type scale that ranges from "strongly agree" to "strongly disagree". This process was named a Peer-Generated Likert Scale.

The author has used this approach on a few occasions. It was first developed for a national evaluation of an NSF-supported high school curriculum, Harvard Project Physics[9] (Welch & Walberg, 1972), and it has been used in the evaluation of a few programs; for example (Welch, Lindbloom, & Flahaven, An Evaluation of the White Bear Lake High School, 1973). A limited literature search did not reveal any similar methods but more investigation is needed to determine if the procedure has been used elsewhere.

This method of survey development helps ensure that the items fit the respondent's frame of reference because they were written by their peers instead of subject experts at a university. This approach is also intended to reduce the tendency to "yea-say" or acquiesce to authority because respondents rate their colleague's statements instead of those made by NSF or an outside researcher.

With this approach, as with most, it is necessary to follow generally accepted procedures for developing measurement instruments. These steps are similar to those described in Research Report 1 on sustainability. However, additional information about the development of the survey and sample selection is included in the report.

A. Carefully identify the thing that is to be measured.

The object of interest for this research is the impact (effect or influence) that an ATE grant had on the institutions or organizations that received a grant. Most of the grants went to community colleges, technical schools, or four-year colleges.

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[9] One of the directors of Harvard Project Physics (a high school physics curriculum), Gerald Holton, a Professor of Physics and History of Science at Harvard, first suggested the idea of asking teachers to respond to statements made by other teachers. The survey was part of the evaluation of the course being conducted by Welch, Walberg, and others.

B. Define the elements of the object sometimes called the domain of content.

The domain of content is a framework of outlines the aspects of an object that might be impacted by implementing a grant. It helps to view the object, in this case the grantee, as a system or a "set" as it is used in mathematics. A systems view looks at the grantee as being composed of various parts that interact with each other. A set is the collection of the things that make up the object.

No frameworks were found that specifically focused on describing potential elements of impact. It was decided that a sustainability framework could be used as a starting point and then use an empirical approach to revise it as necessary. It was empirical in the sense that PIs' statements about impact were mapped against the framework to see if it fit what they were saying. If not, then the framework was revised to accommodate the set of statements.

The working framework is a list of aspects of grantee sites where impact might be detected. These elements are listed below:

1. Faculty
2. Students
3. Business and industry representatives
4. Materials
5. Colleges, particularly community colleges
6. Administration
7. ATE PIs and staff
8. National Science Foundation
9. AACC and other professional organizations
10. Communities/regions
11. Secondary schools

The framework was revised based on the next step, item development, and is shown below.

C. Develop measures of the elements of the content domain.

The Peer-Generated method requires that ATE team leaders and others familiar with the program write statements about impact. This was done using interviews and the following question on the 2008 annual ATE survey conducted by Western Michigan University.

"Please reflect on the impact that the grant is having on your academic program, your institution, the community, or other interested parties? These effects of the grant may be positive, negative, or neutral. They may be intended or unintended. Please describe the most important effects of your project."

A content analysis of their responses plus interviews with people familiar with the ATE program yielded 95 statements about impact. These statements were mapped against the working framework to revise it as necessary based on the dimensions of the domain produced by these statements. This process is intended to ensure the content validity of the survey. That is, the final domain of content is based on the kinds of things that ATE people report, not only on a hypothetical theory of impact.

The revised domain of content is show below. The main topics are followed by a short list of some of the terms used by the people who made the statements. The numbers following each

line are the number of statements that were chosen for the final version of the survey. Thirteen were about people who were affected, six were about influences on the program, and 11 addressed organizations. The main categories are subdivided as shown.

Domain of Content for Measuring ATE Impact

I. People   **(13 statements)**
    A. Faculty of the participating colleges   (2)
        Created network, increased skills

    B. Students   (7)
        Interest, retention, attitude, number of graduates, entry, recruitment, career choice, remedial programs, achievement, skills, enabled

    C. Administrators   (1)
        Support

    D. ATE PIs and staff   (3)
        Confidence, status, sense of worth.

II. Program: **(six statements)**
        Survival during recession, revised (1)
        Not do program without ATE grant (1)

    A. Curriculum: (2)
        New, more, revised, difficult to do, texts, certificates, success, integration,

    B. Instruction   (1)
        Changed, more offered, dissemination,

    C. Educational Materials   (1)
        New texts, films, modules,

III. Organizations   **(11 statements)**
        Collaborations (1)

    A. Colleges

        1. Two-year   (2)
        Goals, better communication, impact, tensions, academic versus occupational

        2. Four-year colleges   (1)
          Engaged, transfers

    B. Schools
        1. Curriculum (0)
              New, revised

        2. Teachers   (2)
              Quality

C. Business/industry   (4)
    Worker pool, working with, job and training, job advancement

D. Communities   (1)
    More informed

The first draft of the impact inventory[10], as it was initially called, included 42 of the 95 original statements. The criteria for selecting a statement were coverage of the domain, readability of the statement, elimination of duplicate items, and using a "what if…" approach. That means a statement was examined and the question was posed in the reviewers mind, "What if 30% or maybe 75% of the people agreed with the statement?" Would those kinds of responses be interesting and/or informative? This review was carried out by the author and yielded the 42 items for the first draft of the impact instrument.

D. Review and pilot test the surveys.

Each item was printed as a quoted statement with a request to respond by indicating the degree of agreement of disagreement using a Likert-type response format. Here is an example.

"Our NSF grant has given us the confidence to seek and obtain funding from other sources." Please indicate the extent to which you Disagree or Agree with the statement using the following response scale.

DD	Strongly Disagree
D	Disagree
U	Uncertain
A	Agree
AA	Strongly Agree
NA	Not Applicable

The "Not Applicable" response option was included because some grants did not address all of the elements of the defined domain of content. For example, some projects developed educational materials while others did not.

The next step was to review the 42-item draft survey. This was done by three experts knowledgeable in the fields of test development, science education, and technology education. They were told that the survey needed to be shortened and asked to review the items and identify those that should be deleted. They were also asked to look for any typos or other grammatical errors. Using their comments, six statements were eliminated and five others were identified as candidates for elimination. (Being a candidate meant that at least one rater recommended that a statement be removed.

The next review step was carried out by three ATE principal investigators who were very familiar with the ATE program and who had been implementing grants for many years. They were given a 36-item inventory and asked to judge the validity and usability from their perspective as users. Based on the reviews of these two groups, a final version of 30 items was selected.

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[10] During the development process and data gathering phase, the word Inventory was used for the instrument. However, the term survey now seems better to describe the process. It is used in Reports 1 and 2.

The final selection criteria were (1) coverage of the defined domain, (2) approval by most of the reviewers, (3) the need to limit testing time for this instrument to 10-15 minutes and (4) meeting the tenants of good item construction. Some of these are; keep the language of the statements simple, keep statements short, express only one complete thought per statement, and avoid jargon and slang words, (Worthen & Sanders, 1987). The review process yielded a survey of 30 items. Each of the elements of the impact domain had at least one corresponding statement. These items were combined with 23 sustainability statements in a four-page booklet.

The first page of the impact part of the survey is attached as Appendix A.

E. Select an appropriate research population.

The following is the explanation provided in Research Report 1 on sustainability.

> The research population consisted of all active ATE grantees that began prior to Jan 1, 2009 and grantees that had expired between Jan. 1, 2007 and Dec. 31, 2009. The potential pool of subjects was 185 active projects/centers and 193 expired projects/centers.

> These grants were a sub-population of all ATE grants made through October 2009. The total population of grants at that time was about 900. Earlier grants were not included because of perceived difficulties in being able to contact PIs from grants that had expired prior to 2007. For various reasons, 23 active projects were excluded leaving a pool of 162 respondents. Planning grants, research and evaluation awards and support for special projects were excluded.

> A large number of expired grants (n=82) was excluded as well. The most common reason was that a site that once had an expired grant currently has an active grant. It seemed an unnecessary response burden to send a PI two surveys.

> Planning grants, research and evaluation projects, support for conferences and special projects were excluded. This left a potential expired population of 111. The total for both the active and expired groups was 273.

> As the returned surveys were being checked for accuracy, another 12 sites were discovered that at one time had an expired grant and now had an active grant. These sites were excluded as well because of burdening PIs with two surveys. The final population was 261 grantees.

The detailed list of reasons for excluding a grant was written in April 2010 and is presented below.

Selection of Sites for the ATE Impact and Sustainment Research Study (April 2010)
by
Wayne Welch and Ashly Barlau.

> This research seeks information from ATE projects and centers about the impact that grants had on the people and institutions involved in the ATE work and the sustainability of those grants after funded ended. We sought information from people familiar with the activities of the NSF grant and decided that the Principal Investigators (PIs) would be the ones most likely to have the information we needed.

The subjects of interest in our research were the currently active ATE sites and sites that had recently expired. The active sites included those grants that started prior to January 1, 2009 and were in operation during 2010 when the study was done. At that time, even the most recently funded sites would have at least one-year's experience with their ATE grant.

We also included in our study those projects that had expired during the three years between January 1, 2007 and December 31, 2009. We thought we would have a good chance of having accurate mailing addresses and emails so most PIs could still be contacted and would have a good understanding of the projects and centers.

Thus, the population of subjects for our research was active projects funded prior to January 1, 2009 and projects that expired between January 1, 2007 and December 31, 2009.

Using NSF's FastLane site, all ATE active awards made prior to Jan. 1, 2009 were identified in October 2009. This yielded a potential population of 185 grantees. We also used the same source to identify the projects and centers whose grants had expiration dates between January 1, 2007 and December 31, 2009. This process added 193 sites to our potential pool making the total 378.

As we analyzed these sites, we discovered that it was necessary to exclude 105 of these sites for various reasons reported below. We will consider the active grants first.

1. Grants excluded from the active population

The 185 active grants were examined first to determine whether the ATE division was the chief funding source of the grant. (NSF sometimes uses multiple funding sources for its awards.) With the help of Elizabeth Teles, the former co-lead program officer for the ATE program, several other situations were found for excluding a project from the study. These were planning grants, research and evaluation projects, support for conferences and special projects where ATE provided some funding but they were not true ATE projects.

These and other situations were examined in detail using the NSF database and the knowledge that Dr.Teles had during her years working on the ATE program. This analysis led to the exclusion of 23 active awardees leaving a potential population of 162 sites.

The reasons and number of exclusions follows.

a. Occasionally, NSF would use the ATE program as a "pass through" funding mechanism and code the grant as an ATE grant even though ATE provided little or no funding. These are called "special projects". An example is the digital library being developed at the University of Wisconsin. ATE put a small amount of funding into this project but the project was not an ATE project that was concerned directly with technological education. Four grantees were excluded for this reason.

b. The initial database of active grantees included seven PIs who had more than one grant. Usually these were continuation grants to ATE Centers. We decided to send just one survey to these PIs and ask them to reference their most recent grant when responding. This reduced the potential pool by seven.

c. Six of the potential subjects received planning grants, usually less than $100,000. These were excluded from the study population because it seemed inappropriate to ask these grantees about the impact and sustainability of their project given they were just starting up.

d. There were four awards to support research and/or evaluation activities. An example is funding for the Evaluation Center at the Western Michigan University. These were excluded from the study group.

e. ATE made two grants during this period to assist PIs in the implementation of their projects/centers. These involved conferences for ATE team leaders and other support activities.

After the above 23 grants were removed, the net population of active grants was 162. These were the institutions and organizations that were implementing programs and activities to improve advanced technological education where some degree of sustainability was expected.

2. Grants excluded from the expired population

Next, we analyzed the 193 expired grants looking for duplications, support of conferences and evaluations, planning grants and sites that had both an expired and an active grant. Eighty-two met the criterion for exclusion. These reasons and the number of grants in each category are listed below.

a. the most common reason for excluding an expired grant from the study is that the same PI or institution still had an active grant. It seemed unnecessary to send them two surveys. This decision reduced the potential population size by 37.

b. Some PIs had multiple grants that expired during the three-year period. When this occurred, the older grants were excluded and surveys were sent referencing the most recently expired grant. This resulted in six grants being excluded.

c. Grants were examined to determine if they were research or evaluation awards. Three such awards were made during the three-year time period and excluded from the study.

d. Three grants were made to support conferences or workshops to assist ATE PIs, for example, the annual PI conference held in Washington, D.C. These were excluded from the population.

e. There were four grants less than $50,000 that were excluded.

f. The ATE program made 16 planning grants during this time and these were excluded from this study.

g. Some grants have an ATE element code but the Division of Undergraduate Education (DUE) is not the primary funding source. For example, the Course, Curriculum and Laboratory Improvement (CCLI) division was the primary supporter of the development of algebra modules for high school and community college students. ATE provided some funds to support this effort because of the community college link. However, this is not considered an ATE project or center. Twelve grants were excluded for this reason.

h. Finally, one grant had two PIs listed and we decided to include only the most recent PI in our population.

Thus, 82 expired grants were excluded for one of the above reasons. Our final study population was 111 expired sites. This meant that surveys were mailed to 273 sites, 111 expired and 162 active.

3. We received 216 returned surveys and while checking them for accuracy, we discovered another 12 sites that at one time had an expired grant and now had an active grant. These sites were excluded as well because we did not want to send a PI two surveys. Our final population, then, was 261 grantees.

3. Note on population, sample, and census.

The total number of subjects of interest in a study is called a population. When the population is large, statisticians will choose a portion of the total they call a sample as a way to reduce the costs of the research. There are several ways to select a sample, for example, chose a sample randomly or select a convenience sample.

When the population is of a manageable size, the researchers can include the entire population in the study. This is called a census study because data is gathered on every member of the population.

This situation generally fits our research except that the grants that we have selected are part of a larger group of more than 800 grants that have been funded by the ATE program. We have chosen a sub-population of those grants and are conducting a census of those grantees. There will be a tendency for report readers to extrapolate our findings to the larger group but such generalizations must be made with a great deal of caution.