The U.S.'s considerable lag behind other countries in the preparation of a quality workforce in science, technology, engineering, and mathematics (STEM) career fields is an issue of national concern (National Academy of Sciences, 2007). Talent is lost throughout the educational pipeline, and women and minorities remain significantly underrepresented in STEM majors and careers (e.g., Committee on Underrepresented Groups, 2010; Chen & Weko, 2009; George-Jackson, 2011; Hoffman, Starobin, Laanan, & Rivera, 2010; Huang, Taddese, & Walter, 2000). Encouraging educational success in STEM fields is a first and essential step toward addressing these challenges. Community colleges have been recognized as providing rich opportunities for improving college access and degree attainment in STEM fields at the associate level, baccalaureate level, and beyond (e.g., National Academy of Engineering, 2005; National Science Board, 2003; Starobin, Laanan, & Burger, 2010; Tsapogas, 2004).

The National Science Foundation's Advanced Technological Education (NSF-ATE) program is one of only a handful of national initiatives that explicitly supports technician education in STEM fields. NSF-ATE focuses on the work of community colleges to establish degree programs, develop partnerships between two- and four-year higher education institutions to create formal pathways to baccalaureate degree attainment, and enhance degree attainment through teacher development (NSF, 2011). Innovative curriculum development in technical fields is strongly encouraged. Applied baccalaureate degrees represent one potential approach to curricular innovation.

Applied academic programs are designed to integrate an academic discipline with contextualized, hands-on learning experiences that demonstrate direct application to the workplace (Pedrotti & Parks, 1991). Applied learning has been associated with occupational and technical education, with two-year college curriculum attempting to facilitate links between academic and workforce preparation (Perin, 2011). Applied baccalaureate degrees are often designed to facilitate baccalaureate degree attainment for adult students who recognize the importance of continued learning in the modern workplace (Ruud & Bragg, 2011). Fields that are continuously evolving and changing require workers to move in and out of education and training in order to advance their skills and knowledge. While descriptions of applied baccalaureate degrees differ across the literature (see, for example, Arney, Hardebeck, Estrada, & Permenter, 2006; Pulley, 2010; Ruud & Bragg, 2011; Walker & Floyd, 2005), a definition presented by Townsend, Bragg, and Ruud (2008) guided this study. Townsend et al. state that an applied baccalaureate (AB) degree is “a bachelor’s degree designed to incorporate applied associate courses and degrees once considered as terminal or non-baccalaureate level while providing students with the higher-order thinking skills and advanced technical knowledge and skills so desired in today’s job market” (p. 4). We determined that this definition was well-suited to our research due to the primary focus that it places on the formalization of associate-to-baccalaureate pathways that may not have existed in the past – the issue of central importance to this work.

While AB degrees are not necessarily a new phenomenon, their prevalence has grown substantially over the past two decades (Ruud & Bragg, 2011) on a state-by-state basis often as the result of advocacy by a small group of education or political leaders (Ruud, Bragg, & Townsend, 2010). Proponents of AB degree programs express that these degrees improve workforce education, expand employment opportunities and economic outcomes for graduates, and increase baccalaureate attainment, particularly for underrepresented student populations such as returning adults and racial or ethnic minorities (e.g., Arney et al., 2006; Walker & Floyd, 2005; Pulley, 2010). As noted by Ruud and Bragg (2011), critics question the quality of education offered by these degrees due to their acceptance of coursework that has been traditionally considered “subbaccalaureate” as a part of the baccalaureate degree. Despite strong opinions on both sides of the issue, very little research has been conducted to provide evidence of the benefits and drawbacks of AB degree programs (Ruud & Bragg, 2011; Townsend, 2005). The scarcity of available research is partly related to the difficult task of identifying AB degree programs. Local efforts to establish AB degree programs have led to an array of program structures and designs, as well as a variety of labels and definitions used to describe programs, making it difficult to locate programs to study that lead to the AB (Bragg & Ruud, 2011).
Our research embraces the challenge of examining AB degree programs in technician education in STEM fields. Funded by an NSF-ATE targeted research grant, we are gathering detailed information about how AB programs operate, develop partnerships, and meet the needs of students, employers, and higher education institutions that are preparing technicians and technologists in STEM fields. This is accomplished in three steps:

1) A brief initial survey to identify NSF-ATE projects and centers that are affiliated with associate degree programs that have established formal pathways to baccalaureate degrees.

2) A follow-up survey to gather in-depth information on existing degree pathways that lead to applied baccalaureate degrees. This survey covers topics such as instructional approaches, accreditation and evaluation activities, recruitment and retention of underserved student populations, partnerships with employers and higher education institutions, and the perceived impacts of NSF-ATE awards for various stakeholders.

3) Case studies with 7 – 10 NSF-ATE projects and centers aimed at uncovering promising and exemplary practices related to applied baccalaureate degrees.

This research brief provides results from the first survey. Findings are shared regarding NSF-ATE projects and centers that are affiliated with associate degree programs that have established formal pathways to baccalaureate degrees. Where possible, distinctions are made between traditional baccalaureate pathways and other emerging approaches including AB degree programs and community college baccalaureate degrees. This survey lays the foundation for deeper data collection and analyses to follow.

SURVEY METHODS

In order to identify NSF-ATE projects and centers that were affiliated with baccalaureate degree pathways and to examine the nature and breadth of degrees among these pathways, we administered an online survey to principal investigators (PIs) of NSF-ATE-funded projects and centers. The survey instrument was designed in consultation with NSF-ATE experts who are members of the project’s advisory group, and refined based on pilot testing with additional colleagues who have ties to NSF-ATE projects and centers or who work with applied baccalaureate degree pathways. The survey instrument was divided into three sections:

- An introductory section, which asked respondents to indicate the name of their ATE project or center and the associated field(s) of study;
- An associate-level section, which allowed respondents to indicate which degree types (e.g., AA, AS, AAS) were conferred; and
- A baccalaureate-level section, which asked respondents to indicate which baccalaureate degrees matriculated students from associate-level work, as well as to share information on underserved student populations and the availability of student-level outcomes data related to baccalaureate degrees.

The sample for this initial survey included all NSF-ATE Principal Investigators (PIs) who were awarded grants between the program’s inception in 1992 and May 2011. After removing duplicates, this list included 857 unique individuals. These individuals were contacted via email to request their participation in the survey. Undeliverable email notices were received from 206 individuals, leaving a sample size of 651. From this group, 233 (36% of the sample) responses were received to the survey from respondents representing 231 NSF-ATE projects and centers. Each NSF-ATE project and center is referred to as a “case” in this research brief. An additional 20 (3% of the sample) email responses were received indicating the respondents felt they were not a good fit for the survey because: (a) the NSF-ATE project or center no longer existed, (b) the respondent was no longer involved in the NSF-ATE project or center, or (c) the NSF-ATE project or center was not associated with degree programs. These 20 responses were categorized as “non-responses” for the purposes of data analysis, yet were reflected upon in the interpretation of data.

KEY DEFINITIONS

To facilitate analysis of the survey data, degrees reported by PIs were divided into four categories: applied associate degrees, transfer associate degrees, applied baccalaureate degrees, and traditional baccalaureate degrees. (See Table 1 on page 3 for descriptions of these degree categories.) The categories of degrees were informed by historical understandings of the transfer and terminal functions of two-year college degree designations as outlined by Eells (1941), as well as more recent literature describing the differences between applied and traditional baccalaureate degrees (e.g., Ruud & Bragg, 2011; Walker & Floyd, 2005).

Additionally, we recognize that applied baccalaureate degrees have often been confused or confounded with community college baccalaureate degrees in past discussions of issues surrounding these approaches (see, Ruud & Bragg, 2011). For this reason, a clear definition of the way that the term community college baccalaureate is used in this study is important. In this study, community college baccalaureate (CCB) degrees include any form of baccalaureate degree awarded by an institution identified as a community college, technical college, two-year college, two-year or technical branch campus of a university system, or any other institution that primarily awards associate degrees. As such, any type of baccalaureate degree (traditional baccalaureate or applied baccalaureate) can also be considered a CCB, depending on the institution that awards the degree.

WHAT WE’VE LEARNED

Within the 231 cases, 151 (65%) indicated that associate degrees were affiliated with their NSF-ATE project or center. Respondents from 95 NSF-ATE projects or centers (41% of the total respondents) indicated that the affiliated associate degree programs had established formal pathways to baccalaureate degrees. The remainder of the results presented in this brief focus on the 95 cases
Table 1. Descriptions of Degree Categories Used in this Study

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
</table>
| **Applied associate** | Degree program that emphasizes applied coursework, often through contextualized instruction, that encourages direct applicability to the workforce. These degree programs often have roots in career and technical education that has been considered terminal (nontransferable) by higher education systems. | Associate of Applied Science (AAS)  
Associate of Applied Arts (AAA)  
Associate of Applied Arts and Sciences (AAAS)  
Associate of Applied Technology (AAT)  
Associate of Engineering Technology (AET)  
Associate of Technology (AT) |
| **Transfer associate** | Degree program consisting of liberal and academic coursework that is transferable to baccalaureate degree programs.†                                                                                   | Associate of Arts (AA)  
Associate of Science (AS)                                                                 |
in which respondents indicated formal pathways between associate and baccalaureate degrees.

In the 95 cases where respondents reported existing formal pathways to baccalaureate degrees, the affiliated NSF-ATE projects or centers were associated with a variety of technical fields of study, with just over half (59%) indicating a single field of study and the remaining 41% indicating between 2 and 6 fields of study. Figure 1 provides a visual representation of the prevalence of each field of study. Manufacturing and engineering technology was indicated most often (33% of cases), while agricultural technology, civil and construction technology, marine technology, and multimedia technology were indicated least often (1% - 2% of cases). The “other” field of study category, reported in 20% of cases, included a broad range of responses such as: aquarium science; architectural and engineering graphics; instrumentation, automation and control; lasers, photonics, and optics; mathematics; mechatronics; quality assurance; robotics; solar and fuel cells; STEM education; supply chain technology; and unified communication (voice, video, data, mobile). The wide range of STEM fields associated with baccalaureate degrees was a new and important finding unique to this survey; heretofore, there was no record of STEM fields that led to baccalaureate degrees emanating from AS or AAS degree programs affiliated with ATE projects and centers.

For almost half of the cases (46 of 95) respondents reported at least one pathway that began from an applied associate degree. In the remaining 49 cases, all pathways to baccalaureate degrees began from transfer associate degrees (AA, AS). For 84 cases, pathways could be clearly identified from data provided, and those pathways varied considerably. We found that:

- 45 cases included transfer associate to traditional baccalaureate degrees
- 32 cases included applied associate to traditional baccalaureate degrees
- 21 cases included applied associate to applied baccalaureate degrees
- 11 cases included transfer associate to applied baccalaureate degrees

Even when multiple fields of study were indicated, 61 (64%) cases included a single type of pathway (as described above). Yet, 22 cases included 2 types of pathways, and 1 included all 4 types of pathways. When 2 pathway types were indicated, there was no clear pattern of paths that were used together.

- 8 cases included both applied associate and transfer associate degrees leading to traditional baccalaureate degrees
- 4 cases included both applied associate and transfer associate degrees leading to applied baccalaureate degrees
- 6 cases included applied associate degrees leading to both applied baccalaureate and traditional baccalaureate degrees
- 4 cases included transfer associate degrees leading to both applied baccalaureate and traditional baccalaureate degrees

![Figure 1. Prevalence of technical fields of study associated with NSF-ATE projects and centers that are affiliated with formal pathways between associate and baccalaureate degrees.](image-url)
Multiple path types within one field of study were indicated by respondents in 22 cases, while in a single case, multiple path types existed only across multiple fields of study.

Formal pathways to baccalaureate degrees for all affiliated associate degrees, regardless of whether the degrees fell in the applied associate or transfer associate categories, were indicated in 72 cases (76% of cases with indicated formal pathways to baccalaureate degrees). In contrast, 23 respondents indicated that some, but not all, of the associate degrees affiliated with their NSF-ATE project or center had established formal pathways to baccalaureate degrees. A wide variety of patterns and pathways were found among this group, ranging from:

- 3 cases where only transfer associate degrees are offered, some with pathways others without
- 11 cases where transfer associate degrees have pathways, while applied associate degrees do not
- 1 case where all transfer associate degrees and some applied associate degrees have pathways, while other applied associate degrees do not
- 2 cases where applied associate degrees have pathways, while transfer associate degrees do not
- 6 cases where only applied associate degrees are offered, some with pathways others without

Community college baccalaureate (CCB) degrees were indicated in 19 (20%) cases. The fields of study associated with these baccalaureate degrees varied widely, including: biotechnology, chemical technology, computer and information technology, cyber security and forensics, electronics, energy, environmental technology, manufacturing and engineering technology, marine technology, nanotechnology, telecommunications, and transportation technology.

For the 95 cases which indicated the existence of baccalaureate degree pathways, respondents were also asked about the availability of student-level data at the baccalaureate degree level. Awarding baccalaureate degrees at a primarily associate degree-granting institution was found to be associated with increased knowledge of data collection regarding student participation and outcomes (See Table 2). As compared to cases in which all baccalaureate degrees were awarded by primarily baccalaureate degree-granting colleges and universities, the 19 cases in which some baccalaureate degree(s) were CCB degrees more often indicated available student-level demographic, academic performance (e.g., in-class grades, retention, completion), and post-graduation outcomes (e.g., graduate school enrollment, employment) data and less often indicated lack of knowledge or no response regarding availability of student-level data. Despite this difference, we detect a considerable lack of knowledge among respondents as a whole surrounding the availability of data related to the pursuit and attainment of baccalaureate degrees in STEM fields.

Finally, of the 95 cases in which formal pathways from associate to baccalaureate degrees existed, 28 (29.5%) indicated formal pathways to baccalaureate degrees that intentionally or explicitly targeted underserved student populations. These targets were most prominent for the fields of transportation technology (2 of 2 responses), geospatial technology (2 of 3 responses), chemical technology (3 of 6 responses), and environmental technology (5 of 11 responses). Yet, the low number of responses in each field of study category requires caution in interpreting these results. Of the remaining cases, respondents in 19 cases (20.0%) indicated no targeted programs for underserved student populations, respondents in 40 cases (42.1%) did not know if targeting programs existed, and in 8 cases (8.4%) respondents did not reply to the question.

Table 2. Percent of Respondents Indicating Availability of Student-Level Data at the Baccalaureate Degree Level, by Institution Type Awarding Degree

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Primarily Associate Degree-Granting Institutions (N=19)</th>
<th>Primarily Baccalaureate Degree-Granting Institutions (N=76)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Demographics</td>
<td>37%</td>
<td>16%</td>
</tr>
<tr>
<td>Academic Performance</td>
<td>37%</td>
<td>21%</td>
</tr>
<tr>
<td>Post- Graduation</td>
<td>26%</td>
<td>21%</td>
</tr>
</tbody>
</table>


IMPLICATIONS AND FUTURE DIRECTIONS

Findings from this initial survey clearly demonstrate the existence of baccalaureate degree pathways that prepare technicians and technologists in STEM fields. The pathways to baccalaureate degrees that are affiliated with NSF-ATE projects and centers not only fit historically traditional patterns of AA and/or AS degrees transferring to BA and/or BS degrees, but they incorporate emerging degree pathway opportunities such as AB and CCB degrees. Furthermore, we found more AB pathways designed as applied associate degrees that transfer to traditional baccalaureate [BS] programs (as opposed to applied baccalaureate [BAS] degrees) than would have been expected based on prior research (Bragg & Ruud, 2011; Townsend et al., 2009).

Taking into account the fields of study and specific degree pathways indicated by respondents, the established pathways to baccalaureate degrees are quite varied from one NSF-ATE project or center to another. The 95 cases in which respondents reported formal pathways between associate and baccalaureate degrees listed more than 30 different fields of study associated with their degree programs. Additionally, a variety of pathways were uncovered (transfer associate degrees to applied baccalaureate degrees; applied associate degrees to traditional baccalaureate degrees; applied associate degrees to applied baccalaureate degrees; transfer associate degrees to applied baccalaureate degrees) with approximately one-quarter of respondents indicating multiple pathways existing for a single NSF-ATE project or center. This variety makes the phenomenon of AB degree pathways both difficult to describe and compelling to examine. It motivates questions of: (a) how are program goals and content designed?, (b) what perceived needs are these degree programs established to meet?, (c) what program features contribute to program effectiveness?, (d) how can effectiveness be measured?, and (e) what can be learned from one AB degree program to be adopted or adapted to another setting?

Finally, the data from this initial survey suggest that considerable uncertainty exists regarding student participation in baccalaureate-level programs, including AB degree programs, and student outcomes (e.g., baccalaureate degree attainment, post-graduation pursuits). Questions regarding baccalaureate-level degree programs demonstrated knowledge gaps such that, in over half of the cases, information about the availability of student-level outcomes data and recruitment of underrepresented student populations were unknown. Further research is needed in these areas to explore relationships and communications between NSF-ATE PIs and baccalaureate degree-granting institutions. It is unclear whether or not this type of data is collected, and if so, how it is shared and for what purposes. Presumably, all baccalaureate degree pathways require productive partnerships among colleges and universities, and an important aspect of our future research will examine what some notable AB and CCB programs are doing to implement these kinds of facilitative processes.

To understand the contribution that AB degree pathways make to national calls for STEM expertise, addressing gaps in the educational pipeline, and improved degree attainment for underrepresented student populations (e.g., Chen & Weko, 2009; Huang, et al., 2000; National Academy of Sciences, 2007), further research is necessary. Analyses of AB degree pathway designs, implementation, and outcomes could provide program designers and policy makers with insights to move beyond opinions and assumptions (Townsend, 2005), toward decisions made on evidence of effectiveness and replicability. This work also has relevance beyond AB degree program development to support technician education in the STEM fields. It contributes to current conversations about the value of a baccalaureate degree, as well as the historical separation of applied degree programs from traditional academic degree programs (e.g., Bragg, 2001; Levin, 2004; Manzo, 2001; Ruud & Bragg, 2011; Townsend, 2005). We look forward to revisiting these issues in discussions that evolve from the follow-up survey and case studies that are planned as this research project proceeds.

References


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In Brief


