Enhancing Targeted Research in the Advanced Technological Education (ATE) Program: Project IX- Research to Define and Measure Effectiveness of ATE Centers/Projects

Final Report to the National Science Foundation

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INTRODUCTION

The National Science Foundation's (NSF) Advanced Technological Education (ATE) Program, begun in 1992, currently consists of 39 centers and about 200 projects with annual funding of $64M for new and continuing awards in FY 2010, which is expected to continue at least through FY2013. The ATE program promotes improvement in the education of science and engineering technicians at the undergraduate and secondary school levels. The purpose of this research was to develop measurable criteria of effectiveness for ATE centers/projects across the range of ATE priority areas – educational materials development, professional development and academic program improvement. Findings of the proposed research have potential to place the assessment of effectiveness for this key federally funded program on a firmer scientific basis. Results of the study are intended to allow NSF to better document the outcomes of the ATE program and to apply an objective effectiveness measurement strategy to ATE and similar programs in the future. This research could be used to demonstrate return on investment in the ATE portfolio to Congressional stakeholders.

BACKGROUND and SIGNIFICANCE

There are currently no generally accepted common metrics or methodologies to measure the effectiveness of ATE activities. Instead, grantees tend to report their effectiveness in particularistic ways. The Evaluation Center of Western Michigan University has been conducting an annual survey of ATE projects and centers for the past 11 years, collecting useful information for the three main priority areas of ATE: program improvement, professional development, and materials development. These data, as well as more informal assessments by NSF program officers and “reputational” testimony by peers, indicate that, as expected in such a large and diverse initiative, there appears to be considerable variation among grantees in the reported “effectiveness” of their programs. (Among grantees effectiveness is also termed “outcomes,” “success,” “accomplishments,” “results,” “innovations” or “impact.”). *Consequently, the present research was proposed to develop measurable criteria of effectiveness for ATE centers/projects across the range of ATE priority areas.*

The NSF solicitation for ATE proposals states the three *central goals* of the national ATE program:

Goal 1. “Producing more science and engineering technicians to meet workforce demands, and

Goal 2. improving the technical skills and the general science, technology, engineering, and mathematics (STEM) preparation of these technicians, and

Goal 3. [of] the educators who prepare them”

Thus, we infer that the national ATE program can be considered effective to the degree that one or more of these central goals is achieved. All three goals require either the measurement of changes in the number of technicians (ideally relative to workforce demand) or measurement of changes in specified technical skills and academic preparation for both students and their educators. The ATE program must also show that it “demonstrably contributes” to achieving these goals, that is, evidence must be produced to show the link between the specific ATE program and such changes in technician availability and in technician and educator technical skills/educational preparation.

The present study will present a comprehensive framework for specifying measurable criteria of effectiveness for ATE centers/projects across the range of ATE priority areas. The study is significant because there are currently no generally accepted common metrics or methodologies to measure the effectiveness of ATE activities. What appear to be are needed are objective, measurable and accepted criteria to enable assessment of effectiveness of ATE projects and centers. Such criteria, however, do not currently exist for ATE; instead, grantees tend to report their effectiveness in particularistic ways.

There are several challenges associated with the evaluation of the effectiveness of the ATE program:

Measuring outputs and determining impact for ATE. The ATE program is "effective" or has "impact" to the degree that the program's outputs contribute to achievement of ATE central goals (we will use "effectiveness" and "impact" synonymously). Measuring such *impact* requires (a) measuring program outputs (b) determining whether the quantity or quality of those outputs have changed (increased or improved) due to implementing the ATE program (c) demonstrating that program outputs demonstrably contribute to the achievement of central ATE goals. For our purposes, an *ouput* is defined as any product of the program (e.g. students completing a course, technicians trained, etc.). An *outcome* is defined as a performance level (e.g. increase in the number of STEM technicians, improved STEM technician skills, etc.) Determining the change in the number of STEM technicians entering the workforce is not always possible to measure directly within the scope of an ATE grant. It may be necessary to limit measurement to outputs that are hypothesized to contribute to achievement of central goals, such as high school students enrolling in dual degree programs or college students completing specific STEM-related coursework. Output units must be operationalized, i.e., they must be associated with explicit measurement procedures. When these measurement procedures are essentially the same across a series of specific ATE projects and centers, we may say the output metrics are standardized. However, standardized measures are not necessarily important, valid or best measures. Value determinations of specific measures requires expert judgment and/or psychometric assessment. Nevertheless, standardization is a necessary step towards making such additional determinations regarding validity and value.

For example, it may be pertinent for a grantee to measure the number of students completing certain "milestones" in secondary school or college - the programmatic outputs. This may be the number of students completing certain workshops or courses or graduating with certain certificates or degrees. Or, it could be the number of persons employed as technicians in a specific work setting or even a whole community. There are numerous possibilities, and some are closer to the central goal than others. Thus, increasing the number of graduate technicians is not exactly the same as increasing the number of technicians entering the workforce, because without additional data one doesn't know how many graduates will actually obtain jobs as technicians.

Determining whether the ATE program leads to a positive impact. A key objective of ATE program evaluation is to determine whether the program results a positive impact. In traditional evaluation, this involves counterfactual analysis, that is, a comparison between the scores of the output variables following program implementation and the scores of the output variables expected in the absence of the program. If there is a difference, and if the difference is in the desired direction, we may say that a positive impact was achieved by the ATE program. If these outputs are shown to demonstrably contribute to the achievement of at least one of ATE's central goals, the program can be delineated effective. Evaluators often strive to do this through an experimental design, but due to the often increased cost and feasibility of experimental designs other credible methodologies can be used. For example, if a community college graduates more technicians after implementing an ATE program than it did before the program, this may constitute evidence that the program contributes to increasing the number of graduates.

This study aims to propose one or more credible methodologies that individual ATE grantees could use to determine the impact of program activities, as defined above. This requires at least one *comparison*; but of course the type of comparison selected is crucial for the credibility of any inferences about change. For example, as indicated above, a possible methodology is to compare the number of technicians graduating in the targeted discipline within some period before the implementation of ATE activities vs. the number of technicians graduating in the targeted discipline after ATE. Whether this is a good design depends on the nature of the ATE activity, however. Thus, if the activity of interest is an instructional innovation that is intended to reduce dropouts from particular technical course, then a parallel groups design with some students taking the traditionally taught course and others the innovatively taught course would be a more sensitive method of determining a possible effect on the production of technicians. This is an instructive example because it illustrates measuring an intermediate output that presumably contributes to achieving the central goal of producing more technicians; it is reasonable to expect that completing key courses (and keeping the student enrolled in technician education) ultimately will lead to more technicians being produced. Since there may be attrition occurring between completing STEM courses and entering the technician work force, the limitation of measuring only intermediate outputs must always be recognized. Intermediate outputs would be part of a "logic model" of a given ATE program, and of course there must be agreement that there is a "reasonable link" between the intermediate and final outputs. Randomized controlled trials (RCTs) are often seen as the "gold standard" for determining program impact, but we do not limit ourselves to that recommendation, because this may be an impractical approach for most ATE grantees. (We also note that NSF does not require RCTs for its grantees.) Additionally, whatever evaluation design is selected should also attempt to verify the hypothesized link(s) between intermediate and final outcome(s).

As mentioned previously, programs must demonstrate that their outputs demonstrably contribute to the achievement of ATE's central goals. Implementation of an ATE project's or center's planned programmatic activities, no matter how well done, is not equivalent to demonstrating a contribution to attaining the central goals of ATE. The ATE Impact reports document many impressive activities by grantees that certainly can be defined as accomplishments or outputs **(**Patton, 2008a,b). However, inferences must almost always be made about whether or to what extent the central goals of ATE are furthered by these outputs. For instance, if a new program to graduate wind turbine technicians is established, it is plausible that the number of graduates (program output) is an addition to the number of technicians being produced in the U.S. (ATE goal 1 outcome). However, if the wind turbine program diverts students from other technician training programs at the college (unintended side effect), then the total number of technicians produced by the college may not change, and thus nothing is added to the national total of technicians. However, the wind turbine program may diversify the national pool of technicians, creating technicians with new skills, and thus *might* be interpreted as contributing to ATE goal 2, which includes "improving the technical skills" of technicians.

The overall purpose of this study is to place the evaluation of effectiveness for the federal ATE program on a firmer scientific basis. The study will propose and illustrate an evaluation framework designed to enable NSF to better understand variations in success of its ATE grantees and to apply an objective effectiveness measurement strategy to the ATE and similar programs in the future. The types of effectiveness measures proposed could be used to demonstrate return on investment in the ATE portfolio to Congressional stakeholders. The framework could also assist ATE projects and centers in meeting demands for accountability and support their requests for continued NSF and other funding. Finally, technician educators and administrators could use the framework to identify the most promising programmatic innovations (taking context and environment into account) and to inform their decisions about improving education/training models and dissemination of evidence-based ATE programs regionally and nationwide.

SPECIFIC STUDY OBJECTIVES

The orienting questions for this study are: How can we measure the desired outputs of the ATE program in a standardized manner? And what kind of practical research design(s) will allow valid inferences about whether such outputs have increased or improved as a result of the ATE program? What outputs demonstrably contribute to the achievement of ATE central goals?

The study has three specific objectives:

1) Formulate a model for standardized measurement of ATE program outputs that is relevant across different projects and centers, irrespective of their substantive focus and environment;
2) Determine what individual project and center outputs represent concrete steps toward achievement of one or more of the ATE central goals and propose additional outputs that could feasibly be measured.
3) Determine what types of evaluation designs individual projects and centers are implementing to measure outputs and/or impact and propose alternative or improved evaluation designs.

The term "standardized measurement of central goal achievement" has two conceptual components. The first component is measurement of an output (goal-related indicator) at a given point in time. For example, this might be the number of technicians receiving an associate degree during some time period (related to central goal 1) or the number of teachers passing a knowledge test after completing a continuing technical education workshop (related to ATE goal 3). The second component is performing a counterfactual analysis by collecting some type of pertinent comparative data (objective 3).

The term "standardized measurement of central goal achievement" has two conceptual components. The first component is measurement of an output (goal-related indicator) at a given point in time. For example, this might be the number of technicians receiving an associate degree during some time period (related to central goal 1) or the number of teachers passing a knowledge test after completing a continuing technical education workshop (related to ATE goal 3). The second component is performing a counterfactual analysis by collecting some type of

pertinent comparative data (objective 3). For example, with respect to the first indicator, this might be to show an increase in the number of graduates over some time period, including starting from "zero" graduates if it is a new degree program. The assumed counterfactual is that the number of graduates would not have increased during that period (or there would have continued to be none) without the presence of the given ATE program.

Now clearly this assumption may be fallacious due to several possible "threats to internal validity." For instance, there may have been a pre-existing trend toward more graduates with this degree over time, or resources other than ATE might have been found to expand the program and produce more graduates. A new or expanded ATE-supported degree program may also have unintended consequences, for instance, diverting students from other technical degree programs, resulting in no net gain in technical graduates or less gain than is apparent. A more sophisticated comparative design may be needed for a given ATE project or center depending on particular circumstances and context. The point to be made, however, is that reasonable attempts at counterfactual analysis must occur to properly evaluate ATE project and center program effectiveness. To return to our example, simply reporting the number of associate degrees awarded may be inadequate to establish whether "more" technicians have been "produced." It would also be necessary to determine whether there has been net increase in the number of graduates as a result of an ATE program that was intended to have that outcome.

This approach to standardized outcome measurement is not intended to be a substitute for particular evaluations of individual ATE projects and centers. The approach is intended to define common data elements that could be collected by such particular evaluations, which could then be aggregated (compiled) to provide evaluative data for the national ATE program.

METHODS

The original design for this study proposed drawing probability samples of ATE projects/centers working in different substantive areas and performing content analyses of their program and evaluation materials to address the three objectives of the present study. It was understood that such source materials could only be obtained directly from the grantees, since applications for funding, progress reports and final reports to NSF, including independent evaluator reports, are not public information. However, after the study began, NSF wanted us to avoid a large number of requests to ATE grantees for information due to the perceived burden of responding. Accordingly, the study relied on data from four sources: Selected ATE project/center progress and final reports solicited by an NSF program official; project/center independent evaluator reports that had previously been submitted to the ATE Resource Center for inspection; ATE project/center websites that had sufficient information for study purposes; and ATE projects/centers described in the Impact publications that had enough information for our study purposes. The result is a convenience sample of projects and centers, but at least a diverse sample in terms of substantive areas.

We selected one project to analyze in each of ten industries and one center in each of seven industries; the industries were as classified in the ATE Impact publications (Patton, 2008 a,b). The project or center chosen within each industry was the one on which we had the greatest amount of source information. Accordingly, we do not claim that these projects and centers are necessarily representative of their industries. However, the aim of the exercise is too demonstrate that the proposed framework is applicable to ATE projects and centers across the ranges of applicable industries. (The projects and centers included are anonymous in this report.)

The study employs a grounded theory approach combined with standard content analysis techniques to analyze the source material for each ATE project or center examined (Neuendorf, 2002). These data are used to inductively derive categories of outputs and their measures and classify the evaluation designs identified.

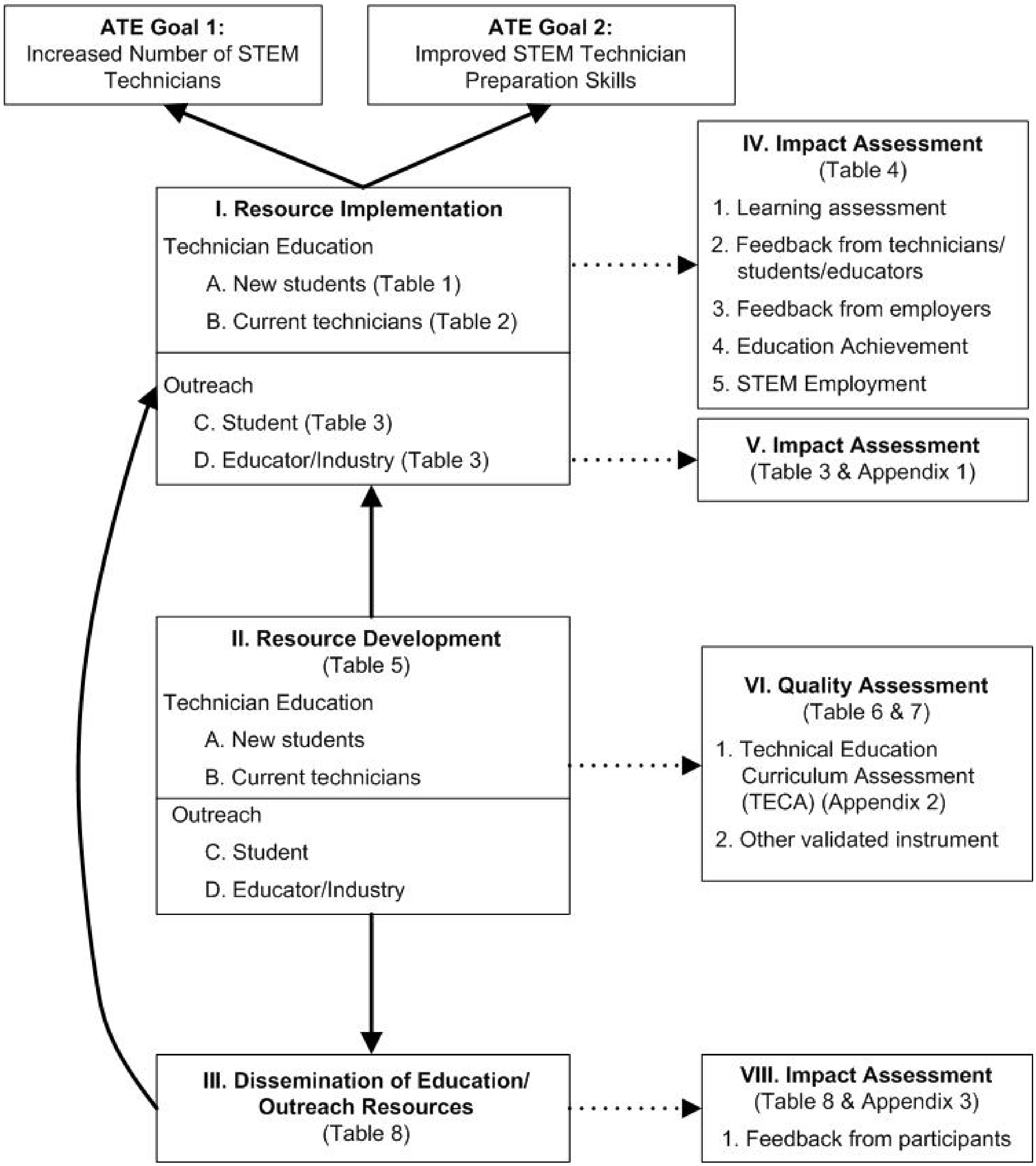
RESULTS

The results for study objectives 1, 2 and 3 are presented for each of the three ATE central goals:

***Objective 1*: Formulate a model for standardized measurement of outputs pertinent to ATE goals 1, 2 and 3.**

The model for goals 1 and 2 is summarized in Figure 1, "Outputs Leading to Production of New STEM Technicians and/or STEM Technician with Improved Skills" and the detail in Tables 1 - 8. This is a model of the "steps" that lead to the goals. It was constructed from an analysis of the objectives specified by various ATE projects and centers, as well as consideration of the logical connections between the different types of outputs. Several observations can be

Figure 1. Outputs Leading to Production of New STEM Technicians and/or STEM Technicians with Improved Skills



made. Why not just measure the number of new technicians each center or project contributes to the workforce (a “final” output)? The main reason is that most centers or projects are not designed to carry through their programs or activities to that final output, but rather are designed to produce certain outputs which are conceptualized as being intermediary steps toward attaining the central goals. For example, attempting to determine whether STEM outreach activities in middle school lead to the entry of technicians in the work force many years later is beyond the scope of any grantees’ evaluation design and is a challenging evaluation problem under any circumstances. And of course, the evaluation problem is made more difficult by the necessity of determining whether the number of technicians entering the work force as a result of a center’s or project’s activities actually constitutes an actual “increase” in such work force entry.

Figure 1 is based on certain assumptions that we propose as reasonable. We assume that there is a plausible connection between the “lower level” outputs and the top level final output. That is, we assume that an indicator such as the “number of secondary school students participating in STEM education outreach” may ultimately affect “number of technicians in the work force.” We should be clear, this is not a guarantee and there is probably little or no firm research that supports the assumption or suggests the strength of a possible link. This lower level output is likely best viewed as a necessary but not sufficient condition to start students on the path to a technical career – you won’t choose the career if you don’t know about it, form a positive attitude toward it and see it as a real and practical possibility for yourself.

The “dotted arrows” are not part of the flow of outputs, but show the types of impact and quality assessments that pertain to each main type of output.

It is likely that new students being educated to achieve ATE Goal 1, increased number of technicians, may also be receiving better or more relevant education than previous cohorts of students. For instance, they may be receiving more effective basic science education or they may be trained in new, cutting edge technical fields; that also implies meeting Goal 2. However, there may be some ATE activities that are aimed only at expanding the capacity of existing STEM programs, thus leading to an increase of technicians only, without a change in the quality of that education. Finally, there are ATE activities devoted solely to improving the quality of STEM education without attempting to affect a net increase in the number of technicians produced.

Creating new STEM-related courses and programs either in high school or college may be a useful strategy to produce more STEM graduates, but it is best considered a preliminary activity because the courses and programs must also be adequately utilized by students. (The programs must also be promoted and supported by the institution.) Thus, actual enrollment and completion/graduation must follow the creation of new or innovative STEM educational resources and opportunities such as those created by ATE projects and centers.

However, please note that this graphic schematic of outputs in Figure 1 is not intended to suggest the relative importance of any output which precedes actual entry of technicians into the workforce. Thus, it may be highly important to inform middle school students about STEM careers, since it may indeed influence later career choice. Determining the strength of the connection between such exposure to information through outreach programs and subsequent career path choice is a suitable topic for intensive research investigation.

The relations between the activities specified in Figure 1 may be summarized as follows. Resource development is the logical first step, which includes appropriate field testing of the resources. Such field testing, designed to improve and/or finalize the resource, is not defined as "resource implementation", however. Once the final product is developed, it may be implemented – this is the "production" activity. Initial implementation activities are often conducted by the grantees (or their partners) who develop the resource, but the final product may also undergo intermediary dissemination, which then leads to implementation by external organizations. Such dissemination activities may be conducted by the grantees that develop the resources or by external organizations. Dissemination activities are defined as those which assist in transferring the resources to other entities to enable the implementation of the resources; dissemination activities may or may not be innovative in themselves. The diagram may appear somewhat deterministic, but it is not incompatible with a more cyclical conceptualization of activities, where (e.g.) experience with implementation informs further improvement of the resource. However, this would take us beyond the primary purpose of the diagram, which is to *classify ATE programmatic outputs that lead to the attainment of ATE central goals.*

Table 1 is the layout in which new student engagement in STEM education can be documented. ("New students" are those who do not yet have a STEM technician degree or certificate.) This can be done for individual projects or centers and the results aggregated for multiple project and centers (for defined time periods). The particular programs, courses, internships or dual programs would be different, of course. Note that software or other educational materials developed for new students are typically incorporated in existing or modified programs and courses.

Table 1. Technician Education Implementation (New Students)

	Post-Secondary			Secondary		
	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)
A. Program	☐	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐	☐
D. Dual Program/ Dual Credit	☐	☐	☐	☐	☐	☐

	Post-Secondary Exposed*	Secondary Exposed*
E. Software/ Materials	☐	☐

Note: *Including in other programs or courses

Table 2 is the layout to record implementation of continuing education for current technicians who already have technical degrees, certificates or similar qualifications.

Table 3 is the layout to record student and professional participation in STEM outreach activities, which for students are typically intended to increase awareness of STEM careers and to encourage involvement in academic activities that lead to entry to STEM careers or academic programs. For educators and industrial professionals, outreach is often directed toward getting them involved in making students aware of STEM career paths and pre-requisites and in helping expose students to STEM-related workplaces. The table layout allows recording of the quantity of student and professionals who participate in the outreach program or activity, how many complete it (if there is a distinction between participation and completion), and an indicator of impact of the outreach. “Educators/industry” includes educators (professors, instructors, and teachers), education administrators and industry professionals.

Table 2. Technician Education Implementation (Continuing Education)

	Post-Secondary		
	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)
A. Program	☐	☐	☐
B. Course	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐
D. Dual Program/ Dual Credit	☐	☐	☐
	Post-Secondary Exposed*		
E. Software/ Materials	☐		

Note: *Including in other programs or courses

Table 3. Outreach Programs

	Student Post-Secondary	Student Secondary	Educators	Industry Professionals
A. Participated (#)	☐	☐	☐	☐
B. Completed (#)	☐	☐	☐	☐
C. Impact Measure*	☐	☐	☐	☐

Note: *See Outreach Impact Checklist (Appendix 1)—students only

A draft framework to measure the impact of outreach for students is shown in Appendix 1; this distinguishes between two levels of impact, increased interest in a STEM career (level 1) and behavioral impact (level 2). The items on the two levels include the subjects of increased awareness of STEM careers, increased interest in pursuing a STEM career and intent to pursue a STEM career and actual behavior – taking steps to initiate a STEM career. The level 1 measure, interests, would be based on a focused student survey at the conclusion of the outreach program/activity and the level 2 measure, behavior, would be based on a follow-up of students who participated in the outreach; the latter is certainly challenging, and may not always be practical to do, but is the only way to determine behavioral impact.

Some grantees have an explicit objective of increasing underrepresented populations with respect to technician characteristics such as race, ethnicity, and/or gender, in the technician pool. In that event, the relevant enumeration in Tables 1, 2 and 3 would be students in the underrepresented categories and/or separate tables for all students and students in specific underrepresented categories. However, it might also be argued that all grantees should track such data, because an ATE program may have an effect on increasing underrepresented minorities, even if that is not a explicit goal for a given program.

Table 4 is the layout to record data on the impact of STEM education for new students and current technicians, distinguishing between learning assessments, feedback from the participants (sometimes termed "reactions") and feedback from employers of new graduates and current technicians. We suggest that proficiency be defined for each resource developed by a grantee and then aggregated as "percent of students achieving proficiency," if the resource also is implemented. Standardized instruments could be developed for the feedback measures that would be applicable across STEM topic areas and types of educational resources, but this would require a dedicated instrument development effort. In the meantime the same approach could be used for feedback from employers and participants: percentages of students and educators rating the academic resources could be aggregated.

Furthermore, one could aggregate percentages of employers rating new or current technicians' skills and knowledge compared with other technicians or against skills and knowledge prior to participation in training (e.g. pretest/posttest). It is especially desirable to assess technical skills improvement directly upon completion of continuing education courses because completion of continuing education, unlike college courses or degree programs, often do not include measures of learning nor require demonstrated proficiency to receive certificates of attendance. (However, institutions or instructors may require a higher standard to receive a certificate of competency or job recommendation.)

Table 4. Technician Education Impact Assessment*

	New Students	Current Technicians
1. Learning Assessment	☐	☐
2. Feedback from technicians/students/ Educators	☐	☐
3. Feedback from employers	☐	☐
4. Education achievement	☐	☐
5. STEM employment	☐	☐

Note: *Instruments need to be developed

Table 5 is the layout to record the quantity of STEM education and outreach program resources of specific *types* that have been developed by ATE projects and centers. *Curriculum development* is of course a key part of creating programs, courses, etc. The table distinguishes among newly created technician academic resources, expanded resources and upgraded resources. Similarly, outreach programs for student and professional can be newly created, expanded or upgraded. Supplementary information could list the particular education resources by category. This is a simple count of resources. Newly created resources are those that did not exist previously, often resources that address relatively new technical areas, e.g., wind turbine technology or nanotechnology. Expanded resources require increasing the capacity of existing education resources to engage additional students; this would include resources adopted from other institutions. Upgraded educational resources require improving the quality of existing resources in some way (including updating resources, revising resources, and improving the techniques with which educational curricula are taught.). "Professional outreach programs" are programs directed toward secondary school teachers, college faculty or industry professionals to engage them in introducing students at various levels to potential STEM careers.

Table 5. Educational/Outreach Resources Development

	Post-Secondary			Secondary		
	Created	Expanded	Upgraded	Created	Expanded	Upgraded
A. Program	☐	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐	☐
D. Dual Program	☐	☐	☐	☐	☐	☐
E. Software/ Materials	☐	☐	☐	☐	☐	☐
F. Student Outreach Program	☐	☐	☐	☐	☐	☐
G. Professional Outreach Program	☐	☐	☐	☐	☐	☐

Table 6 is the layout to record assessments of the quality of educational or outreach resources which are created or upgraded by ATE projects and centers. Based on a review of the literature, we recommend adapting an existing instrument developed to assess the quality of ATE curriculum materials, the Technical Education Curriculum Assessment (TECA) (Keiser et al., 2004), which was developed specifically for the ATE program. This instrument refers to "materials" as the subject for assessment. In our view, it appears that the TECA could be adapted to our evaluative framework by substituting the terms "program," "course," "internship" or "apprenticeship program;" or "software" as appropriate, for the term "materials." Preliminary results examining the reliability and validity of the TECA have been positive (Kaiser et al., 2004). The TECA could be applied by an ATE grantee's external evaluator, visiting committee, or an expert panel constituted for that specific purpose. The use of the TECA would also allow aggregating the quality assessments of education resources using a common metric. Employing an established instrument such as the TECA would enhance the credibility and readiness for national dissemination of STEM education resources developed by ATE grantees, which is a prime activity of the ATE program. The summary scoring pages of the TECA are in Appendix 2; the scores to be entered in the cells of the tables range from 0 to 4 according to the definitions in the TECA scoring rubric.

Table 6. Educational Resources Quality Assessment (TECA scores)

	Industry standards and practices	Real world curriculum	Workplace competencies	Access to in-depth understanding	Overall rating
A. Program	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐
D. Dual Program	☐	☐	☐	☐	☐
E. Software/ Materials	☐	☐	☐	☐	☐

Table 7 is the layout for recording results of a assessing the quality of student and professional outreach program. Using an instrument analogous to TECA would be a feasible method for quality assessment, but would need to be developed.

Table 7. Outreach Program Quality Assessment*

	Secondary Level	Post-Secondary
F. Student Outreach Program	☐	☐
G. Profession Program	☐	☐

Note: *Measures to be developed

Table 8 is a framework for recording the dissemination of innovative educational resources that have previously been created or upgraded –often but not necessarily by ATE grantees. This can involve simple transmittal of the resources or providing technical assistance for the implementation of the resources. In either case, one can count how many clients (organizations or organizational units) have received the materials or technical assistance and what the impact has been; thus included counting "hits" and downloads of materials on websites Impact would include some basic indicators of the actual utilization or implementation of the educational resources. Measuring impact would require follow-up with the clients and may be impractical in some situations, but is the only way to determine impact on actual behavior. It has come to our attention that one grantee is making it a requirement for download of materials to click on an agreement to answer a later follow-up on impact; this seems like a doable approach. Dissemination is the primary focus of ATE National Resource Centers, but all ATE projects and centers also are now required to engage in some level of dissemination.

An example of an impact assessment instrument designed specifically for technical assistance is a questionnaire that was developed recently for the National Research Center for Career and Technical Education (NRCCTE) (Evaluation Center, 2010, Appendix 3); this instrument might be adapted for the ATE program. This instrument has the potential of becoming a generic tool than can be employed across different content areas to yield a common metric for assessing the effect of technical assistance.

Table 8. Dissemination of STEM Education or Outreach Resources for Students*

	STEM Education Resources	Outreach Resources
Publicize resources	☐	☐
Transmit resources	☐	☐
Technical assistance	☐	☐
Impact measure/ utilization	☐	☐

Note: * Detailed measures need to be developed

ATE grantees who develop educational or outreach resources (Figure 1, II) may implement the resources with students in their own institutions, in partner institutions (Figure 1, I) and/or disseminate the resources to other institutions (Figure 1, III).

(In this case we define *partner institutions* as those committed to implementing a resource and presumably reporting data on the results of implementation efforts.)

If the grantee implements the resources with students directly or through partner institutions, then documenting that in Tables 1-4 would be indicated. For resources that are being disseminated to other institutions where the grantee has no direct involvement in the adoption or utilization of the resources, the question of measuring impact on students is more difficult. Ideally one would desire data for Tables 1-4 from these other institutions (thus the inclusions of the 'arrow' from "III. Dissemination" to "I. Resource Implementation" in Figure 1). For an ATE center or project that engages to a great extent in such resource dissemination activities, one can argue that the impact of the center/project cannot be adequately judged without details on whether students are actually exposed to the resources, whether such exposure results in more students taking steps toward STEM careers, and/or whether such exposure improves the academic preparation or skills of the technicians being educated. However, inspection of center/project descriptions indicate that few grantees are funded to conduct such relatively detailed follow-up of the results of their dissemination activities and certainly the institutions that receive the resources are not funded to provide detailed data back to ATE grantees concerning their implementation of the resources. These are issues that NSF should consider.

The conceptual model for ATE goal 3 is summarized in Figure 2, "Outputs for Improved STEM Educator Academic Preparation/Skills." This is a model of the elements needed to document improvement of educator academic preparation/skills. It was constructed from analysis of the objectives specified by various ATE projects and centers, as well as consideration of the logical connections between the different types of program outputs pertinent to the improvement of educator preparation/skills. The model is similar to elements for improving the preparation/ skills of technicians (Figure 1), except that the educators' professional development curricula are aimed towards improved training of technicians as the end result; improving the educators' knowledge and skills is a means to that end. (The term "educators" includes university faculty, instructors, secondary and middle school teachers, industry professionals who teach or mentor and educational administrators at all levels.) Again, figure 2 is not incompatible with a more cyclical iterative conceptualization of activities, where (e.g.) experience with implementation informs further improvement of the educational resource.

Figure 2. Outputs for Improved STEM Educator Preparation/Skills

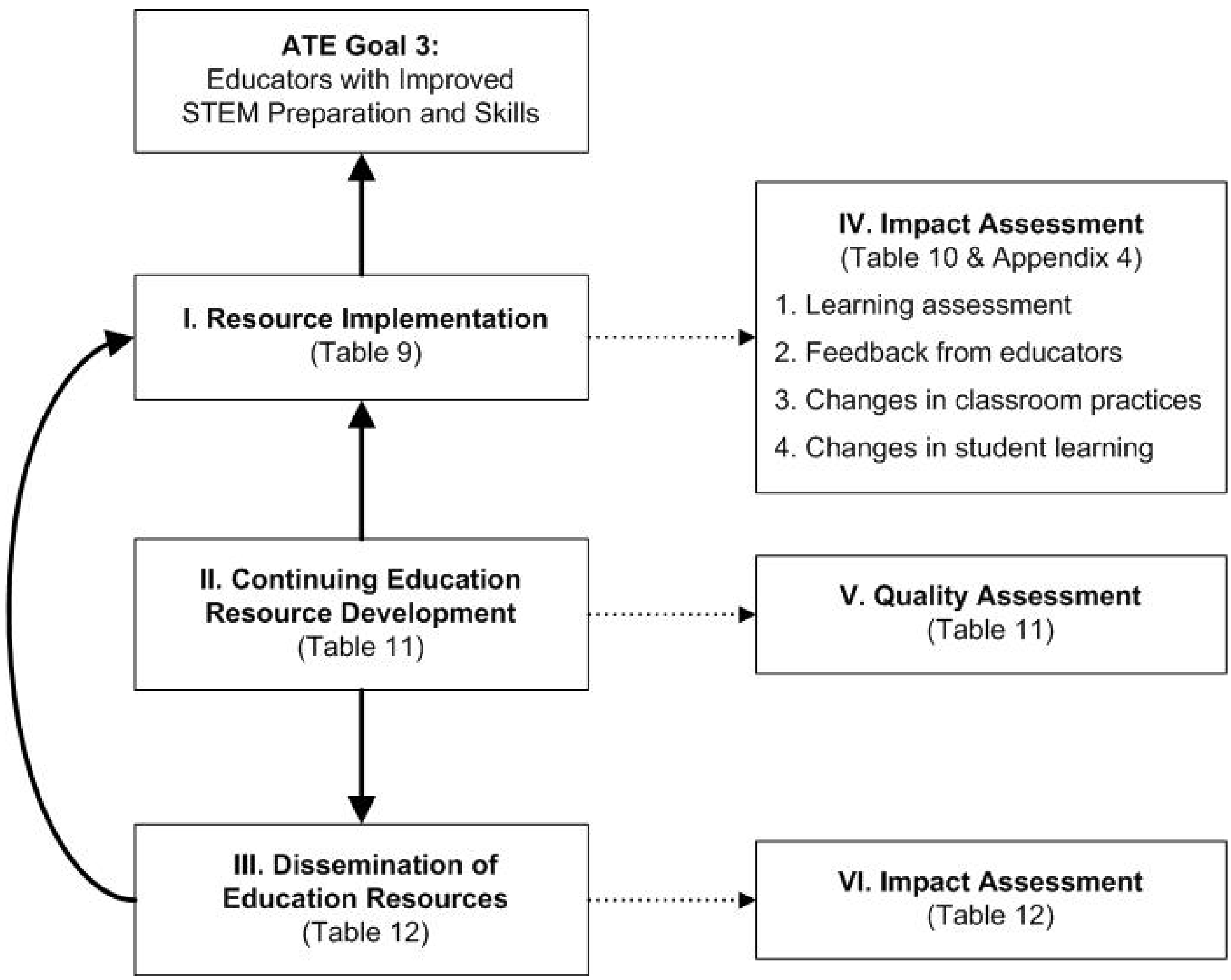


Table 9 is a data layout for recording the number of educators who complete professional development activities and Table 10 is a data layout for recording the impact made by such participation.

Table 9. Educators' Professional Development Implementation

Number of Educators who Complete…	Elementary	Secondary: Middle	Secondary: High	Post-Secondary: Faculty	Post-Secondary: Industry	Post-Secondary: Professional
Professional Development Workshops	☐	☐	☐	☐	☐	☐
Professional Development Courses	☐	☐	☐	☐	☐	☐
Professional Development Fellowships/Mentoring	☐	☐	☐	☐	☐	☐
Professional Development Software/Materials*	☐	☐	☐	☐	☐	☐

Note: *Including hard copy and audio/visual materials for professional development purposes

Table 10. Professional Development Impact Assessment

Educators' Assessment of Learning	☐
Feedback on Professional Development (Reactions)	☐
Changes in Classroom Practice	☐
Changes in Student Learning	☐

An example of a "generic" impact assessment instrument for professional development is a questionnaire that was developed recently for the National Research Center for Career and Technical Education (NRCCTE) (Evaluation Center, 2010 – Appendix 4); we suggest that this instrument can be adapted for the ATE program This instrument has the potential of being a generic tool than can be employed across different content areas to yield a common metric for assessing the quality of professional development material and courses. In addition, there are additional methodologies that have been developed with federal resources that are pertinent to measuring the effectiveness of STEM teacher development (Teaching Institute for Excellence in STEM, 2011; Wested, 2011; ITEST Learning Resource Center, 2011). These methodologies need to be considered for possible adaptation for the ATE program.

Table 11 is a data layout for recording the number and types of professional development resources that are developed by ATE grantees and an assessment of the quality of those resources. Professional development resources are defined as structured activities and materials designed to improve educators' quality of STEM instruction (e.g., knowledge, motivation, classroom skills). We were unable to locate any current measures suitable for assessing the quality of professional development activities and materials, but an instrument analogous to the TECA would be a feasible methodology. (The proposed NRCCTE professional development evaluation instrument assesses impact on participants, but is not an independent assessment of the quality of the professional development activity.)

Table 11. Educators' Professional Development Resources

	Secondary		Post-Secondary	
	Number	Quality Assessment*	Number	Quality Assessment*
Professional Development Workshops	☐	☐	☐	☐
Professional Development Courses	☐	☐	☐	☐
Professional Development Fellowships/Mentoring	☐	☐	☐	☐
Professional Development Software/Materials	☐	☐	☐	☐

Note: *Measure needs to be developed

Table 12 is a data layout for recording the dissemination of innovative STEM professional development resources. This can involve simple transmittal of the resources or providing technical assistance for the implementation of the resources. In either case one can count how many clients (organizations or organizational units) have received the materials or technical assistance and what the impact has been. Impact would include some basic indicators (e.g., ratings) of the actual utilization or implementation of the professional development resources. Measuring impact would require follow-up with the clients and may be impractical in some situations, but is the only way to determine impact on actual behavior. Dissemination is most often an ATE center activity, but projects may also engage in dissemination.

Table 12. Dissemination of STEM Professional Development Resources*

Publicize resources	☐
Transmit resources	☐
Technical assistance	☐
Impact measure/ utilization	☐

Note: *Detailed measures need to be developed

Comparison with ATE Survey Results

The 2008 ATE Survey of project and center activities indicates that a portion of the suggested output measures are already being collected by some projects and centers (Evaluation Resource Center for Advanced Technological Education, 2009). First, in terms of capacity to collect output data, 75% (n=108) of projects and centers indicated that they had an external evaluator, 5% (n=7) had an internal evaluator, and 17% (n=25) reported they had both an external and internal evaluator. Thus, approximately 97% of the projects and centers are already working with an internal and/or external evaluator, which suggests they have the capacity to collect the suggested data and to expand and/or modify data collection. In the section below, examples from the ATE Survey are presented to demonstrate that a number of the proposed measures are feasible, given adequate resources, and already being collected by some projects and centers. Note the estimates represent information from those projects and centers which responded to the survey, not all ATE project and centers.

Resource Implementation (ATE Goals 1 and 2)

As part of the survey, projects and centers reported on the number of ATE funded courses, programs, resources, etc. created, number of students who enrolled in these courses, number of students that applied to programs, number of students accepted to programs, and demographic breakdown of students that participated in a newly formed educational activities by sex, racial/ethnic identity, and employment status as a technician. Projects and centers also report information on students in ATE funded programs indicating estimates such as completion rate (n=53), whether students obtained or continued employment as technicians (n=36), and whether students continued with STEM education (n=37).

Resource Implementation (ATE Goal 3)

For projects and centers that reported evaluating more than one professional development activity, 98% (n=50) reported collecting participant reaction data at the conclusion of the activity. Of those 50 centers and projects, 98% (n=49) collected information on opinions about the training, 90% (n=45) on perceived value of new ideas, materials, or techniques for use in the participants' home institutions and 74% (n=37) on participants' learning/achievement with regards to the given professional development topic. Of the 34 projects and centers which assessed participants' learning, all collected data on participants' self-assessment of how much they learned, 35% (n=13) collected data through hands-on or written assignments and 3% (n=1) through externally prepared exams. For those projects and centers that evaluated their professional development activities, 79% (n=41) obtained follow-up data with participants to determine whether they implemented what they learned.

Resource Development (ATE Goals 1, 2 and 3)

Sixty-five percent (n=41) of projects and centers reported evaluating the materials they developed. Of those projects and centers that reported evaluating the materials they developed, 50% (n=32) had these materials reviewed by external experts (one of our recommendations). The quality of the professional development provided was evaluated by 81% (n=52) of projects and centers. Sixty-three percent (n=33) of projects and centers reported obtaining feedback from experts about the content and instruction of the professional development activities. Program improvement activities were evaluated by 93% (n=39) of the projects and centers. The survey did not ask whether validated instruments were used or whether the external experts worked as a panel for any of the above, both of which we recommend.

Resource Dissemination (ATE Goals 1, 2 and 3)

The survey did not include many questions related to dissemination activities, although projects and centers reported the frequency and size of the audience for several dissemination activities, such as presenting at conferences (n=123) and distributing promotional materials related to the project/center (n=122).

Study Objective 2. **Determine which outputs individual project and centers are measuring as concrete steps toward achievement of ATE goals 1 and 2 and propose additional outputs that could feasibly be measured.**

Study Objective 2 is illustrated for 10 projects and seven centers in subsequent sections. For example, one project has developed and implemented a semester of courses which aim to increase the academic skills of college-age students who are academically underprepared, to start them in community college or enable success in college if already enrolled. This program seeks to increase the number of technicians by increasing the number of students choosing to pursue a STEM-related field or complete college. Among other measures, the project tracked student enrollment and completion numbers from STEM relevant course in post-secondary institutions. A longer-term follow-up would have enabled the project to report on the number who later enrolled in STEM degree or certificate programs.

Study Objective 3**: Determine what types of evaluation designs individual ATE projects and centers are employing to determine impact and propose alternative or improved evaluation designs.**

Study Objective 3 is illustrated for 10 projects and seven centers in subsequent sections. Measuring impact requires both measuring outputs and determining whether the quantity or quality of those outputs have changed due to the ATE program and that these outputs have demonstrably contributed to achievement of ATE central goals. This requires an evaluation design that answers the question posed by the counterfactual, i.e., for ATE goal 1, how many technicians entered the workforce during the operation of the ATE program? vs. how many would have entered in the absence of the ATE program? If we are not able to measure the output of "workforce entries," then the analogous question can be posed with output that is a plausible precursor to workforce entry, e.g., how many students completed a STEM-related internship during the operation of the ATE program vs. how many would have complete a STEM-related internship in the absence of the ATE program? There are numerous possible evaluation designs that can help to answer this question; some are better than others and all have particular strengths and limitations (Shadish et al., 2002).

There are several relatively straightforward evaluation designs that seem feasible for ATE programs to use in measuring outcomes related to the goal of producing more technicians. A design that seems generally applicable is the "before and after" design, specifically, the "cohort control group design" (Shadish et al., 2002). In this design, the targeted output is measured for a current or recent cohort of units and compared with the output for a subsequent cohort of units after the intervention is put in place. For instance, a community college could measure the number of technician graduates entering the workforce in a recent time period and then compare that with the number of graduated technicians entering the workforce in an equivalent time period after implementing an ATE program designed to increase technician graduates. Similarly, a college could measure the number of completed STEM internships in a recent time period and compare that with the number of completed internships in an equivalent time period after a new internship program is put in place. This type of design can also be used for STEM education/outreach programs in secondary schools. Suppose the target output is community college applications for STEM programs from high school seniors in the catchment area. The number of such college applications could be measured for a recent time period (baseline) and then compared with the number of applications for an equivalent time period after an ATE STEM education/outreach program is implemented in local high schools. Baseline data can be challenging to obtain, but sometimes is available as routinely collected administrative data or could be collected as data to support a forthcoming ATE grant application (to help establish the need for the grant). An evaluation design that seems generally applicable to assessing whether program outputs demonstrably contribute to achievement of ATE goals 2 and 3 is the "one-group pretest-posttest" design. Technicians or educators could have their skills objectively assessed before and after an ATE continuing education or professional program. The lack of a control or comparison group would not be critical if it can be reasonably assumed that the participants are unlikely to have acquired the targeted knowledge or skills in the same short period of time by some alternative means. Subjective feedback about perceived learning could be obtained by a post-education participant survey - in other words a "one-group posttest-only" design. A similar procedure could be used to obtain feedback from employers about the perceived utility of the continuing education for their technicians. Of course, valid instrumentation and administration procedures remain to be developed in order to implement such a design.

A recent elaboration of the one-group pretest-posttest design which has methodological advantages is the "pre-/post-/then-test," where the "then-test" refers to a retrospective pre-test (Schwartz, 2010; Schwartz and Sprangers, 2010). This design attempts to account for the possible response shift over time by subjects, for example because of changes in subjects' internal standards, perhaps due to the intervention itself. A retrospective pre-test is usually feasible to obtain.

Ten ATE Projects to Illustrate Study Objectives 2 and 3.

The examples are organized by the ATE goals that the projects are trying to achieve. If a specific ATE goal is not mentioned for a given project, that indicates we judged that goal as not relevant for that project.

Project Example # 1. Focus Area: Agriculture Technology, Marine Technology, and Natural Resources

This agriculture technology project seeks to improve the skills of current and future technicians working in the grape and wine industry. The project provides traditional and nontraditional students with training in viticulture and enology leading to a technical certificate or associate's degree. The project also works to establish and mentor programs of study in the field through collaborations with educational institutions, industry, and government. The project delivers coursework online and organizes opportunities with local vineyards and wineries to provide students with hands-on experience in a local laboratory.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 2: Technicians with Improved Skills

Resource Development. The project developed an online technical certificate program with credits that are able to transfer to an associate's degree program at a local institution which can be documented in Table 5. The literature did not specify whether the online curriculum had been developed with or assessed by experts in the field; thus, it is recommended that the curriculum should be assessed with an instrument such as the TECA by an independent panel of experts (Figure 1).

Resource Implementation. The project could feasibly document the number of future and current technicians which enroll and completed the certificate program (Tables 1 and 2). In terms of an impact assessment, the project currently obtains feedback from participants. Since it was unclear from the project documents, we recommend that this information be collected systematically with a structured survey. Additionally as outlined in Table 4, we recommend that the project also implement a learning assessment and obtain feedback from employers.

Dissemination. The project stated one of its goals was to establish and mentor programs of study through collaborations and listed the partnering institutions which can be documented in Table 8.

Study Objective 3: Project's Current Evaluation Design and Recommendations

The available literature did not indicate that the project was able to demonstrate that change had taken place through either a comparison group or pre- and post-assessment. We recommend that the project administer pre- and post-learning assessments to demonstrate that learning has taken place.

Project Example # 2. Focus Area: Biotechnology

This biotechnology project seeks to improve the skills of future technicians and their educators. The project has created computer based teaching materials in the areas of biotechnology and nanotechnology with the underlying philosophy that understanding of phenomena at the atomic and molecular levels serves as a foundation from which students can better comprehend related phenomena at the macro level. The project offers both a database of educational activities and a computer platform in which students and teachers can use to create their own activities. The materials are intended to be used in science courses and with students training for occupations in the field. The target population for this project focuses on a diverse mixture of students, high schools, and community colleges in grades 10 – 14.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 2: Technicians with Improved Skills

Resource Development. The educational materials developed consist of computer-based lessons, models, and other activities intended to enhance student learning of phenomena at the atomic and molecular levels. The outputs the project collected related to "II. Resource Development," shown in Figure 1, includes recording the number of new tutorials, courses, or other materials created which can be documented in Table 5. We suggest that while it appears as if the project received input from industry and professionals in developing the resources, the project should consider applying the TECA instrument to conduct a formal quality review of the materials using an expert panel which can be documented in Table 6.

Resource Dissemination. Dissemination activities of the project include technical assistance workshops and online tutorials on how best to use the learning materials and implement them in the classroom. The following is a list of the dissemination-related outputs currently tracked by the project: number of workshops, online tutorials, community college educators participating in technical assistance, high school educators participating in technical assistance, website hits for each of the educational materials (used to determine successfulness of database and platform to create activities), presentations where collaborating consortium mentions the project, and hits on collaborating consortium websites that are related to the project. These outputs can be summarized in several indices for publication, transmission, and technical assistance activities in Table 8.

Resource Implementation. The project also implemented the material with partnering community colleges and school districts. The number of students with whom the materials were implemented ("received") can be documented in Table 1. The project also employed an objective student learning assessment (see Figure 1 and Table 4), although it was not specified whether the instrument was validated, which we recommend doing. Scores for skills assessments were collected for the pre- and post-tests, as well as a two to six month post-participation test which can also be documented in Table 4. Assessments of the feedback/reactions of the students to the materials were embedded into the computerized activities and can be document in Table 4. Input was also collected from educators regarding their perceptions of the materials through various means including in-person and telephone interviews, classroom observation, and online surveys which again can be documented in Table 4. Feedback from employers may not be realistic for the project to obtain, since the project is working with grades 10-14 and long-term follow-up of participants may be difficult and costly.

Study Objective 3: Project's Current Evaluation Design and Recommendations

ATE Goal 2: Technicians with Improved Skills

In terms of what was done to assess impacts, specifically student achievement, a within group pre- and multiple posttest design was utilized. As part of the pilot testing, the evaluation did compare pre- and post-test scores from student skills assessments, as well as with a post participation test. The evaluation could have included a comparison group who were educated in the standard or traditional manner. Assessment scores from students who participate in the project should be compared with students in similar classes not participating in the project, who have similar demographics and ideally are at the same school. Thus, ideally an equivalent group design with statistical control for observed baseline characteristics would be created. The design might also have included a longer-term follow-up and additional longer-term output measures, such as whether the student took additional STEM-related courses and grades of future STEM courses. The evaluation should also operationalize what is meant by stating that the program targets a diverse population and collect corresponding data to determine success in reaching that objective. The terms used in the evaluation report are too vague and do not allow for evaluation of the project's success in terms of this objective. For example, the evaluation report only mentioned targeting students with "diverse backgrounds" and that schools that were chosen to participate were from a "large distribution of geographical areas." It is also suggested that the technical assistance provided for the dissemination of the educational resources be reviewed by an expert panel or participants to assess quality and utilization of the resources such as the NRCCTE technical assistance instrument included in Appendix 3.

Project Example #3. Focus Area: Chemical and Process Technology

The overall goal of the chemical and process technology project is to attract underrepresented racial and ethnic groups to careers in pharmaceutical and chemistry industries. The project has developed an associate degree program which includes an internship and outreach activities within a local high school and professional development for both secondary and post-secondary educators.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increase Number of STEM Technicians

Resource Development. The project created an associate degree in pharmaceutical manufacturing which includes an internship which can be documented in Table 5. We recommend that the curriculum for this new degree be examined by an independent expert panel using a standardized instrument such as the TECA (see Table 6 & Appendix 2). Additionally, this is also recommended for the existing chemistry curriculum and project outreach activities.

Resource Implementation. The project tracked the number of enrolled chemistry majors since the beginning of the project. We also suggest tracking the number of students which enrolled in the pharmaceutical associate degree program and those which graduate from the new degree program and other chemistry programs (for both the general and target populations) which can be documented in Table 1. We also recommend that an impact assessment of the existing and newly implemented curriculum be evaluated utilizing a student learning assessment, feedback from students and educators, and feedback from employers participating in the internship program (Table 4). The project also conducts outreach activities within a local high school which can be documented in Table 3. We suggest that the project also assess the impact of these outreach activities in terms of interest in STEM careers as outlined in Appendix 1. If possible, students should be followed-up to assess if behavioral changes have been made.

ATE Goal 3: Educators with Improved STEM Preparation and Skills

Resource Development. The project created and provides professional development to secondary and post-secondary educators. We recommend that the professional development resource be evaluated by an independent expert panel with a standardized instrument.

Resource Implementation. We suggest that the project track the number of educators who participate in and complete professional development activities (Table 9). Further, we suggest that the project implement pre- and post-test learning assessments for educators and students, obtain feedback from participants directly after the professional development, and conduct follow-up interviews or surveys to see if there have been changes in classroom practices (Table 10 and Appendix 4).

Study Objective 3: Project's Current Evaluation Design and Recommendations

The project needs to increase its data collection and evaluation efforts to assess the quality of the produced materials and to assess the impact of the project. Pre- and post-learning assessments are recommended for both the students and educators to document if learning has taken place. It is also recommended that the impact assessment for the outreach activities be administered to students before and after the activity to see if any impact in terms of interest in STEM careers or behavior has taken place.

Project Example #4. Focus Area: Energy Technology

This energy technology project seeks to improve the skills of technicians by providing services to develop middle and high school students' science and math skills. To accomplish this goal, the project created education modules focused on electric power production and transmission and provided technical assistance to educators to help them incorporate the new material into their lesson plans. The project also seeks to raise career awareness in nuclear and energy medicine through interventions intended to improve skill sets such as a science and technology reading program.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 2: Improved STEM Technician Preparation Skills

Resource Development. The project developed modules with examples from electric power production and transmission to improve students' understanding of math and science concepts which can be documented in Table 5. While these modules were developed with input from industry and educators, we recommend that an independent expert panel validate the resources with an instrument such as the TECA (see Table 6 & Appendix 2). The project also created skill building/outreach awareness activities such as a summer career camp and science and technology reading program which can be documented in Table 5. Again, we recommend that an independent expert panel be conducted using a validated instrument such as the TECA to evaluate these newly created resources (See Tables 6 and Appendix 2).

Resource Implementation. The project tracked the number of students who participated in various activities (e.g., nuclear support technologies program, STEM modules, summer career camp, paid summer internship, science and technology reading program) which can be documented in Table 1. We recommend that an impact assessment of the existing and newly implemented modules be evaluated utilizing a student learning assessment, feedback from students and educators, and feedback from employers participating in the internship program (see Table 4). The project also assessed high school students' technical skills against industry standards, we suggest that this be done with a cohort of students from before the project was implemented and with another cohort from after the project was implemented. We also suggest that an impact checklist for the outreach activities be implemented to assess any changes in interest in STEM careers and behavioral impacts (the latter requires follow-up not just a survey) (see Table 7 and Appendix 1).

Dissemination. The project also provided educators with technical assistance to help them integrate the new modules within their existing curriculum which we recommend obtaining systematic feedback on through surveys or interviews to assess the quality and impact of the technical assistance (see Tables 7 and 8 & Appendix 3).

Study Objective 3: Project's Current Evaluation Design and Recommendations

The project needs to increase its data collection and evaluation efforts to assess the quality of the resources produced and to assess the impact of the project. Pre- and post-learning assessments are recommended to document if student learning has taken place. It is also recommended that the impact assessment for the outreach activities be administered to students before and after the activity to see if any impact in terms of interest in STEM careers or behavior has taken place.

Project Example #5. Focus Area: Engineering Technology

The overall goal of the engineering technology project is to help secondary school teachers and college faculty build their knowledge of photonics technology through a web-based, interactive, semester-long course, and which is intended to equip them to "apply their new knowledge to develop and implement more effective instructional practices at both the classroom and program levels." The project also sponsored 1-2 week internships for the educators with companies, colleges and universities.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 3: STEM educators with improved skills.

Resource Development. The project can tabulate the education resources developed in Table 11, which includes the web-based course, the internship program, software (CD-ROMS), and 2-day workshops. Although the course was developed with expert input, no provision was made to do a quality assessment of the final product with an instrument such as the TECA administered by an independent panel of experts, thus this is recommended.

Resource Implementation. This can be documented in Table 9; the workshops, course, and internships were provided to two cohorts of secondary school teachers and college faculty. Impact measures can be documented in Table 10. The project conducted pre- and post-test of educators' content knowledge and obtained feedback from the learners through analysis of web postings during the course. It would be useful to also obtain such feedback, i.e., reactions to the course, in a structured survey. Data regarding intended and actual changes in classroom practice and changes in student learning were not obtained. The evaluation of the project did, however, obtain detailed and useful data on learner interactions with other learners and the instructor during the course, as well as changes on theoretically important constructs such as self-regulated learning and critical thinking.

Dissemination. An objective of the course is to change the way photonics is taught in high school and college and some attempts are made to see whether participants are incorporating what they learned into practice. It may be possible for the project to enter some data in Table 12, e.g., the project reports that one participant developed a photonics course that has been implemented in all technical school in one state. Also the supplementary laboratory kit has been made available for sale to high schools which can also be documented in Table 12.

Study Objective 3: Project's Current Evaluation Design and Recommendations

The web-based course was evaluated by pre- and post-knowledge and other assessments of participants. There was also attention paid to determining how the course results compared with those of the prior classroom-based versions by comparing changes in pre/post content knowledge between the classroom and web-based courses. The classroom data were obtained prior to the web-based course being available. While a randomized study would have been superior, this is a credible quasi-experimental approach. However, the study is only briefly summarized; a more detailed report would be helpful.

Project Example #6. Focus Area: Geographic Information Systems and Geospatial Technology

The overall goal of the geographic information systems and geospatial technology project is to encourage middle and high school students, especially females and individuals from rural school districts, to consider careers employing geospatial information technologies (GIS) through teacher training and career awareness. The project improves the skills of secondary school science educators by teaching them how to use and incorporate GIS into the classroom. The project developed a model for professional development focusing on building competency using geospatial applications in science teaching. The profession development is organized into a summer institute with Saturday workshops, interactive web-based seminars, and on-going technical and curricular assistance. The project also developed a graduate level course titled GIS in Schools which provides secondary school teachers with exposure to using GIS technologies to teach science.

Study Objective 2: Project's Current Measured Outputs and Recommendations.

ATE Goal 3: STEM educators with improved skills.

Resource Development. The project currently tracks the different types of professional development resources offered (Table 11) which include the online model and graduate course. It was not clear whether the professional development resources were developed with input from external experts, but even if this was done, we recommend that the final products be assessed with an instrument such as the TECA implemented by an independent panel of experts (Appendix 2).

Resource Implementation. The project currently tracks the number of educators participating in the professional development events (Table 9) and teacher retention in the program. In terms of impact (Table 10), the evaluation report counted the number of students that benefit from the teacher training and alluded to having gathered data from educators on changes in classroom practice, although we recommend that a formal and structured survey or interview be implemented. Otherwise, the evaluation report did not mention any other impact measures; thus, we suggest that the project obtain feedback from professionals, administer a pre- and post-learning assessment, and gather data on changes in student learning from those courses where the curriculum was revised.

Study Objective 3: Project's Current Evaluation Design and Recommendations

The online professional development course, along with the graduate course should administer pre- and post-learning assessments to educators and if possible, students of the participating educators, to determine if increased learning occurred in the courses where the curriculum was revised. The ultimate goal of the professional development is to increase the number of students entering STEM careers that use this technology which would be difficult to do without extensive targeted research addressing this question, for instance, tracking secondary students over the long-term and comparing those who were taught by the participating teacher versus students not exposed to such teachers.

Project Example #7. Focus Area: Information Assurance, Secure Logistics & Forensics Technology

This information assurance, secure logistics, and forensic technology project strengthens the science and technology of one college's law enforcement program to improve the detection, defense, and diagnosis of homeland security threats. The project works to improve technicians' skills by developing new associate degree programs and disseminating that work by providing technical assistance to educators so that they are able to teach the new curriculum.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increase Number of STEM Technicians

Resource Development. The project developed curriculum and educational materials for three associate degree programs which can be documented in Tables 1 and 2. In addition to an investigative crime certificate program, some of the courses developed are available online and are intended to serve as continuing education for current technicians as can be documented in Table 2. The project tracks the number of courses, certificate, and degree programs created which can be tabulated in Table 5. While not explicit, it is assumed that the new curriculum, materials, and degree programs were assessed by an expert panel since they were reviewed by multiple agencies charged with approving such materials; however, we do recommend that any expert panel utilize a systematic instrument such as the TECA (Appendix 2).

Resource Implementation. The project tracks the number of students enrolled in relevant courses and retention (Tables 1 and 2) and student demographics as they relate to the targeted population (e.g., sex, race, and age). The project also tracked participating student's grade level (i.e., high school, college freshman, sophomore, current technician, etc.) and grades earned per course. We recommend that the project also implement a learning assessment, and receive feedback from participants, educators, and employers (Table 4). The project did conduct some case studies which included feedback from participants but the project did not implement any structured surveys; however, the evaluation report stated that the project plans to begin administering structured surveys within the next year. The project also plans to interview a sample of the survey respondents in order to obtain more in-depth qualitative information.

Dissemination. The project held a two-day technical assistance workshop to introduce educators to the new courses. The project tracked the number of participants and gathered feedback from educators (Table 8). We suggest that the project also follow-up with educators to learn if they are implementing the materials and how many students may be impacted by their participation in the technical assistance workshop (Table 8 and Appendix 3).

Study Objective 3: Project's Current Evaluation Design and Recommendations

We recommend that students be given a pre- and post-learning assessment to determine project impact. It is especially important to administer pre-tests since it is likely that the current technicians already have some knowledge of the materials being presented; thus, without a pre-test learning as a result of the new course and/or degree programs cannot be assumed.

Project Example #8. Focus Area: Information Technology

The overall goal of this information technology project is to increase the number of women and other underrepresented groups in computers science and related fields. The project is an outreach project which seeks to increase the number of technicians from underrepresented groups through recruitment, retention, mentoring, and tuition reimbursement. Additionally, the program also provides mathematics training since research has shown that one of the many reasons women do not pursue careers in computer science is due to a lack of fundamental math skills.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increase Number of STEM Technicians

Resource Implementation. The project currently tracks the number of students that participate in the programs various activities (Table 3). Additionally, the project tracks participant demographic information and compares that with demographic statistics of the community college overall. The project also implements a survey after the mathematics workshops. We recommend that in conjunction with the math workshops that the project also administer pre- and post-learning assessments (Table 4). The project also may want to look at math grades and number of math courses taken for the target population before and after the project. The project followed-up with participants and recorded the number transferring to four-year institutions and/or received an associate's degree (Appendix 1) and compared the transfer rate with that of the community college's overall.

Dissemination. The outreach project tracks how students were recruited, number of individuals information was sent to, response rate, and number that ultimately applied (Table 8). One recommendation is that the project should present information on the number of applications for computer science programs completed by the target population before and after the project. Additionally, while the project reported the number of women in the computer science program in the past, they should also compare these rates with current enrollment rates. If possible, it would be helpful if the project could follow-up with individuals who indicated interest in the program but did not enroll to see if their educational achievement differs with those participating in the outreach project or in terms of demographic or motivational characteristics.

Study Objective 3: Project's Current Evaluation Design and Recommendations

Overall the project needs to gather more data to assess the counterfactual. For example, pre- and post-learning assessments should be administered along with the math workshops. As stated above the project also needs to present current statistics on enrollment, applications, etc. in comparison to those same statistics before the project was implemented.

Project Example #9. Focus Area: Manufacturing Technology

This manufacturing technology project seeks to improve the skills of secondary and post-secondary educators by providing them with externships, technical assistance, and professional development. Educators first complete an externship, followed by independent creation of work-based lessons for students, and then attend professional development sessions on specific technology and industry practices. The industry partnerships created by this project also led to opportunities for students in terms of guest lecturers, tours of companies, job shadowing, and work-study positions; since improving the skills of educators is the primary focus of this project, that will be the focus of this summary, although it is important to note the potentially positive side effects of the project.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 3: STEM educators with improved skills.

Resource Development. The project created an externship and professional development opportunities which can be tabulated in Table 11. It is recommended that these resources be assessed by an independent panel of experts with an instrument such as the TECA (Appendix 2).

Resource Implementation. The project currently tracks the number of educators and companies participating in externships and number of attendees at professional development workshops, all of which can be documented in Table 9. Impact measures can be documented in Table 10. Recommended impact measures include educator learning assessments, feedback from participants, facilitators, and industry partners, documenting potential changes in classroom practices and student learning. Learning assessments for educators and students should be administered before the implementation of the project and after. If this is not possible, then it is recommended that comparison groups be used to assess the counterfactual.

Dissemination. The project currently tracks the number of attendees at technical assistance workshops, all of which can be documented in Table 12. Impact measures can be documented in Table 10, to assess whether changes in classroom practice and student knowledge and behavior have occurred.

Study Objective 3: Project's Current Evaluation Design and Recommendations

It is recommended that the project attempt to assess the counterfactual which is what would have happened in the absence of the project in terms of educators' skills. This can be done with pre- and post-learning assessments for both educators and students. If this cannot be done then the evaluators should gather data from a comparison group. Additionally, it would be helpful to survey or conduct observations both before and after the project to assess changes in classroom practices.

Project Example #10. Focus Area: Pathways to Technology

This pathway to technology outreach project serves academically underprepared and underrepresented young adults in several categories: those who do not intend to go to college or return to college, or are in college but at risk of not doing well or completing their degree. The focus is on generating interest in and preparing them for STEM programs. The project provides students with a semester of courses to help prepare them for success in community college in terms of literacy, digital management, basic software instruction and career exploration, in addition to self-exploration and self-improvement. The project also helps students gain momentum towards obtaining college credits which is thought to be important because the project has found that obtaining at least 20 credits in the first year of college to be a critical predictor of whether or not a student will obtain a degree.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increased Number of Technicians in Workforce

Resource Development. The project created a STEM-oriented outreach program for secondary and post-secondary students, which can be documented in Table 5. This consisted of two for-credit courses which are intended to help prepare young adults for community college. The courses should not be listed separately in Table 5 since together they constitute an "outreach program." (Such details on the program can always be submitted as supplementary information, similar in format to the ATE Projects Impact report (Patton, 2008b). It is recommended that the curriculum for this project be assessed with a validated instrument such as the TECA by an independent expert panel (Table 6 and Appendix 2).

Resource Implementation. The purpose of the student outreach is to encourage secondary school and/or college students to become engaged in STEM education and ultimately to enter a STEM career. As part of the program, students either earn course credits toward an associate degree or transfer credits. The program tracks participation, completion, and retention within the program, all of which can be documented in Table 3. The project proposed to gather data on many of the impact measures listed in Appendix 1's outreach program impact checklist, although we recommend that students completing the program be followed-up to with to determine post-program academic status and accomplishments, such as whether they continue to enroll in and complete STEM courses, enroll in a STEM program, and graduate with a STEM degree, as outlined in Appendix 1. Since the outreach program also targets underrepresented groups to engage in STEM careers, the project should specify some quantitative objectives in terms of target group participation and impact. Thus, a separate version of Table 1 could be sued to document STEM education engagement for underrepresented groups.

Dissemination. The project also engages in dissemination of the outreach program which can be documented in Table 8. The project held week-long technical assistance workshops to disseminate the philosophy, curriculum, and methods of the project to other community colleges throughout the state. Additionally, the project also disseminates "curriculum kits" and provides half-day technical assistance workshops to train faculty on how to use the materials. Currently, the project tracks number of workshops conducted, and number of faculty/administrators and community colleges that participate which can be documented in Table 8. We recommend that post-dissemination impacts, such as those outlined in Appendix 3, be tracked as well.

ATE Goal 3: STEM Educators with Improved Skills

The objective of offering technical assistance workshops was not only to disseminate the outreach program model to other community colleges, but also to train community college faculty to apply the philosophy and principles developed for the program in their regular course curricula. The number of educators conceptualized as participating in professional development training may be documented in Table 9. The project also measured impact of the technical assistance by conducting interviews with faculty after the trainings to assess if changes were made in their classroom practice (see Appendix 3); a major result reported by the project was "most of the faculty members had integrated the [outreach program] curriculum, tools and principles into their [regular] courses."

Study Objective 3: Project's Current Evaluation Design and Recommendations

The project's main evaluation study compared outreach impact measures (see above) and course credits earned between several cohorts of outreach program enrollees and a comparison group of demographically similar students at the same community college (a non-equivalent group design with statistical control for observed baseline characteristics) for two semesters after participation in the outreach program. The evaluation was complicated by the fact that the outreach program changed over time, resulting in original and current versions, so that comparisons of impact with the intervention and non-intervention group were conducted separately for the two versions of the program. The main flaw of the evaluation design is that it was highly vulnerable to student self-selection effects in that only a small percentage of students who initially expressed interest in the program and received information actually enrolled. It is unclear whether those not enrolling were eligible or whether they would have been accepted if they applied. This makes it difficult to determine what an appropriate comparison should be to calculate the magnitude of program effect on outputs.

Further, the evaluation design was weakened by the lack of certain pertinent baseline measures such as degree of motivation for academic success and social/family support for college. Such measures might have been incorporated in the data collection and/or analysis for the outreach program enrollees, which could have allowed determination of whether these variables predict outcomes, at least for the outreach program group. (Obtaining such measures for the comparison group did not appear feasible.) The design might also have included a longer-term follow-up and additional longer-term output measures, such as whether the student took additional STEM-related courses, enrolled in a STEM degree or certificate program, and graduated from a STEM program. This would have provided more direct evidence of a probable effect on producing more technicians. The analysis could also have examined differences in the presence of underrepresented individuals between the program group and the comparison group, to answer the question of whether the program increased participation and success of underrepresented students.

This program is likely to have had more qualified applicants than could be accepted for each program cohort. An alternative evaluation design could have been to offer to place qualified and sufficiently motivated students who could not be accepted on a wait list for one semester, but request their participation in an evaluation study; that would have allowed more valid determination of at least short-term program effects. Finally, it might have been helpful for the evaluator to provide details about the community colleges that participated in the technical assistance and what types of STEM or other degree programs the colleges wish to support with this outreach program.

Seven ATE Centers to Illustrate Study Objectives 2 and 3.

The examples are organized by the ATE goals that the centers are trying to achieve. If a specific ATE goal is not mentioned for a given center, that indicates we judged that goal as not relevant for that center.

Center Example #1. Focus Area: Advanced Manufacturing Technologies

This manufacturing center works towards increasing the number and improving the preparation skills of STEM technicians. The center works to increase the number of manufacturing technicians through a media campaign, educator technical assistance, and provides students with industry tours, robotics camps, and classroom presentations. The center seeks to improve the skills of students by improving and standardizing statewide manufacturing education.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increased Number of STEM Technicians

Resource Development. The center created various outreach resources including a media campaign, educator technical assistance, industry tours, robotics camps, and classroom presentations to increase the number of STEM technicians. It is recommended that the quality of these resources be assessed using a validated instrument by an independent panel of experts which can be documented in Table 7.

Dissemination of Education/Outreach Resources: The center provides technical assistance to educators to promote manufacturing careers through implementation of the center's educational resources, which can be documented in Table 8. Currently, the center records the number of hours spent in technical assistance, total number of participants, and participant feedback. It is also recommended that the center track outputs related to increased interest and behavioral changes that result from the technical assistance, which can be documented in the Technical Assistance Evaluation form (Appendix 3).

Resource Implementation. It is recommended that the impact of the outreach resources should be assessed with an instrument such as the Outreach Program Impact Checklist (Appendix 1). According to this checklist, a student survey can be administered to gauge student interest in STEM careers and follow-up can be conducted to assess behavioral impacts such as whether students enroll in STEM related college programs, both of which can be documented in Table 3. The center currently tracks student interest in STEM careers via surveys administered at the end of industry tours, which attempt to assess student's interest before and after the tour. Additionally, the center also tracks some behavioral impact data such as college enrollment and degrees and certificates awarded per year (Table 1). Thus, it should be feasible for the center to collect the additional follow-up impact indicators as specified in Appendix 1.

ATE Goal 2: Improve STEM Technician Preparation Skills

Resource Development. To improve the skills of STEM technicians, the center developed degree and certificate programs for community colleges and a secondary school curriculum framework. It is recommended that the Center have an independent expert panel assess the newly developed framework and degree and certificate programs with a validated instrument such as the TECA (see Table 6 and Appendix 2).

Dissemination of Education/Outreach Resources: The center developed a statewide articulation agreement, in addition to degree, certificate, and educational standards with statewide applicability. The center currently tracks the percentage of high school and community colleges who adopt these resources which can be tracked in Table 8.

Resource Implementation. It is recommended that the center assess the impact of the resources to improve STEM technician preparation skills. As outlined in Table 4, we recommend that the center conduct pre- and post-student learning assessments, receive feedback from student and educators, and if possible receive feedback from employers. It is likely the center will be able to do latter since they already receive feedback from industry regarding the industry tours.

Study Objective 3: Center's Current Evaluation Design and Recommendations

While the center is doing fairly well in terms of tracking impacts related to outreach activities, more needs to be done to assess the impact of resources intended to improve the skills of STEM technicians. As previously mentioned, pre- and post- learning assessments would help to determine if learning has occurred. Additionally, we recommend that the center implement the learning assessments with a comparison group. For example, before new curriculum is implemented the last cohort who utilized the old curriculum could be given a learning assessment and then those tests could be compared with those of students who are exposed to the new curriculum.

Center Example #2. Focus Area: Agricultural & Environmental Technologies

This sustainable resource center works to improve the skills of STEM technicians through development, marketing, and dissemination of educational resources.

Study Objective 2: Center's Current Measured Outputs and Recommendations

ATE Goal 2: Improve STEM Technician Preparation Skills

Resource Development. To improve the skills of STEM technicians, the center developed instructional modules and accompanying technical assistance workshops for educators. The center reported that an external panel of experts reviewed the instructional modules, although it was not specified whether this panel utilized a validated instrument such as the TECA (see Table 6 & Appendix 2).

Dissemination of Education/Outreach Resources: The center distributes the educational resources via their website and direct mail and currently, tracks the number of materials that are distributed which can be documented in Table 8. The center also obtains feedback from individuals who request the educational materials. The center provides technical assistance to educators who plan to use educational resources developed by the center. Currently, the center obtains feedback from educators regarding the logistics, presenter, activities, and pre-technical assistance information. Additionally, we recommend that the center track information related to changes in student interests and behavior changes that occur due to the technical assistance.

Resource Implementation. The center developed a student questionnaire that assesses students' understanding of the scientific process and is administered pre- and post-test to assess whether learning has occurred which can be documented in Table 4. It was not stated whether this instrument was validated, which is recommended. Additionally, it is recommended that the center also use learning assessments specific to the individual courses to assess the full spectrum of knowledge and skills the students are intended to leave the courses with, not just one that focuses on the scientific process.

Study Objective 3: Project's Current Evaluation Design and Recommendations

In order to assess learning impacts, the center needs to utilize course specific student learning assessments, rather than just their current instrument that solely focuses on understanding the scientific process. Additionally, it would be helpful if the center administered these learning assessments to classes that are not utilizing the center's materials to see if there is any difference in learning achievement,

Center Example #3. Focus Area: Biotechnology, Chemical & Process Technologies

This biotechnology center seeks to develop a world-class biomanufacturing workforce to improve quality of life and strives to do this through the dissemination of curriculum and instructional materials based on industry skill standards and by mentoring biomanufacturing programs at secondary and post-secondary educational institutions.

Study Objective 2: Center's Current Measured Outputs and Recommendations

Goal 2: Technicians with Improved Skills

Resource Development. The biotechnology curriculum was developed by the center in collaboration with industry, which can be documented in Table 5. While it appears as if the center received input from industry on the development of the curriculum, the center should consider applying the TECA instrument (Appendix 2) to conduct a formal review of the quality of the materials using an expert panel, which can be documented in Table 6.

Resource Dissemination. Dissemination activities of the center include distribution of a biomanufacturing curriculum and the provision of technical assistance activities to support and enhance biomanufacturing education. Currently the center tracks the number of website visitors by webpage and number of educators by institution type that attend the technical assistance events, both of which can be documented in Table 8. Additionally, the center is tracking the number of students impacted by the technical assistance in terms of number of students enrolled, graduated, and number of graduates employed at biomanufacturing companies, which can be documented in Tables 1 and 4.

Resource Implementation. The center is not involved in the implementation of materials only the development and dissemination.

Study Objective 3: Center's Current Evaluation Design and Recommendations

Since so much of the center's work revolves around dissemination of the biomanufacturing curriculum, the curriculum should be reviewed with a standardized instrument such as the TECA by an independent panel of experts to assure its quality (Appendix 2). The center should systematically seek input from educational institutions which adopt the curriculum to learn ways it can be improved in the future and to learn if and how it is being implemented.

Center Example #4. Focus Area: Engineering Technologies

This engineering focused center seeks to increase the number of technicians in the optics and photonics related workforce and improve the skills of those technicians and their educators. The Center provides support to secondary and post-secondary programs that focus on lasers, optics, and photonics technology or technologies enabled by optics and photonics. The Center supports these programs through curriculum, assessment, faculty development, recruitment, support for institutional reform, and a clearinghouse of instructional materials. The Center seeks to increase the number of technicians through recruitment of students into laser, optics, and/or photonics technology-related programs. Services to improve technicians' skills are provided to future and current technicians through online courses and dissemination of educational materials.

Study Objective 2: Center's Current Measured Outputs and Recommendations

ATE Goal 1: Increased Number of Technicians in Workforce

Resource Development. The modules and program guides can be counted separately as "materials created" or "upgraded" in Table 5; the materials can be identified by name and purpose in a supplementary document. It is recommended that revised (upgraded) and new (created) educational modules and program planning guides be assessed by an expert panel (such as the Center's Visiting Committee) using a validated instrument such as the TECA (Table 6 and Appendix 2).

Resource Dissemination. The Center currently tracks the following dissemination related outputs: number of workshops conducted, workshop attendees, website visits, meetings/conference sessions which mention work of Center and presentations by partner organizations which mention work of Center which can be documented in Table 8. The Center proposes to count the number of organizations planning to implement the resources and the number of partnering organizations that have implemented the resources. It is also suggested that that the Center report on the projected number of students who were impacted by the adoption of these materials and changes in interest and behavior that occurred because of the outreach activities see the Outreach Program Impact Checklist (Appendix 1). Clearly, this would require a follow-up with participants in the dissemination activities above, which may or may not be realistic depending on the Center's funding.

Resource Implementation. Outputs currently tracked related to implementation include numbers on enrollment and graduation (Table 1), and number of summer learning institutes conducted for students and educators (Table 3). The purpose of the summer learning institutes is to increase number of technicians as well as to improve the skill sets of students and educators. Table 1, "E" can be used to document the numbers of students who are exposed to the materials, including those exposed in a variety of courses and programs leading to graduation with a STEM degree.

It is recommended that the Center report the number of individuals who attend and completed the secondary school summer institutes and dual enrollment programs in the partner colleges (Table 1). Summer institutes would best be listed as a "course" in Table 1, since the term "program" is defined as a course sequence that leads to a degree. It is also recommended that the Center perform formal impact assessments of the implementation activities, to be documented in Table 4. This could be done on a sampling basis if the implementation activities are extensive, as they appear to be. The major impact, however, appears to be graduation rates from the technician degree programs, which can be documented in Table 1. Data on the number of organizations planning to implement and actually implementing the resources can be reported as part of an "impact-utilization" in Table 8. Since there is no existing standardized measure, the Center would need to report such data using its own definitions.

ATE Goal 2: Technicians with Improved Skills.

Resource Development. The project created on online course, which can be documented in Table 5. It is recommended that this course be assessed using a validated instrument such as the TECA by an independent expert panel (Table 6 and Appendix 2).

Resource Implementation. The center currently tracks the number of current technicians enrolling in and completing the online courses, which can be documented in Table 2. The Center is collecting feedback from participants that are using their materials, but apparently only in a qualitative and selective manner. It is recommended that the feedback be collected on standardized surveys with representative samples of participants, which could be reported in Table 4. Further, to assess whether the use of the resources results in technicians improving their skills, the Center's evaluation team should consider conducting a learning assessment with a comparison group of students who are not exposed to the materials disseminated by the Center.

Study Objective 3: Center's Current Evaluation Design and Recommendations

ATE Goal 1: Increased Number of Technicians in Workforce

The quality of the educational resources developed should be assessed by an independent panel of experts using a validated instrument such as the TECA (Table 6 and Appendix 2). When the course is implemented, feedback should be collected from technicians, students, and educators, which can be documented in Table 4. Additionally, enrollment and graduation rates before and after these newly developed/revised resources are implemented should be tracked (Table 1). The Center is been tracking whether its initiatives are resulting in higher numbers of laser technicians graduating and entering the workforce nationally since the Center has been in operation. The Center is also comparing these numbers with estimates of need for more such technicians in the workforce.

Center Example #5. Focus Area: Information and Security Technologies

The information and security technologies center seeks to help students, current technicians, and educators achieve their academic and professional goals within the field of cyber security. The organization has a three-pronged mission in that it works to (1) develop and disseminate curricula for two-year institutions, (2) offers professional development to help educators build programs, and (3) design and implement workforce development programs. The Center attempts to increase the number of technicians in the workforce through recruitment of new students, including students from underrepresented populations. The Center also works to improve the skills of both future and current technicians through events, courses and degree programs, in addition to the facilitation of articulation agreements to help students to obtain certification and move into degree programs. The Center also seeks to improve the skills of educators through various professional development activities.

Study Objective 2: Center's Current Measured Outputs and Recommendations

ATE Goal 1: Increased Number of Technicians in Workforce

Resource Development. The center attempts to increase the number of technicians in the workforce through outreach to students, including students from underrepresented populations. The outreach program can be documented Table 5 and changes in interest level and behavior can be documented in the Outreach Program Impact Checklist located in Appendix 1.

Resource Dissemination. The Center has also worked to bring its existing computer security certification programs to additional academic institutions in Table 5 as "expanded" educational programs.

Resource Implementation. The Center collects data related to implementation including information on enrollment for both new and current technicians (Tables 1 and 2) in the Center's computer security curricula at multiple colleges nationally and the number of students participating in outreach programming (Table 3). We suggest that some effort also be made to estimate the impact of the outreach programs by documenting the number of students that are interested, have enrolled, or intend to enroll in cyber security certification programs after learning about the Center through presentations (Table 3 and Appendix 1). Similarly, the impact of the expanded programs in other colleges could be assessed by collecting information relevant to Table 4.

ATE Goal 2: Technicians with Improved Skills

Resource Development. The center works to improve the skills of both future and current technicians through the development of new curricula and the promotion of certificate and degree programs, in addition to the facilitation of articulation agreements to help students obtain certification and move into degree programs. The center upgraded (revised) existing curriculum and created various educational resources to promote student learning. The numbers of upgraded curricula can be documented in Table 5. The center did not collect data related to validating the quality of upgraded resources; thus, it is suggested that the TECA be utilized to assess the upgraded resources (Table 6 and Appendix 2).

Resource Dissemination. The center can track data related to resource dissemination of curriculum and outreach activities in Table 8.

ATE Goal 3: STEM Educators with Improved Skills

Resource Development. The Center seeks to increase the number of educators with the knowledge base to teach computer security courses, provides three different professional development activities to educators, and provides workplace professional development, which can be documented in Table 11. It is also recommended that the professional development be assessed by an independent of experts using a validated instrument such as the TECA (Table 6 and Appendix 2).

Resource Implementation. Currently data on the number of educators participating in the trainings, three professional development activities for educators, and workforce professional development is tracked (Table 9), although apparently no data are collected related to learning assessments, feedback, changes in classroom practices, or changes in student learning all of which can be documented in Table 10. Additionally, to assess the quality of the professional development it is recommended that feedback be collected systematically using an instrument such as the NRCCTE Professional Development survey in Appendix 4.

Study Objective 3: Center's Current Evaluation Design and Recommendations

The Center should clearly define the underrepresented populations that it seeks to recruit and document the strategies to reach out to these underrepresented populations so that the impact of these strategies can be assessed. From the evaluation report, it is not clear that any extra effort was made to recruit individuals from underrepresented populations, despite the fact that the enrollment numbers for underrepresented individuals was collected at the partner colleges. Further, if possible the center should compare enrollment statistics with partner colleges that implement strategies to recruit underrepresented groups with those that do not have such strategies, to assess impact. If enrollments increase in general, it is possible that underrepresented individuals would also increase, although this is not conclusive evidence that the Center's efforts had any impact in that respect.

The Center should administer pre- and post-tests to students to determine whether the revised materials influence learning, as well as collecting feedback from students, technicians, and educators and holding an expert panel review with a validated instrument. The Center already tracks the enrollment and number of degrees/certificates obtained at each partner institution and thus should be able to track the potential impact of the articulation agreements. The Center should also administer pre- and post-tests to educators to determine whether the professional development activities impact learning, as well as collecting feedback from the educators (Table 10) and conducting an expert panel review of the professional development curricula with a validated instrument (Table 11).

Center Example #6: Focus Area: Learning & Evaluation

This learning and evaluation center works to improve the skills and increase the number and diversity of technicians in the field. The center has developed and implemented two curricula and provides technical assistance to help educators implement the curricula. The center works to increase the number and diversity of technicians through recruitment and the provision of paid internships.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 1: Increased Number of STEM Technicians

Resource Development. The center seeks to increase the number of technicians in the field by developing recruiting methods, paid internships, and improving curriculum to enhance retention, which can be documented in Table 5. We suggest that these resources be assessed by an independent panel of experts using a validated instrument such as the TECA (Appendix 2), the results of which can be documented in Table 6.

Resource Dissemination. The center disseminates resources to increase recruitment of technicians into the field. They currently track the number of materials disseminated that can be documented in Table 8. We also recommend that the center try to collect more data related to dissemination such as those outputs listed in the Outreach Program Impact Checklist (Appendix 1).

Resource Implementation. The center implements recruiting methods specifically targeted at underrepresented populations within the field. The center tracks enrollment rates of different populations (Table 1) and compares that with the rates of participation of underrepresented populations in similar educational programs.

ATE Goal 2: Improve STEM Technician Preparation Skills

Resource Development. The center created and implemented two curriculum components that can be documented Table 5. While the curriculum has been pilot tested, the center documents did not clarify if the curriculum has been reviewed by an expert panel with a validated instrument such as the TECA, which we recommend (see Appendix 2).

Resource Dissemination: The center provides technical assistance to educators to promote implementation of the center's educational resources, which can be documented in Table 8. From the available center documents it does not appear as if the center is tracking outputs related to dissemination such as those located in the Outreach Program Impact Checklist (Appendix 1, which is recommended. In addition, it is unclear from the center documents whether they systematically collected feedback from educators during or after the pilot phase regarding the curriculum for future improvements.

Resource Implementation. The center has implemented two new curriculums. The center currently tracks outputs related to enrollment and graduation, both of which can be documented in Table 1. One strength of the center's evaluation is that it compares enrollment and graduation rates of center participants with a comparison group of non-participants. The center also tracks how long it takes students to complete degree programs. Part of the center's mission is to increase diversity in the field and currently track data on enrollment and graduation of students for underrepresented populations, which can be tracked in Table 1. One way the center tracks ATE student progress is by surveying teachers and asks them to report on their perceptions regarding the skill levels of ATE students versus non-ATE students. We suggest that this comparison be made using pre- and post-learning assessments for each group of students rather than on relying on reports of teacher's impressions to improve accuracy and reliability.

Study Objective 3: Center's Current Evaluation Design and Recommendations

Overall, the center is doing well in terms of tracking outputs. The center could improve in terms of evidence of learning through the administration of learning assessments and not just relying on teacher perceptions of the skills of ATE students versus non-ATE students. We recommend that the center implement the learning assessments with a comparison group.

Center Example # 7. Focus Area: Micro and Nanotechnologies

This micro and nanotechnologies center focuses on improving technician education in semiconductor manufacturing, automation, electronics, alternative and renewable energies, and related fields. The center works to improve the skills of technicians by improving the skills of STEM educators. The center develops and disseminates web-based educational resources so that educators can provide students with information on the most up-to-date technologies and practices within the field.

Study Objective 2: Project's Current Measured Outputs and Recommendations

ATE Goal 2: Improve STEM Technician Preparation Skills

Resource Development. The center developed a clearinghouse for online classroom-ready technology resources, web seminar series, and virtual community with forums, which can be documented in Table 5. If feasible, it is recommended that all the resources in the clearinghouse be assessed for quality with a validated instrument such as the TECA (Appendix 2).

Resource Dissemination: The center disseminates materials through their clearinghouse that can be documented in Table 8. The center polls educators on how they access their resources and tracks how many actually implement the materials into their classrooms. It is also recommended that outreach activities be assessed using the Outreach Program Impact Checklist (Appendix 1) to assess changes in student interest and behavior as a result of any educational outreach activities.

Resource Implementation. The center currently tracks outputs such as the number of students who utilize their educational resources, which can be documented in Table 1. It is recommended that the center assess the impact of their educational resources through the collection of pre- and post-student learning assessments, feedback from student and educators, and if possible feedback from employers, all of which can be documented in Table 4.

Study Objective 3: Center's Current Evaluation Design and Recommendations

The center mainly focuses on development and dissemination of resources and should focus their evaluation efforts on determining the quality of the materials they are disseminating with a validated instrument such as the TECA (Appendix 2). Additionally, the center should focus on assessing the impact of these materials in terms of students impacted and changes that resulted from the dissemination of these resources such as those outlined in the Outreach Program Impact Checklist (Appendix 1).

Conclusions

The national ATE program is a highly diverse set of primarily community college-based project and center grantees who are dedicated to enhancing the technological workforce of the United States. The three central goals of the ATE program are stated succinctly in the federal funding announcement, but the particular strategies that grantees propose and utilize to achieve one or more of those central goals are highly varied. Nevertheless, there are commonalities in the outputs that are posited to demonstrably contribute to achieving ATE's central goals; such common outputs can be specified and potentially aggregated to yield outputs for the national ATE program as a whole.

This study has produced a draft framework for specifying common outputs believed to demonstrably contribute to achievement of the three ATE central goals. Numeric metrics have been suggested for measuring a range of outputs. However, numeric outputs have been subject to a wide range of interpretation. These include counts of educational and outreach resources that are developed, the numbers of students, current technicians and educators participating in the implementation of those resources and the number of students attaining certain educational milestones toward employment as technicians. The proposed framework, consisting of the figures and the tables in this report, narrows down and at partly standardizes the types of data collected across ATE projects and centers. This standardization will result in meaningful aggregation of output measures that will make it possible to better determine program effectiveness.

The more challenging aspect of the study was to identify metrics that could be used to assess the quality of STEM educational and outreach resources and their impact on students' and educators' learning and behavior. We expected that the science education, professional development and related fields would have assessment instruments that could be used or adapted for ATE evaluation purposes, but this proved not to be the case. One bright spot in that search is the Technical Education Curriculum Assessment (TECA) (Keiser et al., 2004), described previously, developed specifically for the ATE program. This can be considered an assessment instruments model for ATE program evaluation. (Each such effort would be a separate project over and above the current study.)

Technical assistance is a key activity of many ATE grantees in order to disseminate ATE educational and outreach resources to colleges and secondary schools nationwide. There is apparently no universally accepted instrument for measuring the impact of technical assistance. Similarly, although there is a considerable literature on training for professional development and Kirkpatrick's (1998) framework for evaluating such training is widely accepted (Guskey, 2000), we could not identify an actual instrument in these books or elsewhere that is generic enough to evaluate the impact of professional development in the ATE context. Consequently, we recommend adapting an instrument recently developed by our organization for the National Research Center for Career and Technical Education (Evaluation Center, 2010; Appendix 4).

There are unfortunately important "gaps" in the availability of instrumentation to measure the quality and impact of certain important ATE activities as indicated in the table layouts described in the narrative. The evaluation framework we have developed at least may be seen to have the merit of identifying the gaps more precisely. These questions arise – is it important to fill those gaps. If so, which ones? Should funding be made available by NSF to fill certain the gaps in instrumentation for evaluation?

In our view, a particularly under-examined topic is the impact evaluation of STEM outreach programs. This is a difficult topic because the hoped-for results of the outreach activities may be many years in the future, such as when an introduction to STEM careers in middle school is expected to increase enrollment in STEM programs in college. Depending on funding levels and available resources, it is difficult to determine if this is realistic. However, those who develop and implement outreach programs rarely know whether students even take the next step, i.e., selecting more mathematics and science electives in high school. We have drafted a simple outreach impact inventory to suggest the types of indicators that would be relevant to evaluating outreach programs (Appendix 1). The second issue is one of evaluation design addressing the counterfactual question - how does one know that a student's behavior changed from what it would have been without the outreach exposure? This would require a relatively long-term longitudinal study design with appropriate comparison groups and determination of whether intermediate outcomes are indeed linked to final outcomes. To our knowledge, such an outcome evaluation of STEM outreach programs has not been conducted, but perhaps should be considered for funding by NSF.

Measuring programmatic outputs is only the first step in determining program impact. Thus, grantees need to measure not only how many students they educated, but also whether that was an increase over the number of students that would have been educated in the absence of their program. This requires some kind of comparative data and adequate justification for the comparison made. (Comparisons could be affected by changes in national and local economic conditions, outsourcing of jobs to other countries and other factors.) Similarly, a grantee might develop new educational curricula or materials that are intended to constitute an upgrade in quality over previous curricula or materials. There are two general approaches to evaluating this: 1) expert validation of the new resource and 2) comparing the preparation/skills of students who are and are not exposed to the new resource, using some defensible comparative evaluation design. Certainly both approaches can be used. The case studies of several ATE projects and centers in the Appendix are intended to demonstrate the applicability of our evaluation framework to the real world activities of actual grantees. The questions we asked were: 1) Can the data that the grantees are collecting be used to "populate" the tables we are proposing? 2) Is it feasible for grantees to collect such data, if they are not currently collecting it? 3) Are the grantees utilizing an outcome evaluation design that can address the counterfactual question and if not, is it feasible for them to implement such a design? In the case studies presented, the framework we are suggesting appears feasible to apply. It is important to emphasize that the framework we are proposing is very comprehensive, thus it is unlikely that all components of it would be applicable to or equally significant for any individual ATE project or center. There is no intent to overwhelm ATE grantees with additional data collection recommendations or requirements. Ideally, each individual grantee should endeavor to identify which elements of the evaluative framework and what instrumentation are most pertinent to the evaluation of their own programs. The first question to be asked is, which of the central goals are pertinent to an ATE grantee's program(s)? The second question is, are the grantee's most extensive or significant activities related to educational resource development, implementation or dissemination, as these have been defined in this report. The third question is, what elements (outputs) in the data layouts (tables) are most pertinent to evaluating the grantee's activities? We do not wish to imply that all the data implied by the tables make sense to collect by every grantee. Grantees should also consider, however, that some of their current evaluation data collection may benefit from a closer alignment with the proposed evaluation framework.

Regarding the ongoing ATE Survey, we found the results useful in helping to develop the evaluative approach described in this report. Doubtless, there would be merit in reconciling or integrating the proposed framework with the approach used by the ATE Survey; this is work that remains to be done.

By proposing this inherently quantitative data framework, we do not intend to diminish the value of qualitative and narrative data that speak to the value, merit or worth of ATE programs. Relevant experiential observations and reactions from students, educators, employers and other ATE stakeholders would be part of any comprehensive evaluation of the ATE program

The ability of ATE grantees to implement evaluation activities clearly also depends on funding levels. There are three types of ATE centers – National, Regional and National Resource, where funding levels tend to decrease in the order given. Projects are the most common grants and vary greatly in their funding levels. Some efficiencies in evaluation activities might be achieved if a more standardized approach to collecting data were adopted, such as outlined in this report; but actual quantitative estimates of potential efficiencies are not feasible at this time.

Some of what should be done from an evaluative standpoint according to the proposed framework is outside the scope of any current ATE grant, such as the example of a long-term study of STEM outreach program impact. Another example would be follow-up of STEM students who participated in ATE centers or projects to determine their degrees and certificates earned, graduation rates and career paths. Such data collection could well fall outside the reasonable scope of work or even time limits of any individual grantee. For such topics, we recommend that NSF consider targeted national or regional studies to collect the requisite data. The current NSF program, Targeted ATE Research, may be one mechanism for such studies.

Finally, although presenting a distinct framework for evaluation, this report should serve primarily as a basis for further discussion, not a final prescription. If the report helps frame and direct further discussion of ATE evaluation, then perhaps it can be considered useful to the field.

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APPENDIX 1: Outreach Program Impact Checklist (draft)

Complete for individual student outreach participants.

LEVEL 1: Interest in STEM career (by student survey)

__Increased awareness of STEM careers

__ Increased interest in college

__Increased interest in STEM career

__Expressed intent to enroll in college

__Expressed intent to pursue STEM career

LEVEL 2: Behavioral Impact (by administrative data, at follow-up)

__Enrollment in college course(s)

__Enrollment in STEM degree or certificate program

__Persistence of college enrollment to the next semester

__Improved grades in next semester

__Move from part-time to full-time college attendance

__Increased number of college credits earned (vs. pre-outreach)

__Passed certain degree requirements (vs. pre-outreach)

__Other impact indicator (specify:____________________)

__Other impact indicator (specify:____________________)

APPENDIX 2: Technical Education Curriculum Assessment (TECA) (Keiser et al., 2004)

Material Name & NSF#: ______________________________

Group Reviewer's Names: ______________________________

HOLISTIC RATINGS (**answered by *all* reviewers**)

1. **Industry Standards & Practices:** Materials should clearly reflect learning objectives that are based on current business, industry and technology standards and practices.

Linked: Industry& Content rubrics 1, 2, 3, 4 & 5

NA/DK		0	1	2	3	4

0: The materials *do not* reflect any industry standards and practices.
1: The materials are *weak* at reflecting industry standards and practices.
2: The materials are *adequate* at reflecting industry standards and practices.
3: The materials are *good* at reflecting industry standards and practices.
4: The materials are *excellent* at reflecting industry standards and practices.

2. **Real World Curriculum:** Materials should engage learners in ways to help them understand the reality of the profession they seek. Instruction should be related to workplace needs. Materials should use tasks that are real activities that people perform while "on the job".

Linked: Industry& Content rubrics 1, 2, 3 & 5
Curriculum, Instruction, & Assessment rubrics 1 &4

NA/DK		0	1	2	3	4

0: The materials *do not* engage the learner in real world tasks.
1: The materials are *weak* at engaging the learner in real world tasks.
2: The materials are *adequate* at engaging the learner in real world tasks.
3: The materials are *good* at engaging the learner in real world tasks.
4: The materials are *excellent* at engaging the learner in real world tasks.

3. **Workplace Competencies:** How well do the materials enable students to develop the high performance skills needed to succeed in a high performance workplace? The Secretary's Commission on Achieving Necessary Skills (SCANS) was appointed by the Secretary of Labor to determine the skills people need to succeed in the world of work. According to the SCANS Report high performance workers need a solid foundation in basic literacy (reading, writing, listening and speaking), computational skills, applying technology, and understanding social organizational and technological systems. They also need thinking skills to put knowledge and resources to work and the personal qualities that make them dedicated, reliable and able to work with others.

Linked: Industry& Content rubrics 3, 4 & 5
Curriculum, Instruction, & Assessment rubrics 2, 3, 4, & 5

NA/DK		0	1	2	3	4

0: The materials *do not* develop workplace skills.
1: The materials are *weak* at developing workplace skills.
2: The materials are *adequate* at developing workplace skills.
3: The materials are *good* at developing workplace skills.
4: The materials are *excellent* at developing workplace skills.

4. **Access to In Depth Understanding:** How well do the materials allow all learners to acquire in depth understanding? Such practices include instructional strategies that actively engage students and allow them to learn in ways consistent with their preferences. The materials also require students to synthesize, generalize and evaluate information and to develop complex understandings of the content by exploring connections and relationships. In addition, materials that allow access to in-depth understanding are also well organized, easy to follow and contain assessments and activities that are aligned with the content.

Linked: Curriculum, Instruction, & Assessment rubrics 1, 2, 3, 4, 5 & 6

NA/DK		0	1	2	3	4

0: The materials *do not* support in depth understanding.
1: The materials are *weak* at supporting in depth understanding.
2: The materials are *adequate* at supporting in depth understanding.
3: The materials are *good* at supporting in depth understanding.
4: The materials are *excellent* at supporting in depth understanding.

OVERALL RATINGS (**answered by *all* reviewers**)

Please rate the effectiveness of the materials in having students learn the knowledge and skills or practices needed to be successful in the technical workplace. Select the description that best characterizes your overall assessment. ***This rating is not intended to be an average of all the previous ratings, but your overall judgment of quality and likely impact of the materials. Please describe the evidence that supports your rating in the space provided.***

To what extent will the materials help students learn the knowledge and skills or practices needed to be successful in the technical workplace?

NA/DK		0	1	2	3	4

0: The materials *will not* help students learn knowledge and skills or practices needed to be successful in the technical workplace.
1: The materials *will be weak* at helping students learn knowledge and skills or practices needed to be successful in the technical workplace.
2: The materials *will be adequate* at helping students learn knowledge and skills or practices needed to be successful in the technical workplace.
3: The materials *will be good* at helping students learn knowledge and skills or practices needed to be successful in the technical workplace.
4: The materials *will be excellent* at helping students learn knowledge and skills or practices needed to be successful in the technical workplace.

Describe the evidence that supports your rating:

APPENDIX 3: NRCCTE Technical Assistance Evaluation

For the purposes of this assessment, technical assistance is broadly defined as a **systemic change** initiative.

1. Please describe the primary reasons for requesting and/or participating in the 2009-2010 NRCCTE technical assistance.

2. Was 2009-2010 the first academic year in which you have participated in NRCCTE technical assistance?
   a. Yes
   b. No

   If no, please indicate years of past involvement:

3. Please rate the usefulness of the Math-In-CTE technical assistance in terms of educational practice and/or policy on the following scale, from 0-Not at all or very limited to 10-Extremely. Indicate NA, if an item is NOT applicable for the technical assistance in which you participated.

To what extent was NRCCTE's 2009-2010 technical assistance . . .		NA	Not at all or very limited		Limited		Somewhat			Highly		Extremely	
1.	Timely for informing practice or policy	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
2.	Well documented	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
3.	Applicable to my job.	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
4.	Applicable for the technical assistance participants	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
5.	Applicable for my state, organization, and/or teachers	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
6.	Applicable for achieving my goals as a state or district leader/official	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
7.	Providing needed information	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
8.	Providing useful materials	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
9.	Providing current information that builds on scientific evidence	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10.	Informing administrative practice/policy	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
11.	Improving teachers' practice	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
12.	Impacting administrative practice/policy.	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

13.	Enabling networking	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
14.	Useful overall	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

4. Please provide a brief example of how you have used your 2009-2010 NRCCTE technical assistance experience in practice/policy.

5. Please provide a brief example of how the 2009-2010 NRCCTE technical assistance has influenced administrative practice/policy in your state or district.

Narrative Critique: This section should reflect your overall assessment of the usefulness of Math-In-CTE technical assistance. It should summarize the salient features and the primary reasons for your scores/ratings. This critique should highlight the strengths and weaknesses of **NRCCTE's 2009-2010** technical assistance.

6. What were the key strengths of NRCCTE 2009-2010 technical assistance?

7. What were the key weaknesses of NRCCTE 2009-2010 technical assistance?

8. How could NRCCTE improve its technical assistance?

9. Would you recommend NRCCTE technical assistance to others in your position?

   - Yes, please explain

   - No, please explain

APPENDIX 4: NRCCTE Professional Development Evaluation

For the purposes of this assessment, professional development is defined as **individual change** initiative, that is, NRCCTE workshops that you participated in during the **2009-2010** academic year. Although you are in a leadership role, we are interested in your perceptions of the professional development, to the extend you observed or participated. “NA” is provided if the questions do not apply to your role.

1. To what extent did you participate in the professional development sessions?

   a. I attended all PD sessions.
   b. I attended most of the PD sessions.
   c. I attended a few of the PD sessions.
   d. I attended the opening presentations only.
   e. I did not attend the PD sessions. [If e, then link to “thank you” page]

2. Was 2009-2010 the first academic year in which you participated in NRCCTE professional development?
   a. Yes
   b. No

   If no, please indicate years of past involvement:

3. Please rate the quality of the professional development on the following scale, from 0-Not at all or very limited to 10-Extremely or NA-Not applicable.

NRCCTE’s professional development 2009-2010		NA	Not at all or very limited		Limited		Somewhat			Highly		Extremely	
Reaction	To what extent was the content/material presented . . .												
	• Timely for the needs of the teachers.	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Relevant for the teachers	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Sufficient for teachers to use in their jobs.	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Able to facilitate peer-to-peer interaction.	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	To what extent was the content/materials . . .												
	• Delivered effectively	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Presented via appropriate instructional modes	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Presented by knowledgeable instructors/facilitators	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

	NRCCTE's professional development 2009-2010	NA	Not at all or very limited		Limited		Somewhat			Highly		Extremely	
Learning	As a result of the professional development, to what extent did . . .												
	• your knowledge increase	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• your skills increase	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• your abilities increase	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Application	To what extent has what you have learned from the PD been . . .												
	• Applied in your work environment/classroom	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Applied throughout your district/state/organization	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Adaptable for your purposes	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Helpful in reaching your stated professional goals	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Personal and organizational impact	To what extent has the PD improved . . .												
	• Your job performance (teaching)	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• The way in which your district/state/organization thinks about CTE	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• The integration of academics and CTE	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Student outcomes	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Educational practice in my state or organization	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
	• Sustained opportunities for professional growth	NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Please judge the extent to which the PD was of high quality overall.		NA	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

4. Please indicate how your leadership practice changed as a result of the 2009-2010 NRCCTE professional development.

5. Please indicate how the 2009-2010 NRCCTE professional development impacted your district/state/organization.

Narrative Critique: This section should reflect your overall assessment. It should summarize the salient features and the primary reasons for your scores/ratings. This critique should highlight the strengths and weaknesses of **NRCCTE's 2009-2010** professional development.

6. What were the key strengths of the 2009-2010 NRCCTE professional development?

7. What were the key weaknesses of the 2009-2010 NRCCTE professional development?

8. How could NRCCTE improve its professional development?

9. Would you recommend NRCCTE professional development to others in your position?

   a. Yes, please explain
   b. No, please explain

APPENDIX 5: Consolidated Tables From Within Report

Table 1. Technician Education Implementation (New Students)

	Post-Secondary			Secondary		
	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)
A. Program	☐	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐	☐
D. Dual Program/ Dual Credit	☐	☐	☐	☐	☐	☐
	Post-Secondary Exposed*	Secondary Exposed*				
E. Software/ Materials	☐	☐				

Note: *Including in other programs or courses

Table 2. Technician Education Implementation (Continuing Education)

	Post-Secondary		
	Enrolled (1)	Completed/ Graduated (2)	Retention (2 ÷ 1)
A. Program	☐	☐	☐
B. Course	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐
D. Dual Program/ Dual Credit	☐	☐	☐
	Post-Secondary Exposed*		
E. Software/ Materials	☐		

Note: *Including in other programs or courses

Table 3. Outreach Programs

	Student Post-Secondary	Student Secondary	Educators	Industry Professionals
A. Participated (#)	☐	☐	☐	☐
B. Completed (#)	☐	☐	☐	☐
C. Impact Measure*	☐	☐	☐	☐

Note: *See Outreach Impact Checklist (Appendix 1)—students only

Table 4. Technician Education Impact Assessment*

	New Students	Current Technicians
1. Learning Assessment	☐	☐
2. Feedback from technicians/students/ Educators	☐	☐
3. Feedback from employers	☐	☐
4. Education achievement	☐	☐
5. STEM employment	☐	☐

Note: *Instruments need to be developed

Table 5. Educational/Outreach Resources Development

	Post-Secondary			Secondary		
	Created	Expanded	Upgraded	Created	Expanded	Upgraded
A. Program	☐	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐	☐
D. Dual Program	☐	☐	☐	☐	☐	☐
E. Software/ Materials	☐	☐	☐	☐	☐	☐
F. Student Outreach Program	☐	☐	☐	☐	☐	☐
G. Professional Outreach Program	☐	☐	☐	☐	☐	☐

Table 6. Educational Resources Quality Assessment (TECA scores)

	Industry standards and practices	Real world curriculum	Workplace competencies	Access to in-depth understanding	Overall rating
A. Pro⍰ram	☐	☐	☐	☐	☐
B. Course	☐	☐	☐	☐	☐
C. Internship/ Apprenticeship	☐	☐	☐	☐	☐
D. Dual Program	☐	☐	☐	☐	☐
E. Software/ Materials	☐	☐	☐	☐	☐

Table 7. Outreach Program Quality Assessment*

	Secondary Level	Post-Secondary
F. Student Outreach Program	☐	☐
G. Profession Program	☐	☐

Note: *Measures to be developed

Table 8. Dissemination of STEM Education or Outreach Resources for Students*

	STEM Education Resources	Outreach Resources
Publicize resources	☐	☐
Transmit resources	☐	☐
Technical assistance	☐	☐
Impact measure/ utilization	☐	☐

Note: * Detailed measures need to be developed

Table 9. Educators' Professional Development Implementation

		Secondary		Post-Secondary		
Number of Educators who Complete…	Elementary	Middle	High	Faculty	Industry	Professional
Professional Development Workshops	☐	☐	☐	☐	☐	☐
Professional Development Courses	☐	☐	☐	☐	☐	☐
Professional Development Fellowships/Mentoring	☐	☐	☐	☐	☐	☐
Professional Development Software/Materials*	☐	☐	☐	☐	☐	☐

Note: *Including hard copy and audio/visual materials for professional development purposes

Table 10. Professional Development Impact Assessment

Educators' Assessment of Learning	☐
Feedback on Professional Development (Reactions)	☐
Changes in Classroom Practice	☐
Changes in Student Learning	☐

Table 11. Educators' Professional Development Resources

	Secondary		Post-Secondary	
	Number	Quality Assessment*	Number	Quality Assessment*
Professional Development Workshops	☐	☐	☐	☐
Professional Development Courses	☐	☐	☐	☐
Professional Development Fellowships/Mentoring	☐	☐	☐	☐
Professional Development Software/Materials	☐	☐	☐	☐

Note: *Measure needs to be developed

Table 12. Dissemination of STEM Professional Development Resources*

Publicize resources	☐
Transmit resources	☐
Technical assistance	☐
Impact measure/ utilization	☐

Note: *Detailed measures need to be developed