Investigating Applied Baccalaureate Degree Pathways in Technician Education

Technical Report

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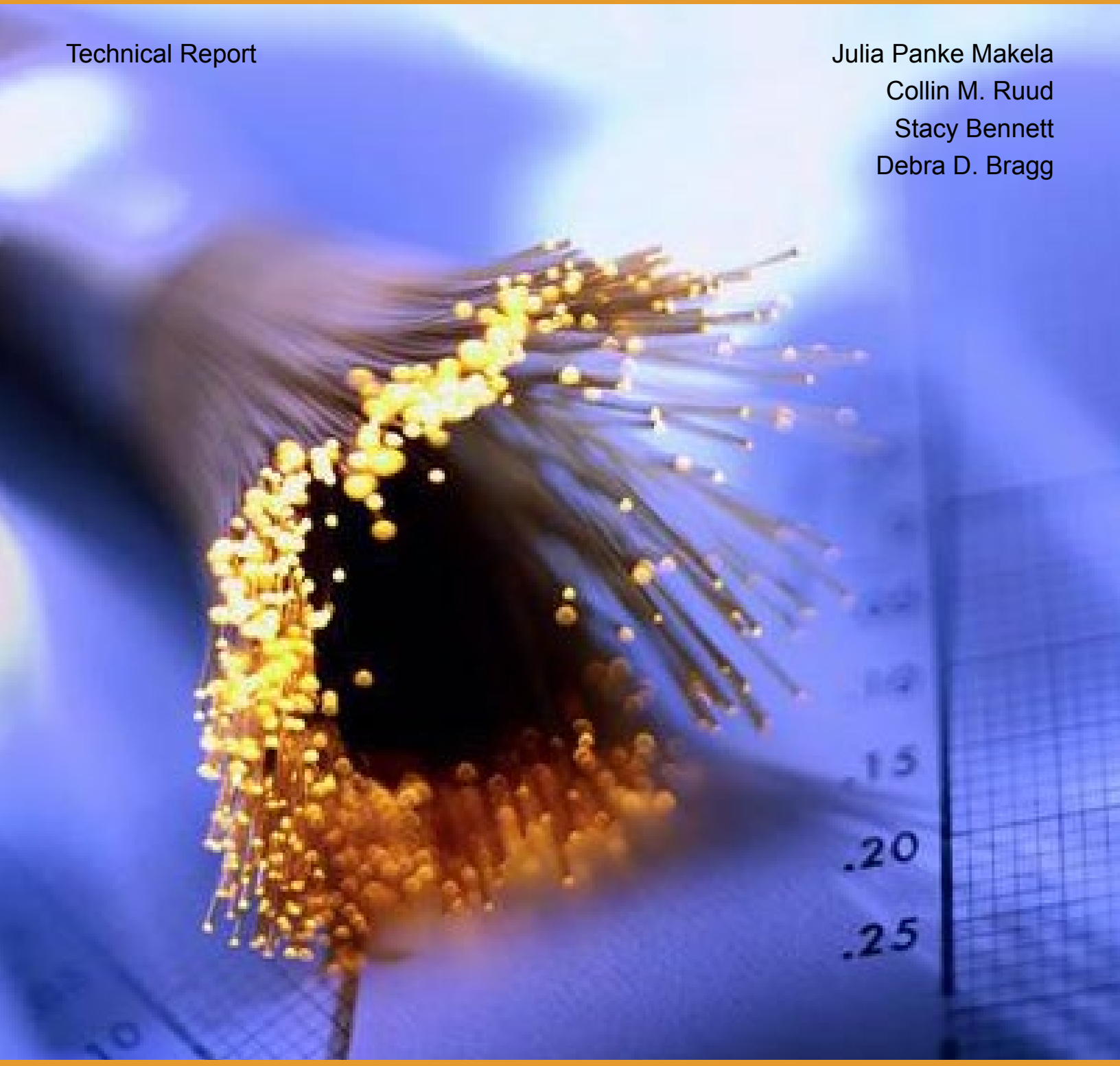

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The Office of Community College Research and Leadership (OCCRL) was established in 1989 at the University of Illinois at Urbana-Champaign. Our primary mission is to use research and evaluation methods to improve policies and programs to enhance community college education and transition to college for diverse learners in Illinois and the United States. Projects of this office are supported by state, federal, and private and not-for-profit organizations. The contents of our publications do not necessarily represent the positions or policies of our sponsors or the University of Illinois. Comments or inquiries about our publications are welcome and should be directed to *OCCRL@illinois.edu*. This document can be found on the web at: *occrl.illinois.edu*.

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Preface

The Office of Community College Research and Leadership (OCCRL) at the University of Illinois at Urbana-Champaign is currently engaged in a four-year study of applied baccalaureate (AB) degree pathways in science, technology, engineering, and mathematics (STEM) fields and technician education. The purpose of this work is to identify the shape, scope, and outcomes of these degree pathways, as well as to uncover exemplary and promising practices to inform the efforts of college administrators and faculty, employers, and researchers who have an interest or investment in emerging approaches to college completion.

This document summarizes our first phase of research. Between May 2011 and January 2012, we used a multi-pronged approach including surveys, website review, and document analysis to identify and characterize AB degree pathways affiliated with National Science Foundation's Advanced Technological Education (NSF-ATE) projects and centers. This document provides an overview of the study motivations, terminology, and approach, as well as an integration of findings across all data analyses employed thus far. The findings provide insights into baccalaureate degree pathways in STEM fields and, more specifically, AB degree pathways that prepare technicians and technologists. Additionally, we share findings related to program development, curriculum design, transferable and nontransferable associate degree programs, data collection practices regarding the outcomes and impacts of degree programs, environmental influences, strategies for communicating with key stakeholders, and concerns about the perceived stigma of applied postsecondary credentials.

For a brief overview of the findings associated with this study, please view the executive summary available at occrl.illinois.edu/files/Projects/nsf_ab/NSF-AB-ExecSummary-2012.pdf.

Setting the Stage

Examining College Completion with a STEM Lens

In recent years, college completion has emerged as a top national priority for postsecondary education in the United States (e.g., Complete College America, 2011; Lumina Foundation, 2010; Obama, 2009). Approximately 60% of Americans who graduate from high school enroll in some postsecondary education (Carnevale, Smith, & Strohl, 2010) and among these students, about 65% complete with an associate or a baccalaureate degree (Ewell & Kelly, 2009). These estimates reflect first-time, full-time students who are most likely to complete, leaving a sizeable proportion of students, both full-time and part-time, without college credentials. Furthermore, estimates suggest that over 37 million Americans, or 22% of the adult working population, have accumulated some college credits without completing a degree (Lumina Foundation, 2010). Degree completion rates are especially disconcerting for underrepresented populations, including racial and ethnic minorities, low income, first-generation, and adult students (Lumina Foundation, 2010; Lynch & Engle, 2010a, 2010b).

Concerns about low degree completion rates are intensified by projections for the United States job market. Carnevale et al. (2010) projected that the U.S. economy will produce 46.8 million job openings by 2018. Approximately 63% of those jobs are expected to require workers with at least some college education, with 12% requiring an associate degree and 33% requiring a bachelor's degree or higher. At current rates of educational attainment, the supply of workers who have achieved a bachelor's degree will fall well below the 16 million job demand. Furthermore, individuals with college degrees have lower unemployment rates, higher earning potential, and greater access to continued education and training than those without college degrees.

The necessity for advanced education is particularly pronounced in science, technology, engineering, and mathematics (STEM) fields. The STEM workforce has been one of the largest growing employment sectors for the past 60 years, having grown 7.7 times larger from 1950 to 2000, compared to the entire labor force, which grew 2.3 times larger (Lowell & Regets, 2006). Continued and increased output from STEM fields is recognized as vital to the country's continued economic well-being and international competitiveness (e.g., Douglass & Edelstein, 2009; Drew, 2011; Toulmin & Groome, 2007).

In addition to being a staple of the United States economy, STEM fields demand a highly educated workforce. In 2008, 92% of STEM employees had at least some postsecondary education beyond high school, with 44% of those individuals having a baccalaureate degree and 27% having a master's degree or higher (Carnevale et al., 2010). These rates of educational attainment are projected to remain steady through 2018 as STEM occupations continue to grow and expand, revealing the importance of pathways that begin at the associate level and culminate with the baccalaureate degree or higher level credentials.

Yet, the United States lags behind other countries in quality workforce preparation for STEM career fields (National Academy of Sciences, 2007). Talent is lost throughout the various stages of the educational pipeline, and women and minorities remain significantly underrepresented in STEM majors and careers (e.g., Chen & Weko, 2009; Committee on Underrepresented Groups, 2010; George-Jackson, 2011; Hoffman, Starobin, Laanan, & Rivera, 2010). STEM fields dominated by aging workers need to recruit a new, diverse workforce that is able to continually upgrade its technological skills and competencies. Strengthening the STEM pipeline to, through, and beyond postsecondary education is essential to maintaining a vibrant economy in an increasingly global economic world.

This combination of growing employment opportunities, increasing demand for an educated workforce, continual retraining of adult workers, and calls for strengthening the educational pipeline points to the importance of studying new and emerging forms of baccalaureate degrees awarded in STEM fields.

Community Colleges and Technician Education

"Unlocking the value of community colleges" (Boggs, 2011, p. 6) has become a common theme for increasing educational attainment and building a competitive workforce (e.g., Business Roundtable, 2009; Obama, 2009). As part of the P-20 educational pipeline, community colleges provide access and support to students to improve success at both the associate and baccalaureate levels. According to National Survey of Recent College Graduates data collected between 2001 and 2007, approximately 50% of students who receive baccalaureate and master's degrees in science, engineering, and health fields attended a community college at some point in their academic careers (Mooney & Foley, 2011).

The National Science Foundation's Advanced Technological Education program (NSF-ATE) recognizes community colleges as a pivotal piece of the educational puzzle in STEM education. Through various funding efforts, National Science Foundation (NSF) has elevated community colleges into a prominent role for "developing the technical skills of credit and non-credit students" (Community College Times, 2000, para. 9). After announcing their program's funding for community colleges would increase from 83 million to around 100 million dollars for the 2012 fiscal year, the acting deputy director of NSF's Directorate for Education and Human Resources, Barbara Olds, spoke to the need for STEM education to become universally accessible by saying, "we're not just interested in Ph.D. scientists. We're interested in a STEM-literate workforce and community" (Patton, 2011, para. 4). Other NSF programs have followed suit, recognizing a growing need for community and technical colleges to provide a large portion of the STEM training required in today's job market.

Calls for increases in STEM education, with an emphasis on community colleges as key providers of such education, have accentuated the need for credentialing at all levels: certificates, associate degrees, and baccalaureate degrees. This need also extends to the construction of pathways and programs of study that extend from certificates and associate degrees to and through baccalaureate degrees, in part as a strategy to facilitate the continued growth and career advancement of adult workers.

The Evolution of Applied Baccalaureate Degrees

Postsecondary degree designations in American higher education fall into several categories based on curricular design and transfer relationships between associate degree and baccalaureate degree level coursework. **Transfer associate degrees** (e.g., Associate of Arts, AA; Associate of Science, AS) consist of liberal and academic coursework that is transferable to baccalaureate degree programs. **Applied associate degrees** (e.g., Associate of Applied Science, AAS; Associate of Applied Technology, AAT; Associate of Engineering Technology, AET; Associate of Technology, AT) usually have roots in career and technical education that has been considered terminal (nontransferable) by higher education systems (Koos, 1970). The word "applied" in relation to these degree programs connotes the importance of applied learning, often through contextualized instruction, that encourages direct applicability to the workforce (Pedrotti & Parks, 1991; Perin, 2011).

Traditional baccalaureate degrees (e.g., Bachelors of Arts, BA; Bachelor of Science, BS) that are made up of liberal, academic, and professional coursework, provide a selection of courses designed to offer both breadth and specialization to students. **Applied baccalaureate (AB) degrees** (e.g., Bachelor of Applied Science, BAS; Bachelor of Applied Technology, BAT; Bachelor of Technology, BT) emphasize applied coursework and applied learning at the upper division or throughout the entire collegiate pathway that begins with an applied associate degree, as previously noted. An intriguing characteristic of many AB degrees is that they accept the transfer of all, or nearly all, credits from applied associate degrees that, in the past, have been considered terminal. This notion of transferring terminal coursework to create pathways for advanced degree attainment where none existed previously has been a defining feature and continues to be an important aspect of AB degrees (Townsend, Bragg, & Ruud, 2008).

Applied baccalaureate (AB) degree pathways offer opportunities for degree attainment in which a baccalaureate degree-granting institution offers a baccalaureate degree program that has established transfer relationships with programs offered by associate degree-granting institutions that emphasize applied associate courses or degrees. These applied degree pathways are not new. AB degree programs can be traced back to the 1970s when a small number of postsecondary institutions in three states created articulation agreements to allow associate of applied science (AAS) students to transfer applied course credits to baccalaureate degree programs (Townsend et al., 2008). The number of states with AB degree programs continued to grow steadily through the remaining decades of the 20th Century. These degrees accelerated pace after 2000 to the point that the vast majority of states adopted state-level policy concerning AB degrees or allowed for inter-institutional agreements that recognize the legitimacy of applied courses or degrees counting toward the baccalaureate degree (Bragg & Ruud, 2011). Growth in AB degree programs over the past decade suggests higher education institutions are increasingly counting credits earned for applied learning toward degrees at both the associate and baccalaureate degree levels.

The growth of AB degree pathways in the United States is attributable to several factors, including advocacy for applied learning options by educators, policy makers, and employers (Ruud, Bragg, & Townsend, 2010). Those that support the implementation of AB degrees often point to workforce needs, as well as state and national calls to improve the United States' international competitiveness. Additionally, advocates of AB degrees have cited the potential to promote greater equity in postsecondary education by providing baccalaureate transfer routes for adult students who have limited geographic access to college and for historically underserved student populations at the postsecondary level (e.g., Arney, Hardebeck, Estrada, & Permenter, 2006; Pulley, 2010; Walker & Floyd, 2005).

Despite the role that AB degrees could play in increasing access to college and improving college degree completion, AB degree programs face considerable criticism. As noted by Ruud and Bragg (2011), providing transfer options to

educational programs once considered terminal has raised questions about the quality of the affiliated coursework at both the associate and baccalaureate levels. Townsend (2009) warned that postsecondary education that emphasizes applied learning may not be comparable in rigor to coursework that is theoretically based. Additionally, by providing training in highly specialized fields, educators may run the risk of training students for career fields that have limited openings or that fail to provide stable, long-term employment. Despite strong opinions on both sides, few in-depth studies have been conducted on AB degree policies and programs beyond a 50-state policy analysis conducted by Townsend et al. (2008) and their related case studies in six states (Bragg & Ruud, 2011).

As developments with the AB continue to evolve, a challenge for researchers, policy makers, and practitioners is to define AB degree programs. For example, Walker and Floyd (2005) use the term "workforce baccalaureate degrees" to refer to AB degree programs, making a direct link between baccalaureate education and workforce preparation. Additionally, AB degree programs are frequently considered by state agencies to be the preferred form of baccalaureate degree awarded by community colleges. In some cases, the AB degree is used synonymously with a **community college baccalaureate** (CCB) degree (which is a baccalaureate degree that is awarded by an institution identified as a community college, technical college, two-year college, or other institution that primarily confers associate degrees). Acknowledging that AB degrees have been defined in different ways (see, for example, Arney et al., 2006; Pulley, 2010; Ruud & Bragg, 2011; Walker & Floyd, 2005), we began our study of AB degrees that prepare technicians and technologists in STEM career fields by using the definition of an AB degree presented by Townsend et al. (2008) due to its direct applicability to our work. Townsend et al. state that:

> The applied baccalaureate degree is defined as 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. (page iv)

This definition recognized AB degree pathways as establishing transfer pathways that encourage students to follow a "logical 'stepping-stone' process" (Bragg, Cullen, Bennett, & Ruud, 2011, p. 20) from an applied associate degree that has historically been considered terminal into the upper division coursework associated with the AB degree program. Following from this definition, AB degrees are awarded either by associate degree-granting institutions (in which case, it is also a CCB degree) or by baccalaureate degree-granting institutions.

Finally, it is helpful to share an understanding of the different curricular models for the AB degree that emerged from prior research, including the 50-state policy study conducted by Bragg and Ruud (2011). **Career ladder programs** provide stepwise academic and technical coursework extending from the associate to the baccalaureate degree program. **Management capstone programs** are those in which the associate degree program is supplemented with business and management-focused coursework at the upper division. The focus of **upside-down and completion programs** lies almost exclusively on general education coursework, while the lower division is accepted as a general elective block or treated as a large portion of the degree program's major. The difference between upside-down and completion tends to be in the structure and prescriptiveness of the curriculum. Upside-down degree programs frontload the technical course work and complement it with general education coursework at the upper-division level. Completion degree programs tend to be more wide-ranging in their requirements and structure, often maximizing students' chances of completing a baccalaureate degree by awarding credit for prior learning (Taylor, 2000). **Hybrid programs** represent a convergence of these models, with a unique blend between two or three program types.

Studying Baccalaureate Degree Pathways

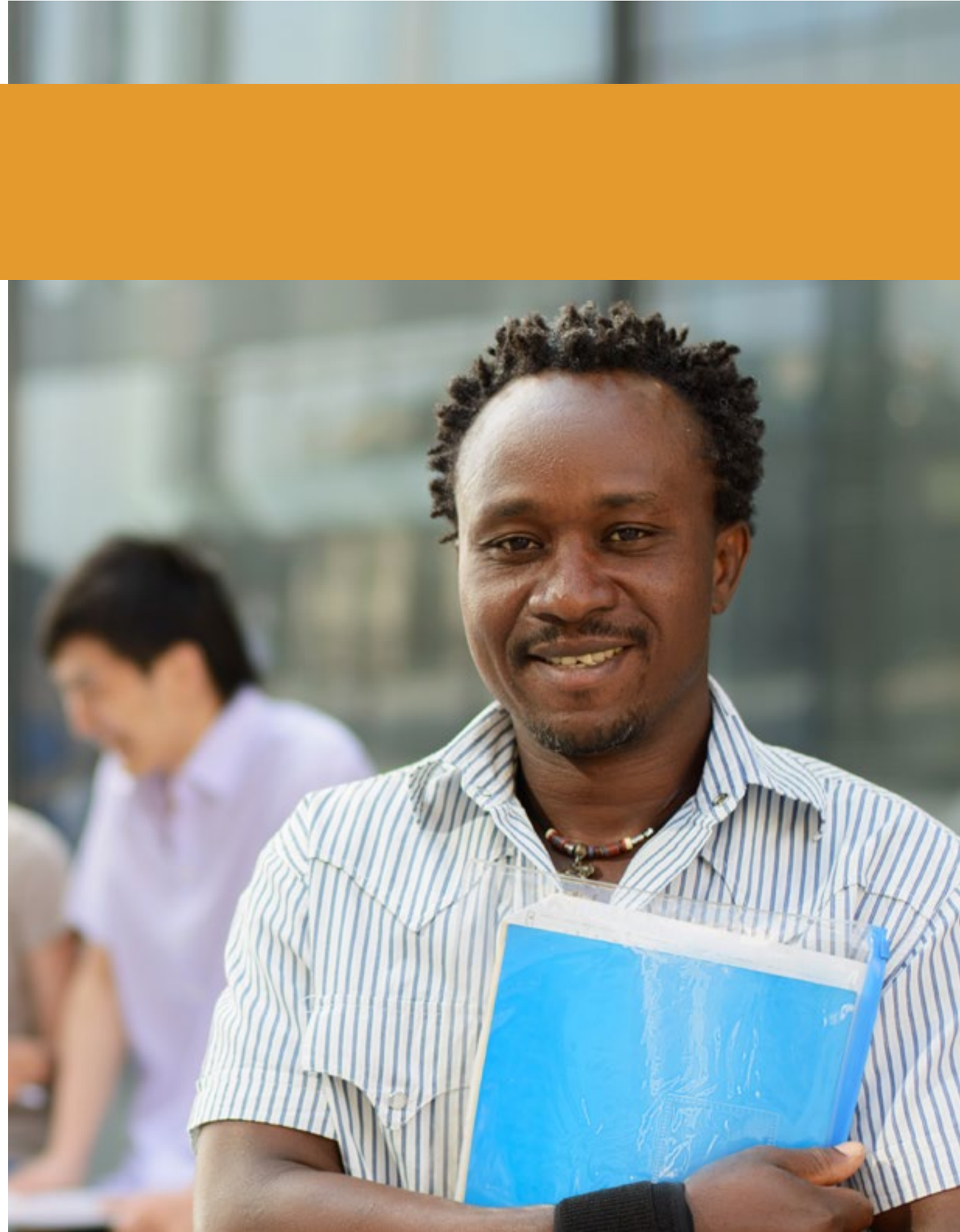
The Knowledge Gap

National calls for expertise and improved degree attainment in STEM fields (e.g., Chen & Weko, 2009; Huang, Taddese, & Walter, 2000; National Academy of Sciences, 2007) have stimulated the growth of degree programs, including emerging designs that create new opportunities for baccalaureate degree attainment where none previously existed. Little is known, however, about these emerging degree programs. Where are AB degree pathways found? How are AB degree programs structured, and what coursework is included in them? What are the driving factors for establishing AB degree pathways, and what are some of the key characteristics that distinguish AB degree programs? Our research aims to shed light on these and other questions related to baccalaureate degree pathways for technician and technologist education in STEM fields, with a particular interest in AB degree pathways.

Our Approach

We examined AB degree pathways through the lens of the NSF-ATE program. This was an attractive starting point because the NSF-ATE program offers a direct connection between STEM education offered by community colleges – the institutions that award applied associate degrees and therefore serve as the first step in the AB degree pathway – and STEM career fields.

The NSF-ATE program provides support for the implementation and creation of the ATE projects and centers, which are the focus of this research. According to the ATE grant solicitation, "**ATE centers** provide models and leadership and act as clearinghouses for educational materials and methods. They are cooperative efforts in which two-year colleges work with four-year colleges and universities, secondary schools, business, industry, and government" (NSF, 2011, p. 6).



ATE projects revolve around either single institutions or small consortia of institutions that intend to improve programs and curricula, establish professional development opportunities for professionals, better train educators and students, and establish programs in STEM fields. The importance of partnerships among two-year colleges, four-year colleges, business and industry, and other organizations is stressed throughout the ATE grant solicitation (NSF, 2011). Considering the focus of our work on pathways from associate to baccalaureate degrees, this focus on establishing inter-institutional partnerships offers promising foundations to support our inquiries.

Our research work to date has focused in three areas: (a) identifying baccalaureate degree pathways in technician and technologist education, (b) exploring the curricula that make up those degree pathways, and (c) describing characteristics of AB degree pathways. A full description of our study methods is available in Appendix A, however a brief description is offered here to provide a foundation for understanding the study findings.

Methods

Our study involved three primary components of data collection. First, we identified NSF-ATE projects and centers across the United States that are affiliated with pathways that lead from associate degrees to baccalaureate degrees. This was accomplished via an exploratory online survey that was sent to all Principal Investigators (PIs) who received NSF-ATE grants in the past 20 years, and led to their reporting of 95 baccalaureate degree pathways. This first survey gathered information on all types of baccalaureate degree pathways (rather than limiting our focus to AB degree pathways) in order to provide context and opportunities for comparison in later analyses.

Baccalaureate degree pathways typically included multiple higher education institutions that offered the associate degree and/or baccalaureate degrees, with as many as five institutions involved in a single pathway (e.g., four associate degree-granting institutions all articulating credits to a single degree program at a single baccalaureate degree-granting institution). When degree pathways crossed institutions, multiple respondents often provided information on the parts of the baccalaureate degree pathway, each person providing details on the part of the pathway with which they were most familiar. For clarity, we use the term "case" to describe each of the 95 baccalaureate degree pathways.

The second component of our research involved exploring curricula associated with the 95 cases of baccalaureate degree pathways identified in the exploratory survey. We searched departmental, degree program, and transfer information pages on the websites of all associate degree-granting and baccalaureate degree-granting institutions involved in each identified baccalaureate degree pathway to locate course requirements and curriculum sequence documents. This aspect of our research was challenging because information posted on the websites frequently omitted key details needed to provide a complete and accurate picture of the baccalaureate degree programs.

Despite recent calls for colleges and universities to post information regarding curriculum sequences, required courses, and outcomes prominently on their websites (e.g., Educational Policy Institute, 2006; Jankowski & Makela, 2010), many of the websites of institutions included in our study offered an incomplete picture of the baccalaureate degree offerings. We found evidence of baccalaureate degree pathways on institutional websites in 51 cases (53.1%), and in 40 cases (42.1%) we were able to examine course requirements and/or sequencing documents. Review of available documents allowed us to: (a) determine whether each case was an example of an AB degree pathway or a traditional baccalaureate degree pathway, (b) determine what curricular models were used (e.g., career ladder, management capstone, upside-down, completion, or hybrid), and (c) examine similarities and differences among identified curricula.

Finally, we used a follow-up survey and in-depth website reviews to examine identified AB degree pathways. The purpose of these activities was to understand the structure of and potential offered by these emerging opportunities for degree attainment. For the follow-up survey, we were able to contact 74 respondents from the exploratory survey, and received responses from 50 individuals regarding 40 baccalaureate degree pathway cases. Within these cases, survey respondents recommended 10 AB degree pathways that had notable characteristics that the research team should examine closely where "notable" was defined as having exemplary or promising characteristics in one or more of the following areas: addressing economic and societal needs, curricular alignment, program design, systematic evaluation, and replicability (Bragg, Bobik, Maxwell, & Palovik, 2002). In-depth website reviews of all departmental and degree program web pages were conducted for all higher education institutions that were involved in these 10 associate-to-baccalaureate degree pathways. The primary purpose of these website reviews was to (a) learn as much as possible about identified AB degree pathways, and (b) understand how information about these AB degree pathways is communicated to stakeholders.

This next section of this report provides an overview of each step in our data analysis and findings. The report concludes with a synthesis of eight key themes, which lead to new questions and directions for future research.

Data Exploration

This section of the report shares information on three stages of analysis, demonstrating our evolving understanding of AB degree pathways in technician education. The first stage of analysis is drawn from the exploratory survey of Principal Investigators (PIs) who received NSF-ATE grants over the past 20 years, aimed at identifying baccalaureate degree pathways. The second stage of data analysis used website reviews and document analysis to characterize curriculum design and to examine differences between applied and traditional degree programs. The third stage of analysis used follow-up surveys and in-depth website reviews to explore key components of AB degree pathways via brief case illustrations and comparisons. The stages of analysis are presented in the order in which they were completed, along with thematic findings derived from each analysis activity.

Identifying Baccalaureate Degree Pathways in Technician Education

Our first stage of data analyses examined results of an exploratory survey that was designed to identify NSF-ATE projects and centers that were affiliated with existing or new pathways from associate degrees to baccalaureate degrees. Identifying baccalaureate degree pathways was viewed as a first, necessary step toward gathering more detailed information on how these degree pathways operate, develop partnerships, and meet the needs of students, employers, and higher education institutions that are preparing technicians and technologists in STEM fields.

The exploratory survey was sent to all PIs who received NSF-ATE grants in the past 20 years. Of the 651 PIs that were

contacted, 233 (35.8%) responded to the survey from 231 NSF-ATE projects and centers. Note that two respondents provided information on the same NSF-ATE project or center. From these responses, 95 unique cases of associate to baccalaureate degree pathways in technician education were identified (41.1% of responding NSF-ATE projects or centers). Of the remaining respondents, 56 (24.2%) indicated that their NSF-ATE projects or centers were affiliated with associate degrees which did not have an established pathway to a baccalaureate degree, and 80 (34.6%) indicated that their NSF-ATE projects or centers were not affiliated with specific associate or baccalaureate degrees. A more detailed discussion of survey methods can be found in Appendix A.

This section of the report presents findings from the survey data analysis and concludes with a brief discussion of themes derived from our interpretation of the data. The findings provide insights regarding the prevalence of both traditional and emerging baccalaureate degree pathways. Survey data also indicate evidence of great variety of baccalaureate degree pathways, along with considerable gaps in understanding student participation and outcomes.

Findings

Respondents from the 231 NSF-ATE projects and centers participating in this study indicated that associate degrees were affiliated with their NSF-ATE project or center in 151 (65.4%) cases. In 95 of these cases (41.1% of the total 231 cases), respondents indicated that the affiliated associate degree programs had established formal pathways to baccalaureate degrees. The remainder of the results in this section focuses on the 95 cases in which respondents indicated formal pathways between associate and baccalaureate degrees.

In 35 of these 95 cases (36.8%), the identified degree pathways included only applied associate degrees (e.g., AAA, AAS), whereas only transfer associate degrees (e.g., AA, AS) were identified in 30 of these 95 cases (31.6%). In the remaining 30 cases (31.6%), respondents identified both applied associate degrees and transfer associate degrees affiliated with their NSF-ATE projects and centers.

In regard to baccalaureate degrees, in 16 cases (16.8%), the identified degree pathways included only AB degrees (e.g., BAS, BAT), whereas 58 cases (61.1%) included only traditional baccalaureate degrees (e.g., BA, BS). In 14 cases (14.7%), respondents identified both applied and traditional baccalaureate degrees affiliated with their NSF-ATE projects and centers. In 7 cases (7.4%), incomplete data was reported by survey respondents regarding the type of baccalaureate degree offered, so a determination between applied and traditional baccalaureate degrees could not be made.

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 over half (59.0%) indicating a single field of study and the remaining 41.0% indicated 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 (32.6% of cases), whereas 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 20.0% 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 (e.g., voice, video, data, mobile). The wide range of STEM fields associated with baccalaureate degrees was an 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.

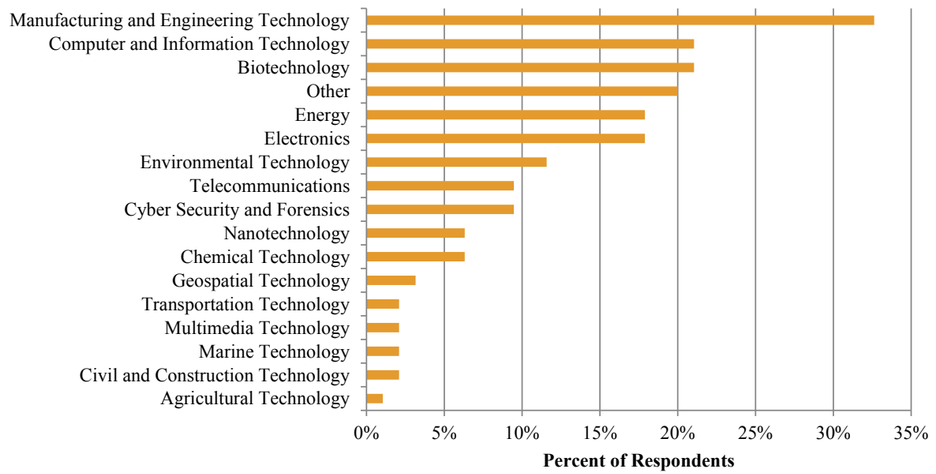


Figure 1. Prevalence of technical fields of study associated with NSF-ATE projects and centers that are affiliated with formal pathways between associate and baccalaureate degrees.

Community college baccalaureate (CCB) degrees were indicated in 19 of the 95 cases (20.0%). 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 that 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 such as a community college was found to be associated with increased knowledge of data collection regarding student participation and outcomes (See Table 1). 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 awarded by a primarily associate degree-granting institution 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. This finding is logical since student enrollment in one institution would simplify the data collection function considerably. Despite this advantage, we detect a considerable lack of knowledge

Table 1. Percent of Cases that Indicated Availability of Student-Level Data at the Baccalaureate Degree Level by Institution Type Awarding Degree(s)

	Baccalaureate Degree Awarded by							
	Primarily Associate Degree-Granting Institutions (N=19)				Primarily Baccalaureate Degree-Granting Institutions (N=76)			
Data Type	**Yes**	**No**	**Don't Know**	**No Response**	**Yes**	**No**	**Don't Know**	**No Response**
Demographics	36.8%	15.7%	42.1%	5.3%	23.7%	13.2%	54.0%	9.2%
Academic Performance	36.8%	21.1%	42.1%	0%	17.1%	13.2%	57.9%	11.4%
Post- Graduation	26.3%	21.1%	52.6%	0%	10.5%	14.5%	64.5%	10.5%

among respondents 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 target 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 suggests 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.

What We Learned

Using a national survey to identify NSF-ATE projects and centers that were affiliated with pathways from associate degrees to baccalaureate degrees provided the opportunity to gain a sense of the prevalence of these pathways. It also stimulated many questions regarding the development of these pathways and the partnerships among participating institutions. The themes presented here demonstrate insights gained from the exploratory survey.

Numerous degree pathways exist, representing both traditional and emerging degree patterns. Findings from the exploratory survey 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 include historically traditional associate (e.g., AA, AS) and baccalaureate (e.g., BA, BS) degrees, but they incorporate emerging degree opportunities, including applied associate (e.g., AAA, AAS) and AB degrees (e.g. BAS, BAT).

Degree pathways are marked by variety. Established pathways to baccalaureate degrees are quite varied from one case to another. For the 95 identified cases of formal pathways between associate and baccalaureate degrees, variation was uncovered in the types of degrees offered (traditional, applied, or a combination of the two), and respondents identified more than 30 different fields of study associated with their degree programs. Whereas in most cases 4-year institutions awarded baccalaureate degrees, we found 19 instances in which baccalaureate degrees were granted by community colleges. 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 expected 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?

Considerable uncertainty remains, even for those who are directly involved in the degree pathways. Finally, the data from this exploratory survey suggest that considerable uncertainty exists regarding student participation in baccalaureate-level 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 underserved student populations were unknown by survey respondents. Further research is needed 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, baccalaureate degree pathways require productive partnerships among colleges and universities, and an important aspect of our future research will examine what notable baccalaureate programs are doing to implement these kinds of facilitative processes.

Exploring Curricula in Baccalaureate Degree Pathways

Our second stage of data analyses focused on results of a website review designed to examine curricula required in the 95 associate to baccalaureate degree pathways that were identified in the exploratory survey for this project. Examining curricula provided an opportunity to (a) determine whether each case of an identified baccalaureate degree pathway was an example of an AB degree pathway or a traditional baccalaureate degree pathway, (b) determine what curricular models were used (e.g., career ladder, management capstone, upside-down, completion, hybrid), and (c) examine similarities and differences among identified curricula. We reviewed departmental, degree program, and transfer information pages on the websites of all associate degree-granting and baccalaureate degree-granting institutions involved in 77 of the 95 (81.1%) baccalaureate degree pathways identified in the exploratory survey. We omitted the remaining 18 cases (18.9%) because the information that respondents provided on the exploratory survey was insufficient to conduct a website review.

Before presenting findings, it is important to recognize some limitations of using higher education institutional websites as a primary data source. The information posted to websites is continually evolving, and there are many reasons that institutions may choose to post (or not post) information to a website. Not being able to locate evidence of a degree pathway in our searches does not necessarily indicate that a degree pathway does not exist. Rather, in this section of the report, we discuss the cases in terms of the pathways for which we could (or could not) find evidence on institutional websites. More detailed information on the website search methods and limitations is available in Appendix A.

This section of the report presents findings from the website search and curriculum exploration analysis in three parts. First, the prevalence of finding evidence of baccalaureate degree pathways in technician education is acknowledged. Pathways that could be identified are then categorized by whether they are applied or traditional baccalaureate degree pathways, as well as by the curricular models that are employed for upper-level baccalaureate courses. Second, we offer examples of each curricular model (career ladder, management capstone, upside-down or completion, and hybrid) to illustrate similarities and differences in practice. Finally, we examine eight identified cases in which both applied (nontransferable) and transferable associate degree programs are offered within a single field at a single institution. These curricula are compared to examine similarities and differences between associate degrees in which courses transfer as a block and those that do not.

This section concludes with a brief discussion of themes derived from our interpretation of the data. Findings provide insights into the design of curricula, as well as development and adaptation of baccalaureate degree pathways over time. The data also shed light on strategies used to mold terminal associate degrees into transferable associate degrees, as well as reveal missed opportunities for communication with key stakeholder audiences.

Descriptions of Curricula

Existence of pathway evidence on institutional websites. Table 2 shows the results of website searches of the 95 cases drawn from responses to our exploratory survey. For 51 (53.7%) cases, evidence of baccalaureate degree pathways was found on institutional websites. We were able to confirm that 35 of those cases were AB degrees, based on the indication of applied coursework in the name of the associate credential (e.g., AAS, AT) or baccalaureate credential (e.g., BAS, BT), as well as examination of coursework within the degree requirement documents. A total of 4 cases were identified as traditional baccalaureate degree pathways and in 12 cases, insufficient information could be located on the course sequences and patterns to make a determination between applied and traditional baccalaureate degree pathways.

In 2 cases credits from applied associate degrees transferred to a traditional baccalaureate degree; however, the number of credits that transferred was well below that of associate degrees that transfer as a block (approximately 60 semester credit hours). In one case, only 36 credit hours of a 64 credit hour AAS degree program transferred. In the other case,

Table 2. Website Search Results

Website Search Results	Number (N = 95)	Percent
Found evidence of baccalaureate pathways	51	53.7%
AB degree pathway	(35)	(36.8%)
Traditional baccalaureate degree pathway	(4)	(4.2%)
Unclear whether the degree pathway is applied or traditional	(12)	(12.6%)
Found evidence of credit transfer to baccalaureate degrees, yet total transfer was well below 60 credit hours	2	2.1%
Degree program no longer exists	1	1.1%
Could not find evidence of baccalaureate pathways on website	23	24.2%
Did not have enough information from survey to complete a website search	18	19.0%

the website stated only that "many of the courses obtained through the AAS degree can be transferred to the [receiving institution's] baccalaureate degree in biotechnology should students wish to continue their studies at a higher level." As such, we created a new category for these baccalaureate pathways due to their considerable differences in design from the 51 cases that transferred associate degrees as a block.

In 1 case, we found evidence that the degree program affiliated with the baccalaureate degree pathway had been discontinued. For the remaining 41 cases (43.2%), we were not able to locate any evidence of the baccalaureate degree pathways that were identified by respondents on the exploratory survey. In 18 of these 41 cases, information provided by the respondent(s) to our exploratory survey was not detailed enough to conduct a focused website search. In 23 of the 41 cases, detailed information was provided on the exploratory survey to identify a clear baccalaureate degree pathway and the higher education institutions involved; however, we could not find evidence of this pathway showing the relationship between degree programs and institutions on the institutional websites.

Curriculum models. Focusing on the 51 cases where we found evidence of baccalaureate degree pathways, we sought degree requirements, course sequences, and articulation agreements for the each of the associate and baccalaureate degrees that were a part of the identified baccalaureate degree pathways. Using these artifacts, with a particular focus on the upper-level coursework that was required for the baccalaureate degree, we categorized the identified pathways into a variety of curricular models, including: career ladder, management capstone, upside-down or completion, and hybrid programs (definitions of these models are provide on page 4 of this document.) We also noted when evidence found on institutional websites indicated that baccalaureate degree pathways were currently in development, as well as cases in which we were not able to determine which curriculum model best described the pathway. The most common reason for not being able to determine a curriculum model was the inability to locate adequate information on degree requirements and course sequences.

Table 3 shows the identified curriculum models across all baccalaureate degree pathways. Note that 28 (54.9%) of the identified baccalaureate degree pathways used a career ladder curriculum model with primarily technical coursework required in the upper-level curriculum, while 9 (17.7%) offered management capstone models with a primarily business focus in the upper-level curriculum. The other curriculum models (upside-down, completion, hybrid) were found less frequently. In 7 cases (13.7%) it was not possible to determine the most fitting curricular models from the information provided on institutional websites. Finally, of the 51 cases with evidence of baccalaureate degree pathways on their websites, 9 (17.6%) of the pathways were currently in development. Of these 9 cases, only 1 had both an established degree pathway and a degree pathway in development. The remaining 8 cases had only degree pathways in development. Further, this finding suggests that, in at least 9.5% of all of the 95 cases in which respondents to the exploratory survey indicated

Table 3. Identified Curriculum Types Across All Baccalaureate Degree Pathways

Curriculum Models	Number of Cases	Percent of Cases*
Career Ladder	28	54.9%
Management Capstone	9	17.7%
Upside-down or Completion	2	3.9%
Hybrid	4	7.8%
Unable to Determine	7	13.7%
In Development – Career Ladder (Technical)	4	7.8%
In Development – Management Capstone	1	2.0%
In Development – Unable to Determine	4	7.8%

* Note that percentages do not add up to 100% because some cases had multiple baccalaureate pathways, fitting into multiple categories of curriculum types.

that baccalaureate pathways existed, we identified a baccalaureate degree pathway that was currently in development. These data suggest that the establishment of baccalaureate degree pathways affiliated with NSF-ATE projects and centers is a growing phenomenon.

Table 4 and Figure 2 show the curriculum model data divided into baccalaureate pathways that were confirmed as applied and traditional, as well as those for which the applied or traditional designation was unclear. Note that all cases of traditional baccalaureate degree pathways where curricula were located for analysis followed a career ladder curricular model. This is not to say that other curricular models do not exist for traditional baccalaureate degree pathways; it simply indicates

Table 4. Curriculum Types for Applied Versus Traditional Degree Pathways

	Applied Baccalaureate		Traditional Baccalaureate		Unclear if Applied or Traditional	
Curriculum Models	Number of Cases	Percent of Cases*	Number of Cases	Percent of Cases	Number of Cases	Percent of Cases
Career Ladder	18	51.4%	4	100.0%	6	50.0%
Management Capstone	9	25.7%	0	0.0%	0	0.0%
Upside-down or Completion	1	2.9%	0	0.0%	1	8.3%
Hybrid	4	11.4%	0	0.0%	0	0.0%
Unable to Determine	5	14.3%	0	0.0%	2	16.7%
In Development – Career Ladder	4	11.4%	0	0.0%	0	0.0%
In Development – Management Capstone	1	2.9%	0	0.0%	0	0.0%
In Development – Unable to Determine	1	2.9%	0	0.0%	3	25.0%

* Note that percentages do not add up to 100% because some cases had multiple baccalaureate pathways, fitting into multiple categories of curriculum models.

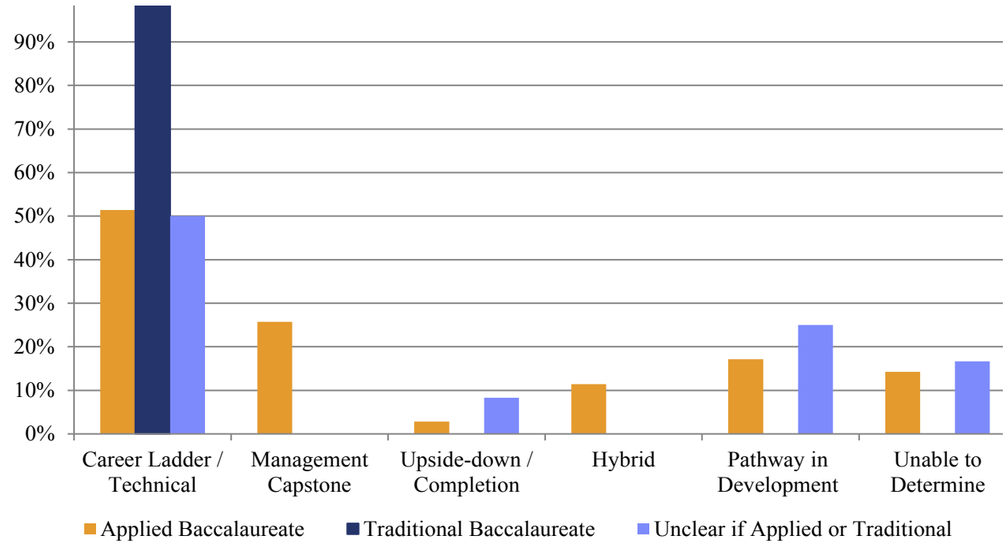


Figure 2. Percent of cases for each curriculum model, comparing applied versus traditional degree pathways.

that evidence of other models was not found during the website searches for this project. The small number of available pathways for consideration (4) indicates that caution is needed when considering the implications of this finding.

In the case of AB degree pathways, as well as pathways that could not be identified as applied or traditional, the curriculum models were more varied. The career ladder model remained the most prevalent (51.4% and 50.0%, respectively). Examples of management capstone, upside-down or completion, and hybrid curriculum models were also found related to AB degree pathways. The upside-down or completion model was confirmed for one pathway that could not be categorized as applied or traditional; other curricular models could not be determined for this group.

General articulation agreements. Finally, we looked beyond the specific degrees and fields associated with the cases reported by respondents to the exploratory survey, asking whether evidence of general articulation agreements existed to facilitate baccalaureate degree attainment. These general articulation agreements typically accepted the transfer of any associate degree (sometimes including applied associate degrees) as a block of credits into one or more baccalaureate degree programs. Of the 51 cases with evidence of baccalaureate degree pathways, information on general articulation agreements was found on 18 (35.3%) of the institutional websites. Table 5 shows the curriculum models offered in the baccalaureate degree programs associated with available general articulation agreements, divided into baccalaureate pathways that were confirmed as applied versus traditional, as well as those for which the applied or traditional designation was unclear. In the majority of cases (61.1% overall), an upside-down or completion curriculum model was offered by these broad articulation agreements. A smaller percentage of cases (16.7% overall) offered management capstone options in these baccalaureate pathways, and we were unable to determine the curricular model in 5 cases (27.8%).

Broad and general articulations that we were able to identify on institutional websites were most often offered by private, for-profit institutions (e.g., Argosy University, Herzing University, Strayer University, University of Phoenix). Private, not-for-profit institutions were also included in this group (e.g., Bellevue University, Franklin University, National Labor University). This is not to say that

Table 5. Curriculum Types for Applied Versus Traditional Degree Pathways, for Institutions with Information about General Articulation Agreements Available on their Websites

	Applied Baccalaureate		Traditional Baccalaureate		Unclear if Applied or Traditional	
Curriculum Models	**Number of Cases**	**Percent of Cases***	**Number of Cases**	**Percent of Cases***	**Number of Cases**	**Percent of Cases**
Upside-down or Completion	8	57.1%	2	66.7%	1	50.0%
Management Capstone	3	21.4%	0	0.0%	0	0%
Unable to Determine	3	21.4%	1	33.3%	1	50.0%

* Note that percentages do not add up to 100% because some cases had multiple baccalaureate pathways, fitting into multiple categories of curriculum models.

general associate degree articulation agreements do not exist with public institutions; it simply indicates that evidence of such transfer relationships were not found during our website searches. The small number of available pathways for consideration (18) indicates that caution is needed when considering the implications of this finding.

Examples of Curricula Models

This section offers examples and discussion of the four curricular models introduced above: (a) career ladder, (b) management capstone, (c) upside-down or completion, and (d) hybrid. The purpose of this section is help readers understand what these models look like in practice. Full lists of course requirements are provided in Appendix B.

The four examples presented here were drawn from the cases in which we found clear evidence of an existing baccalaureate degree pathway, as well as full course requirements and sequence documents available on institutional websites. Note that the baccalaureate degree-level courses are the focus of these analyses, as the upper-level courses in the baccalaureate degree pathway are used to determine the curricular model.

Example career ladder (for technical curriculum). Students who receive the Associate of Applied Science in Information Technology (IT) at any of the institutions in the Kentucky Community and Technical College System (KCTCS) have a transfer option into Western Kentucky University's (WKU) Bachelor of Science (BS) degree in Computer Information Technology (CIT). The CIT degree is offered entirely online, so students who graduate with a KCTCS AAS degree in IT may complete baccalaureate-level coursework without having to relocate to WKU.

WKU offers two routes for transfer students in the BS-CIT degree program to complete their general education requirements. Students enrolled in the BS-CIT program at WKU may: (a) complete 22 credit hours of general education courses at WKU, or (b) complete 23 credit hours of general education courses at another KCTCS institution. In addition to required general education courses, students must take either 36 or 42 credits of CIT-specific courses, depending on whether they fulfilled their general education requirements at WKU or a KCTCS institution, respectively. Of these additional credits, 12 are prescribed and include courses related to the technical major, such as: Online Training Foundations, Web Development, Database Administration II, and Telecommunications II. The remainder of the program consists of 24 credits associated with CIT courses at the 400 (senior) level and any remaining courses at the 300-400 level.

The 6-credit difference between degree sequences consists of 2 additional CIT electives required of students who fulfill their general education requirements through a KCTCS institution. In all, students transfer all 67-75 credits of AAS coursework to the baccalaureate program, take an additional 22-23 credits of general education, and 36-42 credits of technical coursework. The continuation of both academic and technical coursework into the upper-division program provides a solid example of a career ladder curricular model.

Example management capstone curriculum. For this example, it is important to note that the State of Washington operates under the quarter system, rather than the semester system. Within the quarter system, students who acquire baccalaureate degrees typically have a minimum of 180 credit hours whereas those with associate degrees have 90 credits.

Students at Edmonds Community College who graduate with the Associate of Applied Science-Transfer (AAS-T) degree in Energy Management have the opportunity to transfer to Central Washington University's (CWU) Bachelor of Applied Science (BAS) degree in Information Technology and Administrative Management (ITAM). The AAS-T degree requires a minimum of 100 credit hours, including completion of 25 credits of general education (15 credits of English/communication, 5 credits of mathematics, and 5 credits of reasoning); 5 credits in a Human Relations Course; 5 credits of computer specialization; and 61 credits of "core requirements" which includes courses in Energy Management, two courses in general management, and 6 credits of elective courses.

Although the BAS-ITAM degree is awarded by the four-year institution of CWU, classes are offered on the Edmonds Community College campus. Students in this BAS degree may select from two specializations – Information Technology or Administrative Management. Within the BAS program, students fulfill 36-45 credits of "breadth requirements," which consist largely of general education courses such as literature, philosophy, sciences, and world cultures. In addition, students take 36 credits of core courses that are management-related, including Customer Relationship Management, Leadership & Supervision, and Business Math. The Administrative Management specialization requires students to take an additional 26-29 credits, which includes courses such as Managerial Communication and Administrative Management Policy, as well as 7-10 credits in a summer internship.

What makes this program a fitting example of a management capstone model curriculum is that the courses in the BAS degree are not specifically related or tailored to the technical field of Energy Management. Students who receive the AAS-T degree become specialized in the area of Energy Management, and then accumulate 62-65 additional credits of management-focused courses and 36-45 credits of general education courses to receive a baccalaureate degree in Administrative Management. According to an information packet for the BAS-ITAM degree:

> This dynamic program adds the business component to the technical knowledge area to make the student more marketable in their knowledge area. Industry tells us they need workers that can be promoted from the entry-level positions, workers that understand how their job fits within the organization, and those that can manage people, projects, or information. (www.cwu.edu/itam/PDF/BASapply/slick_online_itam_bas.pdf)

This example illustrates how a management capstone supplements a technical associate degree program with business and management-focused coursework at the upper division.

Example upside-down or completion curriculum. Students who graduate with any applied associate degree from Quinsagamond Community College's Business and Technology Division have access to a direct articulation agreement to a completion degree program at Assumption College. According to the articulation agreement:

> This agreement is formed to enable the smooth transfer of Quinsagamond graduates to Assumption College Continuing and Career Education…by 1.) identifying all required and equivalent courses for the relevant programs at each institution, and 2.) facilitating credit transfer and guarantee of admission for students who meet the agreed upon criteria. (www.qcc.mass.edu/transfer/PDFfiles/Assumption_CCE-HumServ_HSRS.pdf)

According to the agreement, students who graduate with an associate degree from the Business and Technology Division with at least a 2.5 grade point average are guaranteed admission to the baccalaureate degree program. All coursework transferred to the Assumption College baccalaureate programs must have been completed with a grade of C-minus or better to qualify. The agreement allows for transfer of up to 75 credits, accepting full transfer of the specified associate degrees as "open electives." In Assumption College's baccalaureate program, open electives make up 63 of the 120 required credits. Remaining courses consist of general education requirements ("core requirements") and a 24-credit concentration wherein students can "choose from criminal justice, economics, psychology, sociology, and general social sciences." A capstone course, described as "a multi-disciplinary directed study, designed by the student, and completed under supervision and guidance of Assumption faculty," is also required. (Information taken from www1.assumption.edu/cce/AcademicPrograms_BachelorofScienceinSocialSciences.html).

Since the baccalaureate degree program provides for transfer of a wide variety of associate degrees and fields, as well as focuses the degree requirements on general education, it serves as a model of a completion degree. Note that the degree does not require additional technical coursework related to a student's associate degree major or management-related coursework, making it a poor fit for the curricular models that were previously discussed.

Example hybrid curriculum. The Bachelor of Applied Technology (BAT) at Idaho State University (ISU) was designed to "provide College of Technology [CTech] graduates the opportunity to expand their general education competencies and to enhance the technical coursework of their AAS with related academic coursework" (isu.edu/ctech/studentservices/degrees-certificates.shtml). Despite the original focus on students who receive technical associate degrees from Idaho State University's CTech, the degree program also accepts out-of-state AAS degrees on a case-by-case basis with the comparison of courses taken to state standards.

The BAT degree program is offered in two tracks. The first track, for students who receive a three-year AAS degree in Electronic System Technology from ISU, allows 76 credit hours to transfer, including some general education coursework. The second track is a pathway for "all other ISU CTech AAS Programs." In this second track, the BAT allows for 50 AAS credits to transfer as a block. AAS programs at ISU require 16 credits of general education, all of which transfer to the BAT.

Students who transfer 50 credit hours of their AAS degree are required to complete an additional 78 credit hours to receive the BAT degree. Individual degree plans are designed by students and must be pre-approved by the BAT Committee. Students must complete an additional 18 credit hours of general education and a minimum of 36 credit hours of academic coursework. Within their academic coursework, 12 credit hours must "support the AAS technical coursework" by being taken in a similar technical area. Based on information posted in the Idaho State University website, it is unclear how the additional 24 credit hours (of the 128-credit hour minimum requirement) are structured. This mixture of general education, academic, and technical requirements related to students' AAS field of study makes Idaho State University's BAT degree program a solid example of a hybrid curricular model.

Synthesis. Table 6 offers a side-by-side comparison of the four example curricula. Note that percentages are offered for each of the required credit hour types. These percentages facilitate comparison because Central Washington University operates on a quarter system (generally 180 credit hours in baccalaureate degree programs), while the other three examples operate on a semester system (generally 120 credit hours in baccalaureate degree programs).

Regardless of the curricular model, all of these examples allow for most of the associate-level courses to transfer as a full block of credits. In the case of Idaho State University, 50 credit hours (as shown in Table 6) is the minimum number that transfers. The actual number of credit hours varies from one associate degree program to the next, with as many as 76 credits transferring from Idaho State University's AAS degree in Electronic System Technology to the BAT.

Additionally, all of the baccalaureate pathway degree examples show a similar percentage requirement (14.1%-19.1%) for general education in the baccalaureate degree. This prescription of a minimum core set of general education requirements is even seen within completion degree programs at Assumption College, which allowed greater flexibility in the selection of upper-division coursework than the other example institutions.

Table 6. Representations of Four Applied Baccalaureate Curricular Models

Model	Career Ladder		Management Capstone		Completion		Hybrid	
Examples†	Western Kentucky University BS CIT		Central Washington University BAS ITAM		Assumption College BS Social Science / BA Humanities		Idaho State University BAT	
	Credit Hours	Percent of Total Curricula	Credit Hours	Percent of Total Curricula	Credit Hours	Percent of Total Curricula	Credit Hours	Percent of Total Curricula
Associate Transfer	67	53.6%	90	47.9%	62	51.7%	50	39.1%
General Education in Baccalaureate Degree	22	17.6%	36	19.1%	21	17.5%	18	14.1%
Technical Coursework	36	28.8%	0	0.0%	0	0.0%	12	9.4%
Managerial Coursework	0	0.0%	62	33.0%	0	0.0%	0	0.0%
Open Electives	0	0.0%	0	0.0%	10	8.3%	24	18.8%
Academic Coursework††	0	0.0%	0	0.0%	27	22.5%	24	18.8%
Total	**125**		**188**		**120**		**128**	

† WKU credits outlined are for the option wherein a student transfers to WKU and completes the general education requirements there. These calculations assume the lowest number of credits that can transfer.
CWU is on the quarter system, generally requiring 90 credits for an associate degree and 180 for a baccalaureate. Credits outlined assume a 90-credit associate degree transfer.
Assumption College credits assume the lowest number of credits transferring from an AAS (62).
Idaho State University requires 128 credits to qualify for the BAT, but prescribes 104, so the additional 24 are assumed to be open electives.

†† Academic coursework is defined as coursework required of a particular degree but beyond core general education requirements (such as a required minor), and not required to be technical.

The most apparent differences across the four example curricula occur in the proportion of technical, managerial, and other elective and academic coursework beyond required general education courses. The career ladder model contained only general education and technical coursework. The management capstone model offered a combination of general education and managerial courses. The hybrid and completion models were more complex. While students in the hybrid model program were required to take 12 credits of coursework in their technical associate degree's focus, there remained flexibility in open electives and other academic coursework. Similarly, students in the completion program were required to take a combination of open-elective credits and credits in a typically humanities-focused "concentration" to fulfill the baccalaureate degree.

Comparison of Applied Associate and Traditional Associate Degree Requirements

One goal of the curricular exploration was to examine the difference between transferable and nontransferable associate degree programs. We identified eight cases in which two distinctive associate degree tracks were available in a single field at a single institution. In each case, we found evidence that one degree track transferred to at least one baccalaureate degree program, whereas the other degree track did not exhibit evidence of an available baccalaureate degree pathway. These eight cases provide an opportunity to consider programs that fall within the same institutional context but represent curricular differences that separate degrees from being transferable to being nontransferable.

Table 7 outlines the eight cases, providing information on which degrees were transferable, as well as the degree of difference between the transferable and nontransferable degrees. It is important to note that during our data collection one of these institutions, Cochise Community College, was in the process of developing a new baccalaureate degree pathway with Arizona State University's College of Engineering that would allow the nontransferable AAS degree to transfer, in addition to the already transferable AS degree. Differences in the transfer arrangements for the AS and AAS degrees were not available at the time of our data collection and, therefore, are not included in this analysis. The Cochise Community College case was addressed in the same manner as the other seven cases that are presented here. The remainder of this section explores three categories (minimal, moderate, and substantial) of differences between the transferable and nontransferable associate degrees.

Minimal differences. In four cases (half of the cases identified), we found minimal differences between transferable and nontransferable associate degrees. In three cases in Florida, the difference between a transferable AS degree and a nontransferable AAS degree, as published in the course catalogs for the 2011-2012 school year, came down to a single 3-credit hour course. This is 5% of the total number of credit hours (60-63) that students complete in these associate degrees. As demonstrated by the Lake-Sumter Community College example in Table 8, in all three Florida cases, descriptions of the AS and AAS degrees on the institutions' websites and in course catalogs match word-for-word, with only the replacement

Table 7. Institutions with Two Degree Tracks in a Single Field

Institution	State	Field	Transferable Degree	Nontransferable Degree	Difference between the Degrees†
Brevard Community College	FL	Engineering Technology	Associate in Science	Associate in Applied Science	Minimal
Hillsborough Community College	FL	Engineering Technology	Associate in Science	Associate in Applied Science	Minimal
Lake-Sumter Community College	FL	Computer Information Technology	Associate in Science	Associate in Applied Science	Minimal
Northeast Wisconsin Technical College	WI	Electrical Engineering Technology	Associate Degree - Transfer Track	Associate Degree - General Track	Minimal
Edmonds Community College	WA	Energy Management	Associate in Applied Science - Transfer	Associate of Technical Arts	Moderate
Cochise College	AZ	Engineering	Associate of Science	Associate of Applied Science††	Substantial
Rochester Institute of Technology	NY	Applied Computer Technology	Associate of Science	Associate of Applied Science	Substantial
Tulsa Community College	WA	Biotechnology	Associate in Science	Associate in Applied Science	Substantial

† Minimal differences between transferable and nontransferable degrees amounted to 1 or 2 classes; approximately 5 – 11% of the curriculum. Moderate differences amounted to 4 or 5 classes, or approximately 20% of the curriculum. Substantial differences amounted to 30% to 60% of the curriculum being different between the degree programs.

†† The Cochise College AAS degree may soon transfer, according to the program's website.

of the degree indication as an AS or AAS. In a case in Wisconsin, the difference between the transfer track associate degree and general track associate degree was attributable to 8 of 70 credit hours (11% of the total credits). Table 8 shows the Northeast Wisconsin Technical College website presents the two degrees together on the website, indicating that calculus differentiates the tracks.

In three of these cases, the difference between degrees relates to mathematics classes. At Brevard Community College in Florida, AS students take College Algebra to prepare for transfer whereas AAS students take Intermediate Algebra. At Hillsborough Community College, AS students take a transferable Mathematics General Education class whereas AAS students take a non-transferable Introduction to Mathematics with Applications course. Speaking with representatives at both of these programs, we learned that the AS programs were relatively new to the campuses. Brevard Community College developed the AS program with higher-level algebra to satisfy requirements for their students to transfer to the baccalaureate degree-granting institution, Daytona State College, and in Fall 2001, the AAS program at Brevard Community College was discontinued. Approximately 40 previously enrolled students remained in that degree program in Fall 2011, and the college was encouraging these students to change to the AS program. Hillsborough Community College indicated political reasons for establishing the AS degree program with higher math requirements. Whereas the Hillsborough Community College respondent did not indicate immediate plans to discontinue the AAS degree, he indicated that "the whole State [of Florida was] moving away from the AAS degree… it will be discontinued statewide." At Northeast Wisconsin Technical College, all students take courses in trigonometry and college algebra. The difference in mathematics curricula is that students in the transfer associate degree track also take 8 credit hours of Calculus divided between Calculus I and II. In place of these upper-level mathematics classes, students in the general associate degree track take 6 credit hours of electives and 2 credit hours of technical courses.

In the case of Lake-Sumter Community College, a single composition course marks the difference between the transferable AS in Computer Information Technology and the nontransferable AAS in Computer Information Technology. Students pursuing the transferable AS degree take a 3-credit hour course in "Composition: literature." Students pursuing the nontransferable AAS degree take an additional 3 credit hours of professional electives, with writing requirements focused on computer literacy and technical report writing to help students prepare for writing that they will experience in the workplace. A representative from Lake-Sumter Community College reiterated political influences in the State of Florida "for the most part, moving back to only an AS degree." Within the next year, Lake-Sumter Community College planned to discontinue all but one AAS degree (including discontinuing the AAS in Computer Information Technology), so that only the transferable AS would remain.

Moderate differences. The transferable AAS-T and nontransferable ATA degree programs in Energy Management at Edmonds Community College overlap in approximately 80% of the required credit hours. The overlap is found in the core requirements and electives, as well as professional development seminars and internships. Courses that differ fall primarily into the area of general education. In some courses, students in the nontransferable ATA degree are given more flexibility regarding the courses from which they may choose. For example, students in the transferable AAS-T degree are required to take English Composition I, while students in the nontransferable ATA degree have a choice between English Composition I, Introduction to College Writing, and Business Communications to fulfill this requirement. Additionally, students in the transferable AAS-T degree are required to take Public Speaking, while students in the nontransferable ATA degree have a choice between Public Speaking or Business Presentations to fulfill this requirement. There are also a few courses that are uniquely required by each degree. Students in the transferable AAS-T degree must take courses in English Composition II and Introduction to Logic. Students in the nontransferable ATA degree must take a course in either Business Math or Mathematics in Society.

Both of these Energy Management degree programs are quite new. The nontransferable ATA degree program was developed first, approximately three years before our Fall 2011 data collection. The transferable AAS-T program was developed a year later based on encouragement from Edmonds Community College administrators to create an articulation with Central Washington University's BAS in Administrative Management. The baccalaureate degree is awarded through Central Washington University, but students can take all courses on the Edmonds Community College campus. The AAS-T and ATA program descriptions available on the Edmonds Community College website demonstrate a clear different focus between the two degrees (see Table 8).

Substantial differences. In this final category of differences between transferable and nontransferable degree programs, at least 30% (and as much as 60%) of the courses differ between the two degree programs. Differences are noticeable across the curricula, including general education / liberal arts, writing, mathematics, and science courses. Although, as illustrated in Table 8 and the examples previously discussed, the program descriptions that appear on websites or in course catalogs may not reflect the differences between the curricula particularly well.

The transferable AS and nontransferable AAS degree programs in Engineering at Cochise Community College in Arizona overlap in approximately 40 credit hours (62% of the total degree requirements) which represent a variety of courses, including upper-level mathematics and science. For example, students in both degree tracks take courses in calculus (three levels), differential equations, physics with calculus (two levels), and programming for engineers. A notable difference is the sequencing of the semesters in which these courses are recommended. AAS degree students are encouraged to start their mathematics sequence with pre-calculus in their first semester, which is applied to their credit requirements for their major. The following calculus courses (levels I – III) are then offered in semesters 2 to 4. AS degree students begin with Calculus I in their first semester, and complete the sequence earlier than their AAS counterparts, even though both groups of students achieve the same level of mathematics course completion. In addition to the difference in course sequencing, the AAS degree allows more flexibility than the AS degree in selecting mathematics and science electives. For example, while AS students are required to take General Chemistry I and II, AAS students have the opportunity to choose between chemistry, biology, and linear algebra for their electives. Finally, AAS students have fewer liberal arts and humanities courses to complete, with a required 6 credit hours in these areas as opposed to the AS students' approximately 15 credit hours in these areas.

The transferable AS and nontransferable AAS degree programs in Biotechnology at Tulsa Community College in Washington overlap by 45 credit hours (approximately 70% of the total required credit hours in each degree). Students in both degree programs take College Algebra, English Composition I, two social science electives, and 24 credit hours of Biotechnology electives. The primary differences in the degrees are found in the liberal arts and social science requirements, as well as the types of science classes required. The transferable AS degree requires students to complete a course in English Composition II, while AAS students take a course in Technical and Professional Writing. Beyond this, AS students complete 9 additional credit hours of humanities electives that may be selected from a list of course offerings. AAS students complete 6 credit hours of humanities electives which are prescribed for them – a course in Medical Ethics and a course in Elementary Statistics. In regard to science classes, AAS students are required to take introductory level courses (e.g., Introduction to Biology for Majors; Introductory Organic and Biochemistry) while AAS students take higher-level science classes (e.g., General Chemistry I; General Chemistry II; Organic Chemistry I).

The transferable AS and nontransferable AAS degree programs in Applied Computer Technology at Rochester Institute of Technology in New York have overlap in courses that make up approximately 40% of the full degree programs. These courses cover topics such as introductory information technology courses, freshman and writing seminars, and wellness education. Beyond this, many differences exist between the degree programs. Both degree programs require 12 credit hours of math, yet

Table 8. Example Descriptions of Transferable and Nontransferable Associate Degrees

Institution	Descriptions of Programs
Lake-Sumter Community College (Minimal difference in curricula)	***Transferable AS degree:*** The Computer Information Technology A.S. degree program develops students who can apply their knowledge & skills in software, hardware, networking and/or programming to troubleshoot problems, analyze opportunities, develop multiple solution strategies, and communicate effectively with all constituencies. (www.lscc.edu/academics/Documents/catalog/201112cat.pdf#page=106) ***Nontransferable AAS degree:*** The Computer Information Technology A.A.S. degree program develops students who can apply their knowledge & skills in software, hardware, networking and/or programming to troubleshoot problems, analyze opportunities, develop multiple solution strategies, and communicate effectively with all constituencies. (www.lscc.edu/academics/Documents/catalog/201112cat.pdf#page=107)
Northeast Wisconsin Technical College (Minimal difference in curricula)	Electrical Engineering Technology (EET) prepares students to test, maintain, and troubleshoot electrical and electronic devices as found in machinery, computers, and communications. ***The program consists of two tracks: a transfer track, which includes calculus, for those students planning to transfer to a four-year EET program, and a general track, for those students not planning to transfer.*** The EET transfer track graduate will be able to transfer to a four-year bachelor's degree program in Electrical Engineering Technology. (www.nwtc.edu/academics/degrees/engineering-manufacturing/engineering/Pages/ElectricalEngineeringTechnology.aspx; Italics added for emphasis)
Edmonds Community College (Moderate difference in curricula)	***Transferable AAS-T degree:*** The Energy Management Associate of Applied Science-Transfer Degree is designed for students who want to transfer to the Bachelor of Applied of Science in Administrative Management at Central Washington University (CWU). This degree will allow students to update existing knowledge and skills and/or acquire up-to-date technical and managerial skills. The degree requires students to work with an Energy Management adviser to select those courses which will help students achieve their educational career goals. (catalog.edcc.edu//preview_program.php?catoid=7&poid=3431&returnto=2913) ***Nontransferable ATA degree:*** Individuals pursuing a degree in energy management will be able to apply basic energy management and technical skills in support of businesses as well as electric, gas, and water utility companies and community action agencies engaged in developing energy-efficiency applications for homes and businesses. The program includes instruction in principles of energy and energy management, the technologies and techniques allowing for energy efficiency and conservation, energy end-use analysis, monitoring systems, energy-use accounting, project management, and report preparation and presentation skills. (catalog.edcc.edu//preview_program.php?catoid=7&poid=3349&returnto=2913)

Table 8, Continued.

Institution	Descriptions of Programs
Tulsa Community College (Substantial difference in curricula)	***Transferable AS degree:*** University Transfer Degree: This degree program is designed for students planning to transfer to baccalaureate colleges and universities… Students will be educated in the fundamentals of biology, chemistry and biochemistry with heavy emphasis on a wide range of laboratory procedures. The topics of lab safety, protein isolation and separation techniques, cell culture, molecular biology and recombinant DNA, and quality control will be addressed as they apply to both a manufacturing and research environment. ***Nontransferable AAS degree:*** Workforce Development Degree: This program is designed for students who wish to acquire the skills necessary to work in the field of biotechnology. Students will be educated in the fundamentals of biology, chemistry, and biochemistry with heavy emphasis on a wide range of laboratory procedures. The topics of lab safety, protein isolation and separation techniques, cell culture, molecular biology and recombinant DNA will be included. The topics of technical writing, medical ethics and quality control will be addressed as they apply to both a manufacturing and research environment. (www.tulsacc.edu/sites/default/files/2011_2012_TCC_Catalog_%28web%29.pdf#page=192)
Rochester Institute of Technology (Substantial difference in curricula)	***Transferable AS degree:*** The associate of science in applied computer technology is an Associate+Bachelor's degree program designed to prepare deaf and hard-of-hearing students to enter and successfully complete a bachelor's degree in the B. Thomas Golisano College of Computing and Information Sciences. NTID's AS degree is a program specifically designed so that students can enroll directly in one of the following programs in the Golisano College: applied networking and system administration, information sciences and technologies, or information technology. Coordination between the two colleges maximizes the number of credits a student may apply toward the baccalaureate degree. ***Nontransferable AAS degree:*** Computers are important to all parts of the economy, and the number of careers that involve work with computers is constantly expanding. Students in the AAS degree program in applied computer technology take courses to prepare them for careers that involve maintaining computer software and hardware, installing and maintaining computer networks, and working with a variety of computer applications. (www.rit.edu/programs/applied-computer-technology-aas)

the specific courses required differ with AS students taking courses in Trigonometry, Advanced Math, and Discrete Math while students in the AAS program take Algebra and two math electives. As compared to the nontransferable AAS degree program, the transferable AS degree program has more requirements in the areas of liberal arts and general education (AS – 27 credit hours; AAS – 16 credit hours), science (AS – 8 credit hours of science with lab; AAS – 3 credit hours of science), and computer programming (AS – 16 credit hours; AAS – 3 credit hours). As compared to the transferable AS degree program, the nontransferable AAS degree program has more requirements in the areas of information technology (AAS – 51 credit hours; AS – 23 credit hours), job search and employment (AAS – 3 credit hours; not included in AS curriculum), and capstone courses (AAS – 6 credit hours; not included in AS curriculum).

Discussions with representatives from cases in which we found substantial differences between the curricula for transferable and nontransferable degrees described these differences as connected to the underlying purpose of the degree. The nontransferable degrees were primarily designed to prepare students for entry-level technology positions, whereas the transferable degrees were designed to prepare students for transfer to four-year degree programs. One respondent described the reason for the differences in general education requirements stating that:

> The difference in the courses is that the [nontransferable] AAS does not include all of the general education requirements for transfer. For example, there are no history, art, or music classes offered to these students. The only general education classes that are required for the AAS degree are those that are deemed necessary for the field that students are entering – namely an accounting class, a psychology class, two economics classes, and a business and technical writing class (which takes the place of the general education English requirement).

Other differences noted by respondents highlighted the hands-on learning nature of the nontransferable curricula, stressing that students in these degree pathways had more opportunities to work with faculty in laboratory and workshop settings. Students in transfer pathways did not have as many opportunities to learn in these hands-on settings because the four-year institutions accepted a limited number of laboratory hours.

Despite the differences in curricula and program purpose, program descriptions of transferable and nontransferable programs that were located on institutional websites were, at times, quite similar (see the example of Tulsa Community College provided in Table 8). However, in all cases, these program descriptions stressed that one degree was designed for transfer to a four-year degree program while the other degree was designed for direct pathways to employment.

What We Learned

Seeking evidence of baccalaureate degree pathways on institutional websites provided the opportunity to examine both degree program curricula and the online representation of inter-institutional relationships. We aimed to discover how institutions recognize and communicate about their own degree programs, as well as degree programs offered by other institution(s) that contribute to identified baccalaureate degree pathways. The themes presented here demonstrate insights gained from these online explorations.

New baccalaureate degree pathways are emerging in technician education in STEM fields. The search for curriculum information on institutional websites revealed that 9 of the 95 baccalaureate degree pathways identified in our exploratory survey were currently in development, with plans, in some cases, to enroll the first class of students in Fall 2012. We discovered several additional degree pathways that enrolled their first class of students within the past five years (e.g., Edmonds Community College). These data, as well as comments from respondents, suggest that many new baccalaureate degree pathways have emerged in STEM fields over the past decade. While we did not have the capacity to explore the direct impact of NSF-ATE funding on the creation of degree programs within this study, follow-up case study research will provide further understanding of the influence of this and other sources of funding on institutional policies, inter-institutional relationships, and curriculum development pertaining to the applied baccalaureate.

Applied baccalaureate degree pathways adapt in response to their environments. It is also notable that these data suggest an adaptive nature to the curricula associated with AB degree pathways. The three Florida institutions discussed in this section of the report provide examples of adaptations in response to political environments. Representatives of each institution indicated the existence of a statewide trend to move away from AAS degrees, in favor of AS degrees. All three institutions had taken steps to modify their terminal AAS degrees into transferable AS degrees. Another case demonstrated the adaptation of a degree program in response to suggestions from leaders who were internal to the respondent's college. Just one year after creating a nontransferable ATA in Energy Management, the Edmonds Community College administration requested that the Business Division adapt this degree to offer a transferable AAS-T degree that would articulate to an existing BAS program in Administrative Management.

Applied and traditional associate degree programs can exhibit strikingly similar characteristics. When comparing curriculum from transferable and nontransferable degree tracks that were available in a single field at a single institution, we discovered that in five of eight associate degree comparisons, there were very few differences. In four of these five comparisons, program representatives confirmed that the nontransferable curricula existed first, and that the curricula were modified to create a transferable degree program. Interestingly enough, the modifications tended to be minor changes related to mathematics or writing classes. At three institutions, the changes affected a single class in the entire associate degree curricula. At another institution, two associate degree classes were changed, while the final institution changed five associate degree classes.

In the remaining three associate degree comparisons, more substantial differences existed such that between 30% and 60% of the courses differed between the transferable and nontransferable degree programs. Some respondents described these degree programs as having different underlying purposes. Yet, at one institution, the program descriptions available online for the two degrees were almost identical.

The similarities found between transferable and non-transferable associate degree programs within this study raise a host of questions about the difference between preparing students for the workforce versus, or perhaps concurrently for, academic transfer. How do students perceive the similarities and differences between terminal and transfer degree programs? Are students in terminal versus transfer degree programs differentially prepared for future careers and educational opportunities? If preparation does, in fact, lead to similar outcomes, why is one degree pathway terminal while the other is fully transferable? Are these types of preparation so similar that an adjustment of 1-5 classes in a terminal pathway can adequately prepare a student for transfer to baccalaureate degree programs? Who is best served by each curricular pathway, as well as modifications to curricula?

A variety of curricular models are used within applied baccalaureate degree programs. Evidence suggests that AB degree programs may exhibit a greater variety of curricular models than traditional baccalaureate degree pathways where direct articulations between a specific associate and baccalaureate degrees exist. Interestingly, although the sample is small (4 cases), all traditional baccalaureate degree pathways (e.g., AS degree to BS degree) for which curriculum requirements could be identified on institution websites followed a career ladder curriculum model. Curricular models varied, however, for identified AB degree pathways. In this category, 18 (51.4%) of the established degree pathways used career ladder models, 9 (25.7%) used management capstone models, 1 (2.9%) used a completion model, and 4 (11.8%) used a hybrid model.

This finding relates to the theme of variety found in the exploratory survey, and suggests that AB degree pathways may contribute to this variety in different ways than traditional baccalaureate degree pathways. Caution is urged with this finding, due to the small number of identified traditional baccalaureate pathways, and the identification of degree pathways using website searches which we recognize can result in incomplete, unstable, and potentially inaccurate information.

A number of institutions appear to be missing opportunities to communicate information about baccalaureate degree pathways on their websites. In many cases, information about baccalaureate degree pathways was not readily available on departmental or degree program web pages. Locating information could be quite challenging, requiring search queries for articulation agreements, press releases, or other digital artifacts of past communications. Despite being confident of a baccalaureate degree pathway's existence based on responses from survey respondents, we were unable to locate information about the existence of pathways in 23 out of 77 (29.9%) cases in which websites were searched. It is possible that some of these degree pathways have been discontinued (as was confirmed in one case within this study). For those degree pathways that still exist, we view the lack of information on higher education institution websites as a missed opportunity to communicate about their academic programs to prospective students, current students, employers, policy makers, and higher education administrators and program directors. Websites are a primary source of information and resources for numerous stakeholder audiences. The lack of information about baccalaureate degree pathways on these websites contributes to the theme of uncertainty identified in the exploratory survey. It is a missed opportunity for communication with stakeholders who could benefit from knowing about the existence of the baccalaureate degree pathway and the relationship between the participating institutions.

Describing Applied Baccalaureate Degree Pathways

Our final stage of data analyses focused on results of in-depth website reviews and a follow-up survey with respondents who indicated affiliation of their NSF-ATE projects and centers with baccalaureate degree pathways. These analyses provided the opportunity to identify specific AB degree pathways that had notable features to examine, as well as to illustrate key components of these degree pathways such as: (a) instructional approaches and settings, (b) targeted student populations, (c) supportive partnerships within institutions, between higher education institutions, and with employers, and (d) impacts of NSF-ATE funding.

From the 95 baccalaureate degree pathway cases identified in the exploratory survey, we were able to contact 74 respondents with the follow-up survey. We received responses with information about baccalaureate degree pathways affiliated with 40 NSF-ATE projects and centers. This represents a 54.1% response rate for the follow-up survey. Data were collected in online and phone surveys from a total of 50 individuals. In five baccalaureate degree pathway cases, data were provided by multiple respondents, with each person addressing the sections of the pathway with which they were most familiar (e.g., associate degree, baccalaureate degree, involvement of NSF-ATE center).

Respondents were encouraged to identify "notable" AB degree pathways affiliated with their NSF-ATE projects or center, where "notable" was defined as having exemplary or promising characteristics in one or more of the following areas: addressing economic and societal needs, curricular alignment, program design, systematic evaluation, and replicability (Bragg et al., 2002). A total of 10 notable AB degree pathways were identified by survey respondents. For each identified notable degree pathway, in-depth website reviews were conducted for all participating institutions. These website reviews sought to gather information on institutional settings, program organization, curriculum, transfer information, student experiences, outcomes, and more. A detailed discussion of follow-up survey and in-depth website review methods can be found in Appendix A.

This section of the report presents findings from the follow-up survey and in-depth website review data analysis in three parts. First, discussion is provided regarding respondents' identification of AB degree pathways versus traditional baccalaureate degree pathways, as well as the criteria and reasoning for labeling a particular degree pathway as "notable." The 10 identified notable AB degree pathways are shared. Second, aggregate analyses from survey data on the 10 notable pathways provide an overview of program development characteristics, key institutional partnerships, instructional approaches, and attention to the needs of underserved student populations. Finally, narrative illustrations are offered to provide readers with a more in-depth understanding of the development and operation of these notable degree pathways. These narrative case descriptions are divided in to three groups, including examinations of established, developing, and adapting degree programs.

This section concludes with a brief discussion of themes derived from our interpretation of the data. The findings provide insights into the emergence and evolution of AB degree pathways, including information on various pathway design components. The data also suggest challenges to implementing and understanding AB degree pathways, such as uncertainties regarding student participation and outcomes, missed opportunities for communicating with key stakeholder audiences, and definitional disagreements that hinder discussion about the transfer of applied associate degree credits to baccalaureate degree programs.

Identifying Notable Applied Baccalaureate Degree Pathways

Table 9 shows the number of AB degree pathways identified in this stage of the study. Across the 40 cases, 22 (55.0%) self-identified AB degree pathways, as defined by Townsend et al. (2008), that were affiliated with their NSF-ATE project or center. A total of 13 cases (32.5%) indicated that no AB degree pathways were affiliated with their NSF-ATE project or center. Traditional baccalaureate degrees were available in some of these cases, while others indicated that only a few applied associate degree courses would transfer to a baccalaureate degree. The remaining 5 cases (12.5%) indicated uncertainty about whether an AB degree existed, and we were unable to reach respondents to discuss their degree offerings and determine the pathway type.

Respondents who indicated that AB degree pathways were affiliated with their NSF-ATE project or center were asked to identify notable pathways that could be examined in more detail. We posited that notable pathways might include one or more of the following characteristics of promising and exemplary programs (as described by Bragg et al., 2002):

- Aligns curricula with clear learning goals, as well as recognized academic and occupational standards;
- Addresses important individual, economic, and societal needs;
- Offers innovative program design that contributes to educational excellence for all learners;
- Engages in systematic evaluation processes that provide evidence of program effectiveness and student outcomes;
- Contains programmatic elements that can be implemented, adopted, or adapted to other educational settings.

In 12 cases, respondents who indicated that AB degree pathways were affiliated with their NSF-ATE project or center could not identify a single notable applied pathway. When asked what made it difficult to identify a notable pathway, one respondent shared that their AB degree pathway was currently in development, anticipating the first class of students to be enrolled in Fall 2012. Since the degree pathway was not yet operational, he felt that it was too early to label it as notable. Two other respondents indicated hesitancy to identify

Table 9. Identification of Applied Baccalaureate Degree Pathways

Identification of Degree Pathways	Number	Percent
Applied baccalaureate	22	55.0%
Respondent identified notable AB degree pathways	(10)	(25.0%)
Respondent could not identify notable AB degree pathways	(12)	(30.0%)
No applied baccalaureate degrees*	13	32.5%
Unclear whether applied baccalaureate degrees exist	5	12.5%

* These respondents reported having only traditional baccalaureate degree pathways, or that only a subgroup of applied associate coursework transfers that is well below 60 credit hours.

existing degree programs with the AB terminology, despite the reality that applied associate degree courses that were once considered terminal were now transferring as a block to baccalaureate degree programs. These hesitancies stemmed from different sources. A respondent from Illinois discussed how AB degrees were not recognized within the current state policy context. He stressed a need to focus on ensuring rigorous general education requirements within associate degrees, particularly those degrees with roots in applied fields, in order to satisfy state requirements for transfer to baccalaureate degrees. A respondent from Kentucky described a hesitancy stemming from baccalaureate degree-granting institutions that sought to avoid the term "applied" in order to associate themselves more closely with their baccalaureate degree-granting institution peers, as opposed to using terminology that may affiliate them with associate degree-granting institutions. For these institutions, concerns about perception and prestige hindered identification of applied associate degrees that transfer to baccalaureate degrees with the AB language.

The remaining 10 cases identified notable AB degree pathways, which are shown in Table 10. At this point in the study, challenges with accurately defining and describing AB degree pathways were brought to the forefront. As noted in past research (e.g., Bragg & Ruud, 2011; Ruud & Bragg, 2010; Townsend, Bragg, & Ruud, 2009), respondents in the field demonstrated a variety of perspectives on what they consider an AB degree pathway to be. The definition that guided this study, and was shared with respondents, focused primarily on bachelor's degrees that are "designed to incorporate applied associate courses and degrees once considered as 'terminal' or non-baccalaureate level" (Townsend et al., 2008, p. iv). In many cases, applied degree designations (e.g., AAS, BAS) served as useful signals for indicating that a degree pathway fit the AB degree pathway definition. However, as was the case in previous research conducted by Bragg and Ruud (2011), we found many cases where the degree titles were not a reliable signal of whether the applied baccalaureate was the intended credential. This lack of standardization and alignment of degree titles with program of study requirements was evident within and between disciplines, institutions, and states.

Some respondents shared that their states and institutions use the traditional baccalaureate degree designation of Bachelor of Science (BS) in STEM-related programs of study, even when these programs accept the transfer of applied associate courses and degrees and often also incorporate applied coursework and applied learning at the upper division level. In cases such as these, BS degrees accept the transfer of all, or nearly all, credits from applied associate courses and degrees, thereby creating an avenue for baccalaureate degree attainment from a once terminal associate degree. It is intriguing to note that eight of the 10 notable degree pathways suggested by respondents in this study followed this pathway structure.

Furthermore, one case was also discovered in which respondents identified the AB degree pathway designation with associate degrees awarded as an Associate of Science (AS) that transferred to a Bachelor of Science (BS) because of the historical lack of transfer opportunities for students who had completed the associate degree. These respondents argued that, whereas the AS degree is theoretically a transfer degree, in this particular case the AS degree was essentially terminal because "students had nowhere to transfer" to advance their education in a related field.

Following the lead of previous studies (e.g., Bragg & Ruud, 2011), we sought to understand the development, content, and design of AB degree programs, without limiting our work based on credential names which can carry their own historic biases. Recalling that, in this study, the incorporation of applied courses and learning into baccalaureate degrees serves as a primary determinate used to identify AB degrees, we privilege the concept of applied learning in our discussions with respondents over credential titles.

We present further information about these cases in two ways: aggregate data across cases, and brief descriptions of individual cases based on the follow-up survey data and in-depth website reviews. Due to the small sample size, we encourage caution, particularly when considering findings from the aggregate data. Data from such a limited group may not be expected to generalize to other AB degree pathways. However, these data have value in that they suggest interesting directions for future inquiry.

Table 10. Applied Baccalaureate Degree Pathways Identified as Notable by Survey Respondents

Associate Degree	Associate Degree-Granting Institution(s)	Baccalaureate Degree	Baccalaureate Degree-Granting Institution
AS/AAS in Automotive Technology	Massachusetts Bay Community College, Vermont Technical College, New Hampshire Technical College	BS in Automotive Management	Benjamin Franklin Institute of Technology
AAS in Network Technology	Lehigh Carbon Community College	BAS in Technical Leadership	Bloomsburg University
AS in Computer Network Systems Engineering; AS in Computer Networking	Moorpark College; Oxnard College	BS in Information Technology	California State University Channel Islands
AS in Engineering Technology	Brevard Community College; Hillsborough Community College; Daytona State College	BS in Engineering Technology	Daytona State College
ASA in Engineering	Northwestern Michigan College	BS in Engineering (multiple fields)	Michigan Technical University
AAS in Electrical Engineering Technology	Northeast Wisconsin Technical College	BS in Electrical Engineering Technology	Milwaukee School of Engineering
AAS in Robotics Technology	Baltimore City Community College	BS in Industrial Engineering	Morgan State University
AS in Computer Programming and Analysis; AS in Computer Information Technology	Valencia College, Seminole State College, Brevard Community College; Lake-Sumter Community College	BAS in Software Development	University of Central Florida
AAS in Information Security	Prince George's Community College	BS in Cybersecurity	University of Maryland University College
AAS in Electronics	Pearl River Community College	BS in Applied Technology	University of Southern Mississippi

Aggregate Analyses of Notable Applied Baccalaureate Degree Pathways

The most common reasons that respondents gave for nominating these AB degree pathways as notable were: (a) curricula alignment with learning goals and recognized academic and occupational standards, as well as (b) innovative program design that contributes to educational excellence for all learners. Engagement in systematic evaluation practices was the least often mentioned aspect of notable programs, mentioned in only one case.

As demonstrated in Figure 3, the majority of these AB degree pathways (70%) were established in the past decade, with only two degree pathways established prior to 2001. Considerable variety was found related to the institutions that initiated the degree pathways (see Figure 4). Degree pathways were reported to be initiated by the associate degree-granting institutions (4 cases), baccalaureate degree-granting institutions (2 cases), NSF-ATE centers (1 case), and through mutual efforts from both associate and baccalaureate degree-granting institutions (3 cases).

Baccalaureate degrees affiliated with the submitted notable AB degree pathways included the bachelors of science (BS; 8 cases) and bachelors of applied science (BAS; 2 cases). Affiliated associate degrees included the associate of applied science (AAS; 6 cases), associate of science (AS; 4 cases), and associate in science and art (ASA; 1 case). A representative of the baccalaureate degree pathway that includes the ASA degree (ASA in Engineering offered by Northwestern Michigan College) stated that "at present, many of our engineering transfer students do not bother with the [ASA] degree," indicating that students choose to transfer to baccalaureate degree programs without receiving the associate degree credential along their path.

Partnerships across higher education departments and services were mentioned as strong contributors to student retention, student advising, and smooth transitions across curricula. In regard to academic departments, Physics, Mathematics, Business, and Engineering departments were cited as important collaborators for offering required courses. One respondent who discussed an Information Technology degree pathway also spoke of the importance of working closely with the Computer Science department, saying: "The computer science department's collaboration is essential, we don't want a competition, and surely not a fight." In regard to student services, internship offices and academic advising were acknowledged with statements such as:

- "We work with other units every day. Trying to figure out individual student data to get them as many credits in the program as we can."
- "The success of the pathway is the placement of the graduates, and the internship office will be playing a key role here."

Finally, supportive partnerships with NSF-ATE Centers, such as CyberWatch (www.cyberwatchcenter.org/) and the CREATE Center (www.create-california.org/), were mentioned as key factors that helped higher education institutions to develop associate and baccalaureate degree programs, as well as to establish baccalaureate degree pathways that connect associate and baccalaureate degree programs.

Coursework for these programs was most often delivered in on-campus classroom settings (100% of cases), followed by online delivery offered in 70% of cases. Off-campus sites, distance education, and employer or business settings were each used in 30% of cases. As depicted in Table 11, a variety of instructional approaches were used within these AB degree pathways. Problem-based learning was mentioned in relation to all degree pathways, while applied learning, laboratory learning, computer-mediated instruction, and peer learning were mentioned in 90% of cases. Apprenticeships, on-the-job training, and customized training were the least common instructional approaches, each mentioned in 20% of cases.

Respondents acknowledged that the notable AB degree pathways did, in many cases, focus on traditionally underserved student populations, as depicted in Tables 12 and 13. When degree programs engaged in recruiting, special efforts were often made to attract women (90% of cases), displaced or unemployed workers (80%), racial and ethnic minorities (80%), and adult learners (70%). Retention services were also mentioned for these groups, often relying on campus-wide resources such as a disability resource center, English as a second language centers, or a veterans' affairs

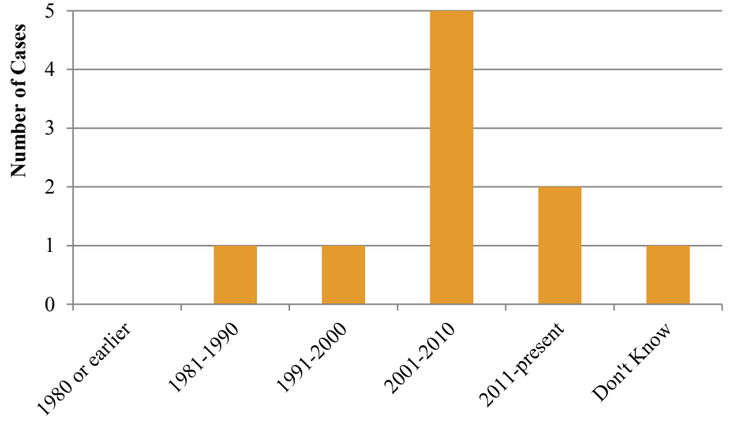


Figure 3. Years when the applied baccalaureate degree pathways were established.

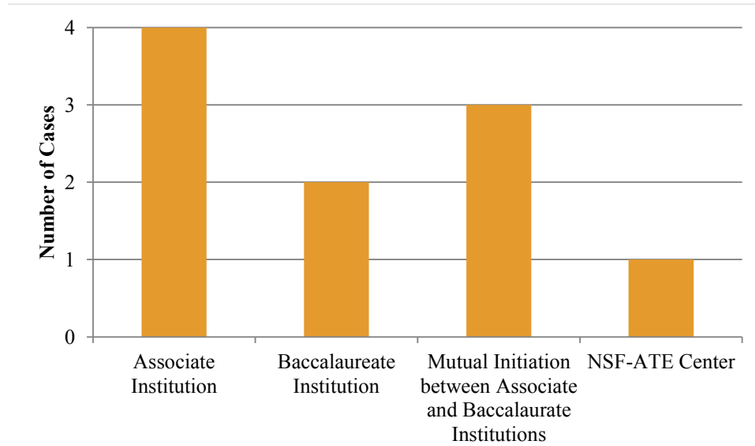


Figure 4. Institutions that initiated the applied baccalaureate degree pathway.

office. As described by one respondent, offering these special recruiting and support services could be difficult, particularly within small academic departments – "We don't do a lot of recruiting period. With only two faculty, there isn't much time for that."

Illustrations of Applied Baccalaureate Degree Pathways

This section highlights examples of eight of the AB degree pathways that were deemed notable by our follow-up survey respondents. Data for the illustrations were drawn from the follow-up survey responses, in-depth reviews of all departmental and degree program pages on the websites of all higher education institutions that were involved in the baccalaureate degree pathway, and input from institutional representatives.

The examples are presented in three categories: established degree programs, adapting degree programs, and developing degree programs. These categories facilitate consideration of the temporal influences that help establish and maintain programs, as well as adaptations that these degree pathways may make in response to new circumstances and environments. Additional themes are noted in the bullet points that precede each case in order to highlight distinguishing features of each AB degree pathway. These themes include:

Table 11. Instructional Approaches Discussed by Respondents

Instructional approach	Percent of Cases
Problem-based learning	100%
Applied learning	90%
Laboratory learning	90%
Computer-mediated instruction	90%
Peer learning	90%
Innovative developmental education	80%
Troubleshooting instruction	80%
Interdisciplinary courses	70%
Formalized training	70%
Internship	70%
Capstone experience	70%
Research experience	30%
Apprenticeship	20%
On-the-job training	20%
Customized training	20%

Note: n=10 cases

Table 12. Recruiting Efforts for Traditionally Underserved Student Populations

Student Population	Percent of Cases
Women	90%
Displaced / unemployed workers	80%
Racial and ethnic minorities	80%
Adults (individuals aged 25 – 64)	70%
English language learners	40%
Immigrants	40%
Students with disabilities	20%

Note: n=10 cases

Table 13. Retention Efforts for Traditionally Underserved Student Populations

Student Population	Percent of Cases
Students with disabilities	80%
Adults	70%
Displaced / unemployed workers	70%
Racial and ethnic minorities	70%
English language learners	60%
Women	60%
Immigrants	50%
Other (Veterans)	10%

Note: n=10 cases

- ***Multiple associate degree entry points.***
  Several degree pathways have associate degrees at multiple community colleges that lead to the baccalaureate program. Other degree pathways offer associate degrees both at the baccalaureate degree-granting institution and at other associate degree-granting institutions. This variety within a single degree pathway raises interesting questions about similarities and differences in student experiences based on the associate degree program they attend. For example, are students equally prepared for the baccalaureate degree program within all associate degree programs regardless of the sending community college? What, if any, differences in preparation have been experienced and what difference do they make to student outcomes?

- ***Explicit foundations in a 2+2 model.***
  All of the AB degree pathways presented here technically follow a 2+2 model, where the first two years of college coursework are completed at a community college and the final two years of coursework are completed at the baccalaureate institution. However, several degree pathways deliberately described their degree offerings on websites and in promotional materials as using the 2+2 language. These pathways provide a clear indication of the intention of the AB to be a fully legitimized transfer model that actively encourages students to follow the available pathway from associate to baccalaureate degree.

- ***Transferable and nontransferable associate degree tracks at a single institution.***
  Several examples were found of associate degree-granting institutions offering both transferable (e.g., AS) and nontransferable (e.g., AAS) degrees in the same academic degree program. While the nontransferable degrees were in the process of being phased out of some degree programs, examining similarities and differences between curricula offered intriguing insights into what is needed for adequate preparation to pursue upper-level baccalaureate degree coursework, as well as how those interpretations might differ across higher education institutions.

- ***Curricular models.***
  This theme recognizes the structure of the baccalaureate-level coursework offered within the degree pathway, categorizing those offerings as a career ladder, management capstone, upside-down or completion model, or hybrid curricular model as defined earlier in this report.

- ***Additional coursework required.***
  This theme recognizes programs within degree pathways that have credit hour requirements equivalent to five or more semesters for an associate degree (75+ credit hours) and/or nine or more semesters for a baccalaureate degree (135+ hours).

- ***Participating institutions located in a single state or multiple states.***
  This theme acknowledges whether all higher education institutions participating in the AB degree pathway reside in a single state, or whether they cross state lines. This dynamic is interesting because state policy contexts regarding applied degree pathways can differ considerably, as noted by Ruud and Bragg (2011). Degree pathways that extend across state boundaries may have to take into count differing political viewpoints and approaches.

- ***Pathway initiated by associate degree-granting institution, baccalaureate degree-granting institution, an NSF-ATE project or center, or a combination of these groups.***
  AB degree pathways were initiated by a variety of sources including associate degree-granting institutions, baccalaureate degree-granting institutions, NSF-ATE projects or centers, and by partnerships among these groups. These diverse sources of initiation demonstrate the variety of actors who can play a role in establishing and supporting baccalaureate degree pathways.

- ***Connected to an NSF-ATE Center.***
  This theme recognizes cases where the baccalaureate degree pathway has some connection to an NSF-ATE Center. The NSF-ATE Center may or may not have been identified as a key player in initiating the degree pathway, but ties to the Center were acknowledged by the respondents.

As a group, these brief examples illustrate how partnerships among higher education institutions, as well as with NSF-ATE projects and centers, have resulted in the creation of opportunities for baccalaureate degree attainment in technician education where no such opportunities previously existed.

Established degree pathways. This section presents four cases of notable AB degree pathways that represent considerable variety in terms of fields of study (i.e., engineering, automotive technology, electrical engineering technology, information security), curricular models (i.e., career ladder, management capstone, hybrid), and state contexts (i.e., Michigan, Massachusetts/Vermont, Wisconsin/Illinois, Virginia/Maryland). Interestingly, in two of the four cases, collaborating institutions highlighted by respondents crossed state borders. Each case is introduced with a set of themes to highlight key aspects of the degree pathways.

Case I: ASA in Engineering; BS in Engineering (multiple fields).

Summary of Case Highlights:

- Explicit foundations in a 2+2 model
- Career ladder curricular model
- Additional coursework required
- Participating institutions located in a single state
- Pathway initiated within a partnership between the associate and baccalaureate degree-granting institutions

The survey respondent from Northwestern Michigan College attributed the development of this AB degree pathway to the opportunity created by NSF-ATE funding. He stated that:

> Originally, in the 1980s, [NSF-ATE] funding allowed collaboration between Northwestern Michigan College (NMC) and Michigan Technical University (MTU)… [with] contacts between faculty of involved departments and administrators at all levels. This transfer program has never weakened since its implementation. We could not have made it happen without the original funding.

Contact continues to be made between faculty at the participating institutions on an annual basis in order to "keep courses matching for smooth [student] transitions" between degree programs. Approximately 15-20 students enroll in the ASA degree program in Engineering each year. Approximately 10-20 students graduate from that program each year, and 10-15 transfer to Michigan Technical University for a BS in an engineering field. However, it was also noted by the survey respondent that "many of [NMC's] engineering transfer students do not bother with the [ASA] degree;" the students transfer into the BS program at MTU without formally receiving the associate degree credential. This pathway uses a career ladder curricular model.

Northwestern Michigan College. Northwestern Michigan College is located in Traverse City. The ASA degree in Engineering is designed to be a transfer degree with 2+2 agreements with Michigan Technological University, Kettering University, and Lake Superior State University. Northwestern Michigan College students in this program are guaranteed admission to these universities. The ASA degree requires completion of 82 – 84 credit hours, which includes four calculus courses. The college also offers a 52 credit hour certificate in Engineering. The Northwestern Michigan College website clearly mentions transfer opportunities to baccalaureate programs in engineering at Michigan Technical University.

Michigan Technical University. Michigan Technical University is located on the northernmost peninsula of Michigan in Houghton and offers more than 120 degree programs. The College of Engineering offers BS degrees in multiple engineering fields, including Applied Geophysics, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Engineering, Electrical Engineering, Environmental Engineering, Geological Engineering, Geology, Materials Science and Engineering, and Mechanical Engineering. With the exception of Applied Geophysics and Geology, all degree programs are accredited by the Accreditation Board for Engineering and Technology (ABET). Required credit hours for the various BS degrees range from 127 to 134. Degree requirements fall into the areas of general education, basic mathematics and science, core engineering courses, a technical emphasis, and directed electives based on the selected major. No specific transfer information was provided on the programs' website about this baccalaureate degree pathway.

The College of Engineering has 160 faculty members and 100 staff, serving more than 3,200 undergraduate engineering students. In addition, there exists an Engineering Advisory Board made up of 15 professionals in engineering fields. In regard to instructional strategies, the College of Engineering faculty use a discovery-based learning method where students listen to a 15-20 minute lecture by a professor and then spend the rest of the class period working on activities with a team. Senior design courses allow students to work with a team to solve real industry problems. Students can also participate in the Enterprise Program where teams of students from freshmen through seniors work on projects in a business-like setting. Faculty members serve as coaches and industry partners serve as mentors and clients. The Michigan Tech co-op program has nearly 2,000 registered employers with more than 500 students participating annually. Additionally, students have an opportunity to participate in more than 40 engineering-related student organizations.

The College of Engineering has several programs designed to recruit underrepresented students. For example, the college hosts a one-day Get Women in Engineering (Get WISE) event each year for more than 250 sixth, seventh, and eighth grade girls. Additionally, the Engineering Scholars Program and the Women in Engineering Program provide high school students from traditionally underrepresented groups with weeklong experiences learning engineering concepts.

According to their website, 98% of College of Engineering graduates are either employed in their area, in the military, or in graduate school within six months of graduation. In 2009, 280 employers recruited on campus and students averaged seven interviews each.

Case II: AS/AAS in Automotive Technology; BS in Automotive Management.

Summary of Case Highlights:

- Multiple associate degree entry points
- Management capstone curricular model
- Additional coursework required
- Participating institutions located in multiple states
- Pathway initiated by the associate degree-granting institutions

This AB degree pathway, established in the 1990s, offers students several entry points through associate degrees in Automotive Technology offered by Massachusetts Bay Community College, Vermont Technical College, and Benjamin Franklin Institute of Technology, among other regional institutions. The survey respondent also mentioned New Hampshire Technical College, yet we were unable to locate any information about an automotive program on that institution's website. Each of these associate degrees transfers to a BS in Automotive Management offered by

Benjamin Franklin Institute of Technology. This BS degree is an example of a management capstone baccalaureate pathway. Each of these degree programs is taught primarily in on-campus classes, using a variety of active learning techniques, such as laboratory learning, problem-based learning, troubleshooting instruction, and cooperative work experiences. Interestingly, individual institution websites do not mention transfer or articulation agreements that link the AS degrees in Automotive Technology with the BS in Automotive Management. The relationships between these higher education institutions were brought to our attention by the survey respondents.

Massachusetts Bay Community College. Massachusetts Bay Community College, located in the suburbs of Boston, MA with campuses in Wellesley Hills, Framingham, and Ashland, offers an AS degree in Automotive Technology within its Division of Transportation and Energy. The automotive technology program is overseen by the Dean of the Transportation and Energy division. Staff include six professors, one instructor, one learning specialist, one coordinator for Automotive Youth Education Systems, and two staff assistants. All faculty are Automotive Service Excellence (ASE) Master certified and the programs are accredited by the Automotive Technician Educational Foundation (NATEF).

Four associate degree options are available within the Automotive Technology program, allowing students to specialize in BMW, Toyota/Lexus, Chrysler, or General Motors. Each automaker has a different arrangement with the college and generally requires students to work at a dealership of the automaker at some point in the program. Through these co-op work experiences students can earn between $4,000 and $16,000. Requirements for associate degrees range from 72 credit hours to 79 credit hours, and are designed to take 21 months to complete. Two certificates are also available ranging from 26-47 hours. The Massachusetts Bay Community College Automotive Technology program website reports a 98% job placement rate for AS degree graduates.

Vermont Technical College. Vermont Technical College, with its main campus located in Randolph Center, offers an AAS in Automotive Technology. According to the degree program website, this program is designed to be comprehensive so that students will be able to work with all vehicles. The program is certified by the National Automotive Technicians Education Foundation (NATEF) and The National Institute for Automotive Service Excellence (ASE). The AAS in Automotive Technology requires 65 credit hours, and includes a 10-week co-op experience to provide students with practical experience. Several scholarships are available for automotive technology students offered by the AAA of Northern New England, the Vermont Automobile Dealers Association, and the Vermont Automobile Enthusiasts. The program website reports that 98% of graduates are either employed in their area or furthering their education within six months of graduation.

Benjamin Franklin Institute of Technology. Benjamin Franklin Institute of Technology (BFIT) is a small, private, technical college located in Boston, which offers three certificates, nine associate degrees, and one baccalaureate degree. Programs related to the AB degree program of interest include an AS degree in Automotive Technology and a BS degree in Automotive Management. The associate degree requires 70 credit hours and the baccalaureate degree requires 143 credit hours. To pursue the BS degree, students are required to have completed the AS degree at BFIT or another accredited associate degree program. Departmental faculty members are certified by the National Institute for Automotive Service Excellence (ASE).

Approximately 12 new students enroll in the BS degree program each year, and 8-12 students graduate each year. Program administrators estimate that 80% of graduates are either employed or pursuing further education within 6 months of their graduation.

Case III: AAS in Electrical Engineering Technology; BS in Electrical Engineering Technology.

Summary of Case Highlights:

- Explicit foundations in a 2+2 model
- Transferable and nontransferable associate degree tracks at a single institution
- Career ladder curricular model
- Additional coursework required
- Participating institutions located in multiple states
- Pathway initiated by the baccalaureate degree-granting institutions

This AB degree pathway was initiated by the baccalaureate degree-granting institution. The BS degree in Electrical Engineering Technology, offered by the Milwaukee School of Engineering, is designed specifically for transfer students as a 2+2 program. Transfer agreements are established or pending with 7 of the 16 technical college districts in Wisconsin (Fox Valley Technical College, Gateway Technical College, Madison Area Technical College, Milwaukee Area Technical College, Northeast Wisconsin Technical College, Waukesha County Technical College, Western Technical College), as well as with College of Lake County which is located in Illinois. The survey respondent singled out the AB degree pathway between Northeast Wisconsin Technical College and the Milwaukee School of Engineering as particularly notable due to: (a) alignment of curricula with academic and occupational standards, (b) innovative program design, and (c) attention to important individual, economic, and societal needs. This degree pathway uses a career ladder curricular model.

Northeast Wisconsin Technical College. Northeast Wisconsin Technical College (NWTC) is located in Green Bay, WI. The AAS degree in Electrical Engineering Technology degree requires completion of 70 credit hours and offers two curricular tracks. A transfer track is available for students who are planning to transfer to a four-year degree program, while a general track is available for those who do not intend to transfer. The required courses are the same in each degree, with the exception of 8 credit hours. Transfer track students take 8 credit hours (2 classes) of Calculus. In lieu of Calculus, general track students take eight credit hours of additional technical courses and electives.

Each year, approximately 25 students enroll in the program, 5 graduate, and 2 transfer to a four-year degree program. No specific information about the AAS degree in Electrical Engineering Technology offered by NWTC transferring to the BS in Electrical Engineering Technology offered by the Milwaukee School of Engineering was provided on the related departmental and degree program web pages at NWTC. However, for students who pursue the transfer track, there exists an "Education and Transfer" webpage on the broader NWTC website where students can search for "Electrical Engineering Technology" and find six transfer program options. Three of these programs offer management capstone curricula, and three offer career ladder curricula in the field of electrical engineering technology. The Milwaukee School of Engineering's BS degree in Electrical Engineering Technology is acknowledged on the NWTC website.

Milwaukee School of Engineering. The Milwaukee School of Engineering (MSOE) is located in Milwaukee, WI. The BS degree in Electrical Engineering Technology is offered by the Department of Electrical Engineering and Computer Science. This degree is designed only for students transferring with an associate degree. Students with an AAS degree in electrical or electronics engineering from a college in the Wisconsin Technical College System are admitted to the program with junior standing. Students with

other AAS degrees are encouraged to apply, but may have to complete additional pre-requisites. Curricula tracks are available for both full- and part-time students. The final two years of the degree require 99 credit hours within Milwaukee School of Engineering's quarter system. When added to the 70 semester credit hours for the AAS degree, the full baccalaureate degree pathway totals approximately 136 semester credit hours.

Throughout the curriculum, strong emphasis is placed on applications and laboratory experimentation. Student-led senior design projects are highlighted prominently on the degree program website. The curriculum has been approved by the Federal Aviation Administration (FAA), which allows students to participate in FAA internships and other opportunities through the FAA Collegiate Training Initiative. According to the website, 100% of the previous year's electrical engineering technology graduates were employed with average starting salaries of more than $56,000. Graduates of the BS degree program have also attended graduate schools across the country.

Case IV: AAS in Information Security; BS in Cybersecurity.

Summary of Case Highlights:

- Hybrid curricular model
- Participating institutions located in a single state
- Pathway initiated within a partnership between the associate and baccalaureate degree-granting institutions
- Connected to an NSF-ATE Center

CyberWatch, an NSF-ATE Center that is headquartered at Prince George's Community College, was instrumental in establishing this AB degree pathway. While CyberWatch has played a facilitative role in helping to establish several baccalaureate pathways, a CyberWatch representative singled out the pathway between Prince George's Community College and University of Maryland University College as particularly notable due to the curriculum alignment with clear learning goals, connection to important societal needs, innovative program design, systematic evaluation processes that are in place, and replicability of program components to other environments. NSF-ATE funding was credited by one respondent as providing the necessary support to map curriculum to industry standards, as well as to develop robust K-12 initiatives, public awareness campaigns, student competitions, and faculty development. As identified by both the survey respondents and the research team upon reviewing the curriculum, this degree pathway represents a hybrid curricular model. There are clear elements of the career ladder curricular model, with increasingly more complex technical and academic coursework in the baccalaureate degree curriculum that expand upon the technical and academic coursework from the associate degree curriculum. Yet, there is also an interdisciplinary nature to the coursework required at the baccalaureate level, drawing upon social science disciplines such as policy, psychology, ethics, and sociology. This mixture of technical, academic, and social science lead us to label the degree pathways as a hybrid model.

Prince George's Community College. Prince George's Community College (PGCC) is located in the Washington, DC area, with its main campus in Largo, MD and additional sites in Hyattsville and Laurel. According to the degree program website, the College's courseware has been certified by the Committee on National Security Systems and the National Security Agency as meeting the National Training Standards for Information Systems Security (INFOSEC) Professionals. Additionally, the National Security Agency (NSA) and the Department of Homeland Security (DHS) have designated the College as a National Center of Academic Excellence in Information Systems Security Education.

The AAS in Information Security is offered in the Information Engineering Technology Department of the Science, Technology, Engineering, and Mathematics Division. The AAS degree requires 62 credit hours, and the website mentions that this program prepares students for both employment and transfer to a baccalaureate degree program. However, no mention of the transfer relationship with University of Maryland University College was found on the associate degree program website. The department also offers two related certificates (Information Security and Information Security Management) that require 16-19 credit hours. The department has 17 full-time faculty and 47 part-time faculty.

University of Maryland University College. The University of Maryland University College (UMUC) is part of the University System of Maryland and is headquartered in Adelphi, MD. The college has classroom locations in the Washington, D.C. metropolitan area, Europe, the Middle East, Africa, and Asia. The BS in Cybersecurity is offered by the Department of Computer Information Systems and Technology, located at the Largo, MD campus, less than 15 miles away from PGCC. The BS degree requires 120 credit hours of completed coursework. Tools are provided to help students track personal progress in both classes taken at UMUC and courses that were transferred in from another institution. UMUC also supports transfer students by offering a $3,300 scholarship for transfer students who want to study Cybersecurity.

The department also offers an 18 credit hour certificate in Information Assurance that can be completed while working on the BS degree. Additionally, UMUC Cybersecurity graduates are able to cut 18 credit hours from the Cybersecurity or Cybersecurity Policy master's degree programs at UMUC. No specific information about transfer from PGCC's AAS program in Information Security is available on the UMUC Cybersecurity degree program's website.

Adapting degree programs. The degree pathways presented in this category have recently undergone or were currently undergoing significant changes during the time of data collection for this project. These changes altered curricula, the presentation of information about the degree pathway, and in one case, the baccalaureate degree-awarding institution

Case V: AS in Computer Network Systems / AS in Computer Networking; BS in Information Technology.

Summary of Case Highlights:

- Multiple associate degree entry points
- Career ladder curricular model
- Participating institutions located in a single state
- Pathway initiated by and NSF-ATE Center
- Connected to an NSF-ATE Center

In the late 1990s, faculty and administrators in the Ventura County Community College District recognized an employment demand for computer skills related to infrastructure, such as supporting desktop, network, internet, wireless applications, and voice over IP. These skills were not taught in existing computer science programs, which focused on programming skills. Development of degree programs such as the AS degree in Computer Network Systems offered by Moorpark College and the AS in Computer Networking offered by Oxnard College created alternative pathways for students to gain skills that were in high demand in the workplace. As AS degrees, these programs were viewed by the State of California as transferable to baccalaureate degrees from the start. However,

"when [students] wanted to go further with their education, they had nowhere to transfer." Baccalaureate degree-granting institutions did not offer programs that focused on technology infrastructure, essentially leaving these associate degrees as terminal tracks by virtue of a lack of opportunity.

Program administrators from all three higher education institutions who participated in this study enthusiastically pointed to the leadership of the Director of the California Regional Consortium for Engineering Advances in Technological Education (CREATE; www.create-california.org) as instrumental in the development of this AB degree pathway. As described by one respondent, the Director of CREATE "brought the foresight, leadership, mindset, and funding" to incentivize higher education institutions to collaborate to develop new degree pathways. She approached California State University (CSU) Channel Islands in 2002, shortly after the University opened its doors to the first students. External support provided by NSF-ATE provided flexibility at CSU Channel Islands to "fast-track the degree creation" to get the BS in Information Technology program started and to "move students through the pipeline." The degree program now attracts so many students that, despite the end of the NSF-ATE funding and integration of the program into state funding structures, the program continues to grow and adapt. A program representative reflected that "now it is hard to distinguish the computer science students from the information technology students." This degree pathway is best described as a career ladder curricular model.

Oxnard College. Oxnard College offers an AS degree in Computer Networking through the Department of Engineering Technology, within the Career and Technical Education Division. The college is a Cisco Regional Academy and a CompTIA Learning Partner. The degree program has one full-time faculty member and five part-time faculty members. It is overseen by the Dean of Career and Technical Education.

According to the program website, the AS degree in Computer Networking is designed both for career opportunities and transfer to a baccalaureate degree program. The degree requirements include 60 credit hours, with 1 credit hour dedicated to internship opportunities for students to build on-the-job experiences and references. Many of the participating employers are government entities such as school districts, hospitals, the county courthouse, and college districts. While the course catalog states that the degree is articulated with baccalaureate degree-granting universities, no specific schools are named and no information on articulation agreements is provided.

Approximately 5 new students enroll in the AS degree program in Computer Networking each year. Students enrolling in the program range from recent high school graduates to unemployed workers who are engaging in retraining to keep their skills fresh as they look for work. Approximately 3-5 students transfer to a baccalaureate degree program each year. Although the program administrators do not have a formal way to track graduates, anecdotally they are aware of 15-20 graduates who have specifically transferred to CSU Channel Islands.

Classes are offered on-campus, online, and in hybrid, on-campus-online formats. In-person, hands-on, laboratory learning is stressed as essential. Evaluation practices center around student learning outcomes assessment, examining outlines and objectives of courses and choosing a few student learning outcomes to assess at a time. Faculty meet as a department to discuss results and to make adjustments to enhance student learning.

Moorpark College. Moorpark College offers an AS degree in Computer Network Systems Engineering (CNSE), within a department of the same name as the degree. The program is a Cisco Local Academy, a VMware Academy, and a Microsoft IT Academy. It also offers Microsoft Engineering and Microsoft Administration certification courses. Classes are offered both in-person and online, and all computer courses are available via distance learning. The AS degree program requires the completion of 64.5 credit hours. It is designed to prepare students for entry level positions in networking administration and to be completed in 4 to 5 semesters. The program page of the website mentions the pathway to CSU Channel Islands and provides a worksheet to track lower division requirements taken at Moorpark College.

In Fall 2011, there were 216 students enrolled in courses related to the AS degree in CNSE, however, as many as half of these students were already employed in the IT field and seeking recertification rather than the associate degree. In 2010-2011, 11 students graduated with the AS degree. Information on how many students transfer to CSU Channel Islands or other baccalaureate institutions is only available to Moorpark College program administrators for the college as a whole; the data are not available disaggregated by degree program.

California State University Channel Islands. CSU Channel Islands offers a BS in Information Technology within the Department of Computer Science, in the School of Arts and Sciences. The department also offers a BS in Computer Science, a MS in Computer Science, and minors in Computer Science, Computer Game Design and Development, and Robotics Engineering. The department has 16 faculty, with 2 of these faculty contributing primarily to the Information Technology degree program.

CSU Channel Islands is in the process of revising the Information Technology curriculum to better reflect the composition of current students. Students native to CSU Channel Islands have shown a strong interest in the BS in Information Technology degree program, and more students internal to the university are enrolling in this program than are transferring into the program by approximately a 2-to-1 ratio. Therefore, a new degree map has been approved which deemphasizes the role of transfer courses in favor of focusing on courses offered at CSU Channel Islands.

The original degree program required 121 hours and, in its description, discusses how the degree is designed both for traditional freshman and for students who have earned an associate degree in a related field. The revised degree program, which will become available in Fall 2012, requires 120 hours and does not mention transfer options. The new degree program offerings are designed to be interdisciplinary, covering the "ground between a BS in Computer Science and a BS in Management Information Systems." Both degree programs allow for either four or five years for completion; students are provided with roadmaps for each timeline. No specific information about transfer and this particular baccalaureate pathway was provided on this degree programs' website.

There are approximately 40 students enrolled at various stages in the BS in Information Technology degree program. A total of 8 students graduated from the program in 2011. All of the students had secured jobs before graduation. The respondent attributed this to the fact that most students work, at least part time, while enrolled in the program and many students stay with those jobs.

Courses are offered in both on-campus and online settings, with efforts to move away from lecture-style courses and toward more laboratory learning and interdisciplinary studies. Capstone experiences will become available to students in Fall 2012. Due to only having two faculty committed to the degree program, little activity is sustained in the areas of employer relations, recruiting, retention services, and evaluation. They are currently focused on hiring additional faculty so that projects might be sustained in these areas.

Case VI: AS in Engineering Technology; BS in Engineering Technology.

Summary of Case Highlights:

- Multiple associate degree entry points
- Explicit foundations in a 2+2 model
- Transferable and nontransferable associate degree tracks at a single institution
- Career ladder curricular model
- Participating institutions located in a single state
- Pathway initiated within a partnership between the associate and baccalaureate degree-granting institutions
- Connected to an NSF-ATE Center

This AB degree pathway was brought to our attention by the Florida Advanced Technological Education Center (FLATE), a NSF Center of Excellence in high-technology manufacturing. The baccalaureate degree was originally established at the University of Central Florida, and was moved to Daytona State College in the past year. In the first year at Daytona State College, the BS in Engineering Technology program enrolled approximately 250 students. There were plans to grow the program to 400 students. Approximately 700-800 students were enrolled in current associate degree programs at Daytona State College, with the capacity to grow the programs to 1,200 students. Adult students (ages 25–64) and unemployed or displaced workers were a primary focus at each of the higher education institutions involved in this baccalaureate degree pathway.

Two survey respondents shared insights on this baccalaureate degree pathway. Both stressed the role that NSF-ATE grant funding plays in reaching out to traditionally underserved student populations. A respondent from Brevard Community College discussed new opportunities created by the funding, such as providing resources to purchase equipment so that students may train with the resources employers desire. The respondent from Daytona State College reflected that NSF-ATE funding allowed colleges to "do things that [they] do better." Their institution used the funding to enhance student recruitment, curriculum coordination, and faculty training. As a result "a larger number of students receive a higher quality product—[students] benefit most." This degree pathway uses a career ladder curricular model.

Brevard Community College. Brevard Community College is located in Eastern Florida with campuses in Cocoa, Melbourne, Palm Bay, and Titusville, as well as a center at Kennedy Space Center. At the time of data collection for this project, Brevard Community College offered both an AS and AAS in Engineering Technology. Both degrees required the completion of 60 credit hours. The required courses were the same in each degree, with one exception. AS students were required to take a 3-credit hour college algebra course, while AAS students took a 3-credit hour intermediate algebra course. The AAS program at Brevard Community College was discontinued in Fall 2011, reportedly due to a movement away from AAS degrees in the State of Florida. Approximately 40 previously enrolled students remained in the AAS degree program, and the college was making an effort to encourage students to change to the AS program.

Three specialization tracks were offered to students including: advanced technology, electronics, and alternative energy systems. According to the degree program website, both the AS and AAS degrees were designed to either prepare students for a career in manufacturing or to provide supplemental training for those who had worked in industry. After the first year of classes, students have an opportunity to take the Manufacturing Skills Standard Council test that provides industry-recognized, nationally portable credentials. No information was available on the Brevard Community College's website regarding transfer opportunities to the BS in Engineering Technology at Daytona State College.

Hillsborough Community College. Hillsborough Community College is located in west central Florida with campuses in Brandon, Dale Mabry, Plant City, South Shore, and Ybor City. Hillsborough Community College offered both an AS and an AAS in Engineering Technology at the time of data collection for this project. Both degrees required the completion of 60 credit hours. The required courses were the same in each degree, with one exception. AS students were required to take a 3-credit hour mathematics general education course, while AAS students took a 3-credit hour introductory mathematics with applications course. The AAS introductory mathematics course was not intended for transfer. A representative for the Engineering Technology program at Hillsborough Community College indicated political reasons for establishing the AS degree program with higher math requirements. While he did not indicate immediate plans to discontinue the degree at Hillsborough Community College, he did indicate that the State of Florida seemed to be moving away from the AAS degree entirely.

Students may be awarded 15 credit hours toward their degree if they have passed the Manufacturing Skills Standards Council assessment exam and been certified as a Certified Production Technician. The AS degree program transfers to baccalaureate degree programs, and the Hillsborough Community College website encourages students to consider the BS in Engineering Technology at Daytona State College or the BS in Applied Science at University of South Florida.

One full-time faculty member serves as both a program manager and instructor for the AS and AAS degree programs. A 15-member Engineering Technology Advisory Committee made up of local professionals from industry and education also contribute to the program.

Daytona State College. Daytona State College is located in Daytona Beach, Florida with additional campuses in Deland, Flagler/Palm Coast, Deltona, and New Smyrna Beach. It is a large institution, enrolling over 18,000 students and offering more than 100 associate degrees and certificates, as well as 7 baccalaureate degrees.

The BS in Engineering Technology is offered by the School of Engineering Technology in the College of Technology. There are 9 faculty associated with the School of Engineering Technology. The BS degree requires completion of 128 credit hours and offers three concentration options: General Concentration, Electrical Engineering Technology, and Information Systems Technology. A 2+2 model is used, such that individuals who have completed an AS or AA degree may apply to the Engineering Technology program. Applicants may either transfer to Daytona State College with their associate degree or may complete their associate degree at Daytona State College in AS degree programs such as Computer Engineering Technology and Electronics Engineering Technology. No specific information regarding transfer or this particular baccalaureate degree pathway were provided on the institutions' website.

As described by one respondent from Daytona State College, program evaluation is "a part of the day-to-day culture" of the institution. Experimentation with various teaching strategies and formats is encouraged within and among courses. Assessing student learning achievements is the preferred evidence of instructional quality. Student retention and course completion are continuously tracked by a dedicated retention coordinator.

New degree programs. The two notable AB degree pathways presented in this section were in development during the data collection for this study. They were awaiting final approval with anticipated plans to enroll the first students in Fall 2012. One case offers a career ladder degree pathway in software development established in the state of Florida, while the other case offers a management capstone curricula in technical leadership established in the state of Pennsylvania.

Case VII: AS in Computer Programming and Analysis / AS in Computer Information Technology; BAS in Software Development.

Summary of Case Highlights:

- Multiple associate degree entry points
- Transferable and nontransferable associate degree tracks at a single institution
- Career ladder curricular model
- Participating institutions located in a single state
- Pathway initiated by the associate degree-granting institutions

The baccalaureate degree pathway leading to a BAS in Software Development offered by the University of Central Florida (UCF) was in development in Fall 2011, scheduled to accept its first class of students in Fall 2012. The degree pathway was initiated by the four participating community colleges. Valencia College, Seminole State College, and Brevard Community College offer AS degrees in Computer Programming and Analysis which can be transferred as a block, allowing students to begin their upper-level baccalaureate courses upon arrival at UCF. Lake-Sumter Community College offers an AS degree in Computer Information Technology, which can be transferred and supplemented by a set of bridge courses taken at the baccalaureate degree-granting institution.

These degree pathways are supported by a program entitled DirectConnect to UCF, which "guarantees admission to UCF for the AA or AS graduates of the four collaborating colleges… DirectConnect college graduates are accepted before any first year students," as reported by one survey respondent. The specialized nature of the baccalaureate degree ("not everyone is going to be a software developer") necessitated the combination of students from four community colleges into one BAS degree program. Additionally, the geographically dispersed community college campuses have "pretty much dictated that these BAS courses will be online." This degree pathway follows a career ladder curricular model. As may be expected due to the novelty of the degree, at the time of data collection for this project, no information regarding transfer opportunities to the BAS in Software Development at UCF were provided on any of the participating institution's websites.

Brevard Community College. Brevard Community College is located in Eastern Florida with campuses in Cocoa, Melbourne, Palm Bay, and Titusville, as well as a center at Kennedy Space Center. According to the degree program website, the AS in Computer Programming and Analysis degree program is designed for entry-level employment and has a 63 credit hour requirement. Students choose to focus on either Desktop Applications Programming or Web Applications Programming.

Lake-Sumter Community College. Lake-Sumter Community College (LSCC) is located in Central Florida with campuses in Leesburg, Clermont, and Sumterville. At the time of data collection for this project, LSCC offered both an AS and AAS in Computer Information Technology. The AS degree was designed to transfer to four-year degree programs, while the AAS was designed as a terminal degree which prepares graduates to enter the workforce. Both degrees require the completion of 63 credit hours. The required courses are the same in each degree, with one exception. AS students are required to take a 3-credit hour general education course in composition and literature, while AAS students take an extra 3-credit hour professional elective course. A representative of LSCC stated that, due to a movement in the State of Florida away from offering AAS degrees, the AAS in Computer Information Technology was to be discontinued in the next year. A footnote in the course catalog encouraged students to take a specific elementary statistics class if they planned on transferring to any degree program at the UCF.

Students completing their AS degree at LSCC will be required to complete a set of three bridge courses for the BAS program in Software Development at University of Central Florida. The reason for these bridge courses is that the LSCC degree program is in information technology (rather than the computer programming degrees offered at the other community colleges that articulate to the BAS degree program at University of Central Florida). The available degree program at LSCC offers fewer opportunities to gain programming experience as compared to degree programs at the other participating community colleges. Being a small institution, LSCC did not have the capacity to offer multiple degree programs in a single field at this time. Therefore, LSCC graduates from the AS degree program in Computer Information Technology are required to take three programming classes at University of Central Florida. However, these classes do not add extra credit hours to the students' schedules, as they can be taken as a part of the required professional electives.

Seminole State Community College. Seminole State College is located in Central Florida with campuses in Sanford/Lake Mary, Altamonte Springs, Heathrow, and Oviedo. The college offers nine degrees in the fields of computer science and information technology, including a BS degree in Information Systems Technology; AA degrees in Computer Science, Computer Engineering, and Information Technology; and AS degrees in Computer Programming and Analysis, Computer Programming and Analysis with a Web Programming Specialization, Computer Information Technology; Information Systems Technology, and Network Services Technology. More than a dozen college credit certificates are also offered. Courses are taught by 3 full time professors and 18 adjunct professors.

The A.S. degree in Computer Programming and Analysis requires completion of 63 credit hours. The degree is designed to offer students opportunities to transfer to a baccalaureate degree program or to enter the job market following graduation.

Valencia College. Valencia College is located in central Florida with campuses in Kissimmee and Winter Park, as well as several Orlando campuses. The AS degree in Computer Programming and Analysis requires completion of 63 credit hours. Two computer programming certificates, requiring 18 or 33 credits, are also offered and can be applied to the associate degree. Industry certifications may also be eligible for college credit. The program page highlights that all AS degrees from Valencia College transfer to UCF. Yet, no information was available regarding the specific degree pathway to a BS in Software Development.

University of Central Florida. University of Central Florida (UCF) has 10 regional campuses that offer the bachelor of applied science degree with 22 majors and 15 minors. At the time of data collection for this project, no information was available on the university website regarding the BAS in Software Development.

Case VIII: AAS in Network Technology; BAS in Technical Leadership.

Summary of Case Highlights:

- Explicit foundations in a 2+2 model
- Management capstone curricular model
- Participating institutions located in a single state
- Pathway initiated by the associate degree-granting institution

NSF-ATE grant funding provided a foundation from which Lehigh Carbon Community College initiated a new management capstone AB degree pathway with Bloomsburg University. The pathway will allow graduates of 15 of LCCC's AAS degree programs (e.g., Biotechnology, Computer Specialist, Construction Management, Drafting and Design, Electrical Engineering Technology, Heat AC&R Technology, Industrial Automation, Kitchen and Bath Design, Mechanical Technology, Nanofabrication Technology), as well as 7 AA and AS degree programs, to pursue a newly developed BAS degree in Technical Leadership offered by Bloomsburg University. All baccalaureate degree requirements may be completed on the LCCC campus, and students enrolled in the Lehigh Career and Technical Institute will be able to enter the program at the high school level.

The survey respondent indicated that this pathway would be notable for its innovative program design which offers a "true 2+2+2" for students to transition from Lehigh Career and Technical Institute, to Lehigh Community College, and then to Bloomsburg University. She also reflected that program elements could be adapted to other educational settings, as she expects that the number of baccalaureate degrees in technical leadership will grow considerably in the coming years in order to "take highly qualified technicians and make polished professionals."

This baccalaureate pathway was in development during the data collection period for this project. The BAS in Technical Leadership degree was approved by Bloomsburg University's Board of Trustees on November 30, 2011 and by the Pennsylvania State System of Higher Education (PASSHE) Board of Governors on January 19, 2012. The formal articulation agreement between Lehigh Community College and Bloomsburg University is scheduled to be signed on March 29, 2012. The program is scheduled to enroll the first class of students in Fall 2012. As may be expected due to the novelty of the degree, at the time of data collection for this project, no information was available on either institution's website regarding the availability of this baccalaureate degree pathway.

Lehigh Carbon Community College. Lehigh Carbon Community College (LCCC) is located in Schnecksville, PA with satellite facilities in Nesquehoning, Allentown, and Tamaqua. This AB degree pathway was initially designed to focus on the transfer of three AAS Computer Specialist degrees (Network Technology, Programming, and Web Design) offered by the Computer Science Department in the School of Computer Science and the Arts. The AB degree pathway began with this department because the faculty demonstrated an interest in creating it. Four faculty and staff members in this department offer a total of five AS degrees, five AAS degrees, and one certificate.

The Computer Specialist AAS degrees require completion of 62-65 credit hours. The Network Technology specialization helps prepare students for a variety of certification exams including Certified Cisco Administrator (CCNA), Microsoft Certified Technology Specialist (MCTS), Microsoft Certified Information Technology Professional (MCITP), CompTIA A+, Network+, Linux+, and Security+. Each year, approximately 30-40 students enroll in these degree programs annually, and 6 students graduate with the degree. Students who are interested in transferring to a baccalaureate degree program are encouraged to take a specific college-level English class and to choose LCCC math courses based on recommendations from the baccalaureate degree-granting institution to which they would like to transfer.

Later in the process of developing the AB degree pathway, opportunities to transfer were opened to a greater variety of associate degree programs at LCCC. A primary reason for expanding to include additional associate degree programs was to achieve the equivalent of 20 full-time enrolled students in first year of offering the BAS degree.

Bloomsburg University. Bloomsburg University is located in Bloomsburg, PA and is part of the Pennsylvania State System of Higher Education (PASSHE). The BAS in Technical Leadership will be offered by the Department of Instructional Technology, which is made up of five faculty and eight staff members. Other programs offered by this department include a MS in Instructional Technology and an eLearning Developers Certificate. No other baccalaureate degrees are offered by the department at this time.

On the Bloomsburg University website, at the time of data collection for this project, information about the BAS in Technical Leadership was only available in a press release announcing the coming degree (www.bloomu.edu/media/releases/11-11-30). Although the curriculum had not yet been finalized, the press release indicated that the degree would include courses in information technology, communications studies, accounting, business education, information and technology management, and general education. The majority of courses would be offered online, with face-to-face classes offered on the Lehigh Carbon Community College campus.

What We Learned

The follow-up survey and in-depth website explorations allowed us to take a deeper look at a handful of AB degree programs that respondents indicated were particularly notable. The themes presented below demonstrate insights gained regarding the development, maintenance, and continued adaptations of these AB degree pathways.

New applied baccalaureate degree pathways are emerging in technician education in STEM fields. This theme is repetitive of the findings in our curriculum search, yet it is still worth noting that seven of the ten notable AB degree programs suggested by respondents were developed within the past ten years. Of these, three AB degree programs were begun in the last three years. This represents further evidence that AB degree programs are continuing to emerge in technician education in STEM fields.

Applied baccalaureate degree pathways are initiated by a variety of sources. From case to case, the key stakeholders who were involved in initiating AB degree pathways differed considerably. Representatives of associate degree-granting institutions initiated the creation of the AB degree pathway in three of the notable pathway cases. In one case, initiates came from the baccalaureate degree-granting institution; while in another single case the initiative came from an NSF-ATE Center, which used ATE grant funding to facilitate the connection of a group of community colleges with a university that developed a new baccalaureate degree to complete the degree pathway. In the remaining three cases, pathways were initiated within existing partnerships between associate and baccalaureate degree-granting institutions. This finding adds a new dimension to the theme of variety discussed previously.

Applied baccalaureate degree pathways often led to traditional baccalaureate (as opposed to applied baccalaureate) degrees. In eight of the 10 suggested notable cases, the baccalaureate degree pathways began with associate degrees which the respondents identified as historically terminal and ended with traditional BS degrees. The historically terminal associate degrees were AAS degrees in five cases, AS degrees in four cases, and an ASA degree in one case. This finding of applied associate degrees transferring to traditional baccalaureate degrees demonstrates an integration of applied and traditional pathways, suggesting that the lines between these degree options are flexible and, at times, blurred. This finding is supported by past research (e.g., Ruud & Bragg, 2011; Townsend, Bragg, & Ruud, 2009), and highlights the challenges in regard to accurately defining and describing the variety of pathways available to current day

students. Fuller descriptions of the emerging forms of baccalaureate degrees are needed, and more research is needed to explore the perceptions that stakeholders bring to consideration of transfer and applied degree opportunities.

Applied baccalaureate degree pathways adapt in response to their environments. Furthermore, we found evidence of AB degree pathways shifting and adapting over time. In one case, the adaptation was marked by moving the baccalaureate degree offerings from a baccalaureate degree-granting institution (University of Central Florida) to a primarily associate degree-granting institution that offers a few baccalaureate degrees (Daytona State College). In another case, the adaptation was marked by a change in how the baccalaureate degree is described at the baccalaureate degree-granting institution, California State University (CSU) Channel Islands. The changes on their degree requirement and course sequence documents favor highlighting the pathway experienced by students who are native to CSU Channel Islands, while making the curricular pathway for transfer students less prominent and more difficult to see in promotional materials. Situations such as these offer opportunities to consider steps taken to sustain AB degree pathways which operate in environments that are continuously changing.

Uncertainties regarding students and outcomes abound. In many cases, respondents indicated a lack of knowledge regarding the number of students who transferred from the associate degree to the baccalaureate degree, as well as a lack of knowledge regarding outcomes for those students. When data were available, a small number of students from associate degree programs made the transfer to the baccalaureate degree programs in most cases, with some notable exceptions. Several reasons were cited regarding the inability to track student progress, including the small number of faculty (often 1 or 2) who manage these programs and their not having time and staff support to pursue evaluation and tracking efforts. The lack of reporting systems that cross institutional boundaries is endemic to the P-20 context and something especially problematic to understanding applied baccalaureate degree programs.

Website communication gaps persist. Even among the AB degree pathways that were identified as notable by respondents, gaps in website communications exist. Excluding the two cases that plan to enroll their first students in Fall 2012, a small number of institutions acknowledged the specific baccalaureate degree pathways on their websites. Of the 11 associate degree-granting institutions that are part of the 8 notable degree pathways cases, only 4 (36.4%) mention the transfer relationship with the baccalaureate degree-granting institution that is a part of the identified degree pathway. Only 2 of the 8 (25.0%) baccalaureate degree-granting institutions mention the transfer relationship with the associate degree-granting institution(s). We interpret this as a missed opportunity to communicate with stakeholders who could benefit from knowing about the existence of the baccalaureate degree pathway and the relationship between the participating institutions.

Definitional challenges hinder discussion. Two respondents clearly expressed hesitancy to identify existing degree programs with the "applied baccalaureate" terminology, despite the reality that applied associate degrees that were once considered terminal are now transferring nearly all associate degree credits to baccalaureate degree programs. This hesitancy stems from both a lack of recognition of AB degrees with state policy contexts and concerns about lowering perceptions or institutional prestige for those who identify with AB degrees. This is important to keep in mind as it impacts communication about associate and baccalaureate degrees that emphasize applied coursework and applied learning. Terminology can affect the openness to discussion among professionals who need to share and learn from each other's experiences to create, sustain, and evaluate emerging opportunities for baccalaureate degree attainment.

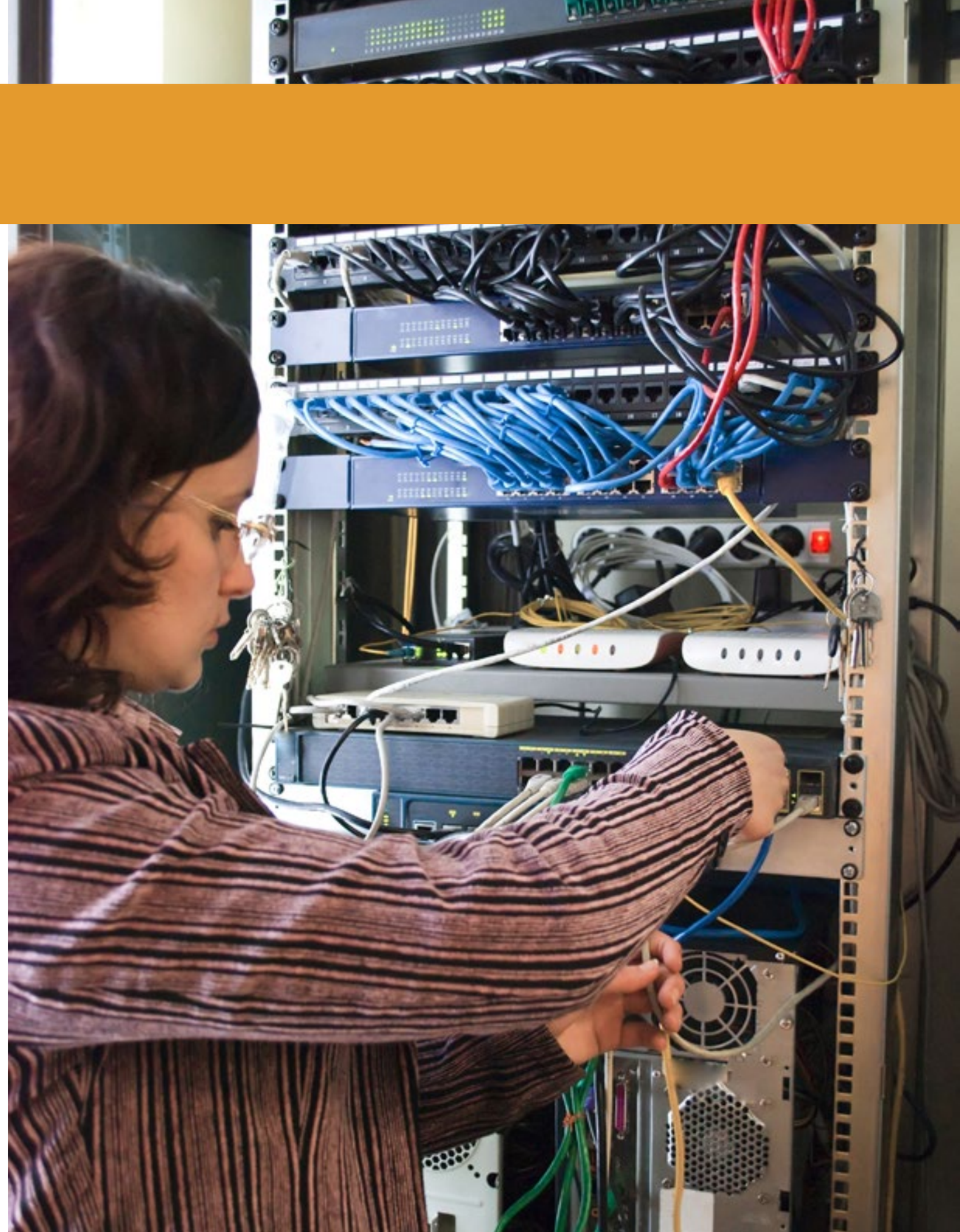
Synthesis of Findings

Eight main themes were derived through the analysis of data in this study. The themes address the development, variety, prevalence, and evolution of baccalaureate degree programs and pathways, as well as potential areas for further inquiry into relationships between applied and traditional associate degree programs, uncertainties about outcomes and impacts, missed opportunities for communication, and challenges identifying terminology that facilitates discussion. Each theme is presented in more detail below.

Theme 1: Baccalaureate degree pathways are dominated by variety.

Findings from the exploratory survey clearly demonstrated a wide variety of baccalaureate degree pathways that prepare technicians and technologists in STEM fields. For example, more than 30 different fields of study were reported for the 95 identified traditional and AB degree pathways. The baccalaureate degree pathways were initiated by a number of sources, including associate degree-granting institutions, baccalaureate degree-granting institutions, NSF-ATE-funded centers, or a combination of sources. For 20% of the identified baccalaureate degree pathways, respondents reported affiliation with one or more community college baccalaureate degrees. Baccalaureate degree pathways not only included historically transferable associate (AA, AS) and traditional baccalaureate (BA, BS) degrees, but they incorporated emerging degree opportunities including applied associate (e.g., AAA, AAS) and AB degrees (e.g. BAS, BAT).

Furthermore, based upon our analysis of curricula, variation was found in the types of degrees involved in specific baccalaureate degree pathways (e.g., applied associate to applied baccalaureate, applied associate to traditional baccalaureate, transfer associate to traditional baccalaureate), as well as the curricular models employed (i.e., career ladder, management capstone, upside-down, completion, hybrid).



Theme 2: Current definitions of AB degree pathways and programs were insufficient to describe identified cases.

This study mirrored past literature that exposes challenges with accurately defining and describing AB degree pathways (e.g., Bragg & Ruud, 2011; Ruud & Bragg, 2010; Townsend, Bragg, & Ruud, 2009). Respondents demonstrated a variety of perspectives on what they consider an AB degree pathway to be. The definition that guided this study, and was shared with respondents, focused primarily on bachelor's degrees that are "designed to incorporate applied associate courses and degrees once considered as 'terminal' or non-baccalaureate level" (Townsend et al., 2008, p. iv). In many cases, applied degree designations (e.g., AAS, BAS) served as useful signals for indicating that a degree pathway fit the AB degree pathway definition. However, as was the case in previous research conducted by Bragg and Ruud (2011), we found many cases where the degree titles were not a reliable signal of whether the applied baccalaureate was the intended credential. This lack of standardization and alignment of degree titles with program of study requirements was evident within and between disciplines, institutions and states. Here are just a few examples of the different AB degree pathway structures discussed in this research.

Applied associate degree to traditional baccalaureate degree. Some respondents shared that their states and institutions use the traditional baccalaureate degree designation of Bachelor of Science (BS) in STEM-related programs of study, even when these programs accept the transfer of applied associate courses and degrees and often also incorporate applied coursework and applied learning at the upper division level. In cases such as these, BS degrees accept the transfer of all, or nearly all, credits from applied associate courses and degrees, thereby creating an avenue for baccalaureate degree attainment from a once terminal associate degree. It is intriguing to note that 8 of the 10 notable degree pathways suggested by respondents in this study followed this pathway structure.

Transfer associate degree to AB degree. During the curriculum analyses, we found articulation agreements in Florida in which respondents identified an AB degree pathway which included an Associate of Science (AS), a traditionally transferable degree designation, that now transfers into a Bachelor of Applied Science (BAS) at a public university.

AB degree as a community college baccalaureate (CCB) degree. In another Florida case, an AS in Engineering Technology transferred to an AB degree program that was an applied BS in Engineering Technology (BSET) at a primarily associate degree-granting institution, making it a CCB. Examples of these types of transferable associate to AB degrees are supported by past research (Bragg & Ruud, 2011) that shows most CCBs are designated as AB degrees. The relatively new nature of this development, which is tied to the growth in CCBs in particular states, makes it important to follow the development or emergence of these programs.

Transfer associate degree to traditional baccalaureate degree. Furthermore, one case was also discovered in which respondents identified the AB degree pathway designation with associate degrees awarded as an Associate of Science (AS) that transferred to a Bachelor of Science (BS) because of the historical lack of transfer opportunities for students who had completed the associate degree. These respondents argued that, whereas the AS degree is theoretically a transfer degree, in this particular case the AS degree was essentially terminal because "students had nowhere to transfer" to advance their education in a related field.

Upon reflection on the progress of our work, we believe it has been helpful to broaden our consideration of AB degree pathways to understand the full scope of degree programs associated with technician and technologist education. Following the lead of previous studies (e.g., Bragg & Ruud, 2011), we sought to understand the development, content, and design of AB degree programs, without limiting our work based on credential names which can carry their own historic biases. Recalling that, in this study, the incorporation of applied courses and learning into baccalaureate degrees serves as a primary determinate used to identify AB degrees, we privilege the concept of applied learning in our discussions with respondents over credential titles.

However, we also see the need for more definitional work. This issue of clarifying definitions and understandings of AB degree pathways deserves much more attention in future research.

Theme 3: New baccalaureate degree pathways are emerging in STEM education, and AB degree pathways have a strong presence.

As evidenced by our exploratory survey, both traditional and AB degree pathways are emerging in high-demand STEM fields such as manufacturing and engineering technology, computer and information technology, and biotechnology. Almost 10% of all identified baccalaureate degree pathways were in some stage of development, with plans in some cases to enroll the first class of students in Fall 2012.

Of the 51 degree pathways for which we found evidence of the degree pathways on institutional websites, 68.6% were AB degree pathways, according to our initial and expanded definition (see Theme 2). Furthermore, the follow-up survey asked respondents to name AB degree pathways that were "notable" in terms of having exemplary or promising characteristics. Of the "notable" nominee AB degree pathways, 70% had been developed within the past 10 years. These data, as well as comments from respondents, suggest substantial development of baccalaureate degree pathways in STEM fields over the past decade and indicate a likelihood that program development will continue in the years to come.

Theme 4: Applied and traditional associate degree programs can exhibit strikingly similar characteristics.

When comparing curriculum from transferable and nontransferable degree tracks that were available in a single field at a single institution, we discovered that in five of eight associate degree comparisons, there were very few differences. In four of these five comparisons, program representatives confirmed that the nontransferable curricula existed first, and that the curricula were modified to create a transferable degree program. Interestingly enough, the modifications tended to be minor changes related to mathematics or writing classes. At three institutions, the changes affected a single class in the entire associate degree curricula. At another institution, two associate degree classes were changed, while the final institution changed five associate degree classes.

In the remaining three associate degree comparisons, more substantial differences existed such that between 30% and 60% of the courses differed between the transferable and nontransferable degree programs. Some respondents described these degree programs as having different underlying purposes. Yet, at one institution, the program descriptions available online for the two degrees were almost identical.

The similarities found between transferable and non-transferable associate degree programs within this study raise a host of questions about the difference between preparing students for the workforce versus, or perhaps concurrently for, academic transfer. Some of these questions are presented in the next section regarding future research.

Theme 5: AB degree pathways adapt in response to their environments.

Based on conversations with respondents that followed the survey data collection and curricular analysis, we discovered several cases in which AB degree pathways responded to perceived pressures and influences from the environments in which they operate. Influential sources included state policy contexts, higher education institution leadership, and departmental and program-level expectations.

For example, in three Florida community colleges, respondents indicated that their degree programs were moving away from offering AAS degrees. Responding to changes in the State political environment, all three institutions were in the process of modifying their nontransferable AAS degrees into transferable AS degrees. In another Florida case, we identified a degree program that had recently moved the baccalaureate degree

offerings from a public university to a primarily associate degree-granting institution, which offers a few CCBs.

Further, respondents from an institution in Washington state indicated that their creation of a transferable Associate of Applied Science–Transfer (AAS-T) degree in Energy Management was in response to their campus administration's encouragement to articulate the degree with a specific baccalaureate degree program. This AAS-T degree program was developed as a modification of a nontransferable Associate of Technical Arts (ATA) in Energy Management, which was launched just one year before the transferable option.

Finally, a baccalaureate degree-granting institution in California shared their process of reshaping descriptions and curricular maps for their degree program in response to their departmental recognition that more native students than transfer students were pursuing upper-level baccalaureate degree coursework. New materials highlight the degree pathway for students who were native to the four-year institution, while making the external prospective transfer student's path less apparent.

Theme 6: Despite recent program developments, limited evidence exists about the outcomes and impacts of baccalaureate degree programs and pathways.

Study findings suggest that considerable uncertainty exists regarding student participation and outcomes. Exploratory survey 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 by survey respondents. Our survey instrument did not request sufficient information to determine whether or not these data are collected, and if so, how they are shared and for what purposes. However, this issue will be examined closely in our continued research.

Based on the follow-up survey and discussions with respondents, several respondents indicated a lack of knowledge regarding the number of students who transferred from the associate degree to the baccalaureate degree, as well as a lack of knowledge regarding outcomes for those students. When data were available, a small number of students from associate degree programs made the transfer to the baccalaureate degree programs in most cases, with some notable exceptions. Several reasons were cited regarding the inability to track student progress, including the small number of faculty (often 1 or 2) who manage these programs and their not having time and staff support to pursue evaluation and tracking efforts. The lack of reporting systems that cross institutional boundaries is endemic to the P-20 context and something especially problematic to understanding applied baccalaureate degree programs.

Theme 7: Departmental and degree program websites miss opportunities to communicate baccalaureate degree pathways to key stakeholders.

Despite being confident of a baccalaureate degree pathway's existence based on survey responses, we were unable to locate information about the existing pathways in 23 out of 77 (29.9%) cases in which websites were search. Even among the AB degree pathways that had been identified as notable by respondents, gaps in website communications existed. Of the 11 associate degree-granting institutions that are part of the 8 degree pathways identified as notable by respondents and currently enrolling students, only 4 (36.4%) mentioned the transfer relationship with the baccalaureate degree-granting institution that was a part of the identified degree pathway. Only 2 of the 8 (25.0%) baccalaureate degree-granting institutions mentioned the transfer relationship with the associate degree-granting institution(s) on their website.

We view the lack of information on institutional websites as a missed opportunity to communicate about the existence of baccalaureate degree pathways. Websites are a primary way higher education institutions communicate about their academic programs to prospective students, current students, employers, policy makers, and higher education administrators and program directors. The lack of information about baccalaureate degree pathways on these websites contributes to the previous theme of uncertainty. It is a missed opportunity for communication with stakeholders who could benefit from knowing about the existence of the baccalaureate degree pathways and the relationships between the institutions that participate in the baccalaureate degree pathways.

Theme 8: Some respondents avoid applied language due to perceived stigma.

Reminiscent of a pattern observed in OCCRL's earlier work on AB degrees (Ruud & Bragg, 2011), two respondents clearly expressed hesitancy to identify existing degree programs with the "applied baccalaureate" terminology, despite the reality that applied associate degrees that were once considered terminal are now transferring nearly all associate degree credits to baccalaureate degree programs. This hesitancy stems from both a lack of recognition of AB degrees with state policy contexts and concerns about lowering perceptions or institutional prestige for those who identify with AB degrees. This is important to keep in mind as it impacts communication about associate and baccalaureate degrees that emphasize applied coursework and applied learning. Terminology can affect the openness to discussion among professionals who need to share and learn from each other's experiences to create, sustain, and evaluate emerging opportunities for baccalaureate degree attainment.

Calls for Future Research

Further research is necessary to understand the contribution that AB degree pathways make to national calls for preparing students for STEM careers, addressing gaps in the educational pipeline, and improved degree attainment, particularly for underrepresented student populations (e.g., Chen & Weko, 2009; Huang et al., 2000; National Academy of Sciences, 2007). Analyses of AB degree pathway designs, implementation, and outcomes is needed so that program designers and policy makers can move beyond opinions and assumptions (Townsend, 2005), toward decisions made based on fuller and more complete descriptions of existing and emerging AB degree pathways and evidence of their effectiveness and replicability. This section offers some potential directions for future research.

Pathway Development and Sustainability

The recent development of baccalaureate degree programs and pathways, particularly those that emphasize applied coursework and applied learning, encourages questions regarding the factors, resources, and environments that support program development and sustainability. For example, what perceived needs are these AB degree programs and pathways established to meet? How are program goals and course content designed? Once an AB degree pathway is developed, what contributes to its sustainability over time? How do programs and pathways adapt over time to meet new internal and external environmental demands? What programmatic characteristics encourage flexibility and longevity?

Outcomes and Data Dissemination

Additionally, questions emerge about the outcomes and impact of baccalaureate degree pathways. It would be helpful to know more about both the intended and the actual outcomes of baccalaureate degree programs. What outcomes are anticipated for these degree pathways? How are student, institutional, employer, and economic impact outcomes measured? What evidence is available to suggest that baccalaureate degree pathways achieve

their intended outcomes? What contributes to outcome attainment? Further, we are interested in how outcomes information is shared across the institutions that are involved in baccalaureate degree pathways. What purposes drive data collection, and with whom are the results of data analyses shared? What information and experiences are shared across institutions? What supports the sharing of data, and what additional resources and supports are needed to facilitate this communication?

Replicability

The amount of variety discovered in comparisons of baccalaureate degree pathways results in a picture that is both difficult to describe and compelling to examine. As suggested by earlier research, many efforts to develop AB degree programs and pathways have been quite localized, resulting in an array of program structures and designs, as well as a variety of labels and definitions used to describe programs (Bragg & Ruud, 2011). What does this mean for the replicability of degree pathways or the transferability of lessons learned from one environment to another? What can be learned from one baccalaureate degree program or pathway to be adopted or adapted to another setting?

Stakeholder Communications and Perceptions

The importance of stakeholder communications regarding the existence and outcomes of baccalaureate degree programs was perhaps best highlighted by findings related to this study's examination of websites for programming information, yet questions about communications run much deeper than illustrated by this data collection. On the one hand, there is a need to pay attention to methods of communication. How is information shared with prospective and current students; employers; higher education administrators, faculty, and program directors; and policy makers? What avenues for communication are optimal? On the other hand, issues of perceptions are also key to communication. How are baccalaureate degree pathways, particularly those that include applied coursework and applied learning, perceived by key stakeholders? What contributes to those perceptions? How can the transition of once terminal applied associate degrees into baccalaureate degrees be described in a way that encourages identification and discussion, rather than shuts down conversation?

Comparisons of Terminal and Transferable Associate Degrees

Finally, the comparison of terminal and transferable associate degree programs within this study raised a host of questions about the difference between preparing students for the workforce versus, or perhaps concurrently, for academic transfer. Are these types of preparation so similar that an adjustment of 1-5 classes in a terminal pathway can adequately prepare a student for transfer to baccalaureate degree programs? For example, does the completion of college algebra (as opposed to intermediate algebra) now prepare students for upper-level baccalaureate degree work? Are students in terminal versus transfer associate degree programs differentially prepared for future careers and educational opportunities? If preparation does, in fact, lead to similar outcomes, why is one associate degree pathway terminal while the other is fully transferable? What value exists for maintaining separate tracks versus merging all pathways into transferable curricula? Should separate tracks be eliminated so that all pathways transfer? Examining these issues from multiple stakeholder perspectives would also be helpful. For example, how do students perceive the similarities and differences between terminal and transfer degree programs? From an equity standpoint, which students pursue terminal associate degree tracks when similar, transferable degree programs exist at the same institution? Who is best served by these curricular decisions?

Broader Implications

This research has clear relevance beyond baccalaureate degree pathway development within 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 case studies that are planned as this research project proceeds.

Next Steps

OCCRL's team of researchers will continue to pursue the questions raised by this research. During the second phase of this study, to be carried out in 2012 and 2013, our team will conduct case studies with several NSF-ATE projects and centers that are affiliated with AB degree pathways. Our case study work aims to uncover exemplary and promising practices that can inform college administrators, employers, and researchers with up-to-date, detailed information about the development, operations, and outcomes of AB degree programs and pathways in technician education.

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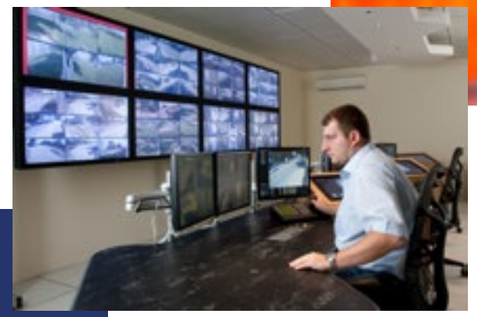

Appendix A: Study Methods

This study used a multi-pronged approach to identify and explore baccalaureate degree pathways affiliated with NSF-ATE projects and centers, The approach included:

- Exploratory surveys sent to NSF-ATE Principal Investigators in order to identify baccalaureate degree pathways affiliated with NSF-ATE projects and centers;
- Website searches for curricula associated with baccalaureate degree pathways identified in the exploratory survey;
- Follow-up surveys to gather more detailed information about baccalaureate degree pathways identified in the exploratory survey;
- In-depth website reviews of identified, notable applied baccalaureate (AB) degree pathways.

This appendix provides descriptions of the methods employed in each data collection strategy.

Exploratory Survey

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 AB degrees. 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.

Respondents were also asked to indicate whether they were willing to participate in follow-up research related to this project, which includes follow-up surveys and site-level case studies. Respondents who were willing to participate provided their names and contact information.

The sample for this initial survey included all NSF-ATE 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. The first survey invitation was sent via email on June 2, 2011. Undeliverable email notices were received from 206 individuals, leaving a sample size of 651. After two follow-up reminder emails, the survey was closed on August 3, 2011.

A total of 233 (36% of the sample) responses were received to the survey from 231 NSF-ATE projects and centers. Note that two respondents provided information on the same NSF-ATE project or center. An additional 20 (3% of the sample) email responses were received indicating that 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. From the survey responses, 95 unique cases were identified in which NSF-ATE projects and centers were affiliated with associate to baccalaureate degree pathways.

Website Search for Curricula

In this first website search, we aimed to gather degree requirement and course sequence data for the 95 baccalaureate degree pathways identified in the exploratory survey. Procedures for data collection were designed and tested on 15 cases between November 21, 2011 and November 29, 2011. The research team then discussed and refined the procedures. Three researchers individually analyzed single cases, and then compared results to refine the procedures and enhance inter-rater reliability. The resulting website review procedure included:

- Identify college and university websites to review based on contact information provided by respondents to the exploratory survey.
- Identify the degree(s) affiliated with the field of study reported in the exploratory survey, using navigation and search features available on the institution's websites, as well as Google searches when necessary.
- Locate information on the identified degree(s) and download copies of course sequence and degree requirements documents, as well as any articulation agreement or other documents that show transfer relationships for the identified degree(s).
- Review websites of institutions with transfer relationships to locate information on their identified degree(s). Download copies of course sequence and degree requirements documents, as well as any articulation agreement or other documents that show transfer relationships for the identified degree(s).
- Review course sequence, degree requirement, articulation agreement, and other documents, as well as other descriptions of the degrees and degree pathways provide on the websites to determine: (a) the curricular model represented by the degree pathway, and (b) whether or not this represents an AB degree pathway as defined in this study.
- Review websites of institutions offering associate degrees for evidence of general or all-major articulation agreements to identify additional opportunities for baccalaureate degree attainment outside of the specific associate degree field. Download copies of course sequence, degree requirements, articulation agreement, and other documents were applicable. Review those documents to determine the curricular model represented by the degree pathway.

Space was provided for researchers to make notes about the search process, to record text from websites, and to reflect upon interpretations of curriculum models.

The full set of 95 cases identified in the exploratory survey were divided among the three researchers. While one researcher conducted the website search for each initial survey respondent, opportunities were available for consultation among the research team throughout data collection. Data collection was conducted between November 29, 2011 and December 6, 2011. Between December 7, 2011 and December 9, 2011, all recorded notes were reviewed and questions about data recording or interpretation were brought to the full team for clarification.

We recognize several limitations of using higher education institution websites as a primary data source. First, we are capturing data at one period in time from a data source that is constantly evolving. For this reason, we carefully tracked the dates in which the data collection occurred, and endeavored to complete all of the reviews in a short time period. Ultimately, we completed all data collection and review within the span of 11 days. The data presented in this report reflect a snapshot of information available during this brief timespan.

Second, we recognize there are many reasons for posting (or not posting) information to a website. The data collected are not necessarily a complete picture of the baccalaureate degree pathway offerings indicated within the 95 cases identified by the exploratory survey. Not being able to locate evidence of the degree pathway in our website search does not necessarily indicate that a

degree pathway does not exist. Rather, we discuss these cases as "pathways for which we could find evidence on institutional websites."

Finally, categorization of curriculum as AB or traditional baccalaureate, as well as determinations regarding what curricular models best described identified pathways (e.g., career ladder, management capstone, upside-down, completion, or hybrid), were made by the research team based on the definitions and theoretical lenses employed in this study. It is important to recognize that administrators and faculty members of individual degree programs may choose to use different labels to describe their curriculum offerings.

Follow-Up Survey

The follow-up survey was conducted to identify specific AB degree pathways that had notable features to examine, as well as to illustrate key components of these degree pathways including: (a) contextual information on the development of the pathway, (b) instructional approaches and settings, (c) targeted student populations, (d) supportive partnerships within institutions, between higher education institutions, and with employers, (e) systematic evaluation strategies, and (f) impacts of NSF-ATE funding.

Of the 95 cases identified in the exploratory survey as having baccalaureate degree pathways affiliated with an NSF-ATE project or center, 74 had supplied enough information for future contact and had indicated willingness to participate in the follow-up survey. In most cases, the follow-up survey invitations were sent to the PIs who responded to the first survey. In a few cases, the PIs identified other individuals who they felt had better knowledge of the degree pathways.

The follow-up survey was launched on October 6, 2011, through e-mail invitations sent to identified individuals. Reminder e-mails were sent to non-respondents on October 12, 2011 and October 24, 2011. Personal contact was made with non-respondents, either via telephone, e-mail, or through personal interaction at the NSF-ATE Principal Investigator conference (October 26 – 28, 2012), and a round of personalized survey invitations was sent out between November 1 and November 7, 2011. The survey was closed on November 25, 2011.

From the 74 survey contacts, responses were received with information about baccalaureate degree pathways affiliated with 40 NSF-ATE projects and centers. This represents a 54.1% response rate for the follow-up survey. Data was collected in online and phone surveys from a total of 50 individuals. In 5 baccalaureate degree pathway cases, data was provided by multiple respondents, with each person addressing the sections of the pathway with which they were most familiar (e.g., associate degree, baccalaureate degree, involvement of the NSF-ATE project or center).

Within these cases, survey respondents recommended 10 AB degree pathways that had notable characteristics that the research team should examine closely, where "notable" was defined as having exemplary or promising characteristics in one or more of the following areas: addressing economic and societal needs, curricular alignment, program design, systematic evaluation, and replicability. For the identified notable AB degree programs, we developed a two-page profile which provided a narrative description of the pathway based on our understanding of the survey responses. The profiles were intended to serve as an incentive to encourage participation and to provide an immediate, tangible product to respondents. Profiles were shared with respondents, who were given a chance to suggest edits and fill in gaps in our information. The profiles provided an opportunity for member checking, and led to additional information about the identified AB degree pathways.

In-depth Website Reviews

To complement the follow-up survey data, we conducted in-depth reviews of departmental and degree program pages on websites from all higher education institutions associated with the 10 identified notable AB degree pathways. A total of 22 websites were reviewed between November 1, 2011 and January, 11 2012. Data were recorded regarding:

- Program context: mission statements, program goals, program history and development, program setting, strategic plans, accreditations, accreditation letters
- Program operations: staffing, funding, budgeting
- Curriculum: Degree requirements, course descriptions, course sequences
- Faculty: numbers, full-time versus part-time employment, qualifications
- Target student populations
- Costs: tuition, fees, financial aid opportunities
- Admissions requirements
- Enrollment
- Resources and services: advising, career assistance, job placement, student life, internships, apprenticeships, work-based learning opportunities
- Sample evaluation materials: surveys, student evaluations, curriculum evaluation plans
- Promotional materials
- Awards and recognitions
- Other innovative or unique characteristics

Additionally, background information on each institution was collected from the Integrated Postsecondary Educational Data System (IPEDS).

Two-page summaries were written for each institution based on the information gathered in the website reviews. Seven categories were addressed in these categories, including: institutional setting, program organization, curriculum, transfer information, student experience, outcomes, and other. The amount and type of information found varied greatly across the institutions, yet the majority of institutions had some information to inform each of these seven categories.

As discussed above in regard to the website search for curricula, relying on websites as a source of research data has limitations. Websites may change frequently, meaning that our reviews offer only a snap shot in time during the two-month period when these searches were conducted. Additionally, focusing primarily on the departmental and degree program pages may have limited the type of information to which we had access. Despite these limitations, we remain confident that the information gained from the web reviews provided important supplementary information to the data gathered in the follow-up surveys.

Appendix B: Course Requirements for Curricular Model Examples

Table B.1. Career Ladder Curriculum Example

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Kentucky Community and Technical College Systems, AAS in Information Technology – Network Administration							
X					3	ENG 101	Writing I
X					3	ENG 102	Writing II
X					3	MT 150	College Algebra
X					4	Not Specified	Science with Lab
X					3	Not Specified	Oral Communications
X					3	Not Specified	Social Interaction
X					3	Not Specified	Heritage / Humanities
	X				3	CIS 120	Program Design & Development
	X				4	ET 107*	Computer Applications for Technicians
	X				3	IT 105*	Computer Maintenance Essentials
	X				3	IT 205*	Advanced Computer Maintenance
	X				4	IT 120	Cisco Internetworking I
	X				3	IT 170	Introduction to Database Design
	X				4	IT 130	Web Site Design and Production
	X				3	Not Specified	Beginning Level Programming Language
	X				3	NIS 211	Administering Microsoft Windows Professional
	X				3	NIS 213	Administering Microsoft Windows Server
	X				3	NIS 214	Supporting Windows Network Infrastructure
	X				3	NIS 245	Designing a Secure Windows Network
	X				3	Not Specified	Technical Elective
	X				3	Not Specified	Technical Elective
22	**45**	**0**	**0**	**0**	**67**	**TOTAL for AAS**	

Table B.1. Career Ladder Curriculum Example (continued)

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Western Kentucky University, BS in Computer Information Technology, Networking Administration							
X					3	Not Specified	Foreign Language
X					3	Not Specified	Humanities
X					3	Not Specified	Humanities
X					3	Not Specified	Social/Behavioral Sciences
X					3	Not Specified	Social/Behavioral Sciences
X					2	Not Specified	Natural Science
X					3	Not Specified	World Cultures/American Cultural Diversity
X					2	Not Specified	Health and Wellness
	X				3	CIT 300	Online Training Foundations
	X				3	CIT 302	Web Development
	X				3	CIT 352	Database Administration II
	X				3	CIT 372	Telecommunications II
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
	X				3	Not Specified	CIT Elective
22	**36**	**0**	**0**	**0**	**58**	**Total for BS**	
44	**81**	**0**	**0**	**0**	**125**	**Total for AAS to BS pathway**	

* Indicates situations where the specific course taken may be selected from a small group of courses.

Table B.2. Management Capstone Curriculum Example

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Edmonds Community College AAS-T in Energy Management							
X					5	ENGL 101	English Composition I
X					5	ENGL 102	English Composition II
X					5	CMST 220	Public Speaking
X					5	Not Specified	College-Level Math
X					5	PHIL 106	Introduction to Logic
X					5	MGMT 100	Human Relations
X					5	BSTEC 130*	Computer Fundamentals
	X				3	ENRGY 100	Introduction to Energy Management
	X				5	ENRGY 102	Energy Basics
	X				3	ENRGY 105	Introduction to Sustainability
	X				5	ENRGY 120	Energy Efficiency
	X				5	ENRGY 130	Energy Assessment and Analysis
	X				3	ENRGY 135	Energy Accounting
	X				5	ENRGY 140	Commercial Lighting
	X				5	ENRGY 145	Building Operations and Maintenance
	X				5	ENRGY 230	Energy Assessment and Analysis II
	X				5	ENRGY 245	Energy Management Planning and Operations
	X				5	ENRGY 250	Energy Efficiency Program Planning & Design
	X				2	CIT 110	Energy Efficiency Technician
		X			5	MGMT 214	Principles of Management
		X			5	MGMT 270	Project Management I
	X				3	ENRGY 150*	Renewable Energy Systems
	X				3	OSH 140*	Regulatory Environment
35	**57**	**10**	**0**	**0**	**102**	**Total for AAS-T**	

Table B.2. Management Capstone Curriculum Example (continued)

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Central Washington University, BAS in Information Technology and Administrative Management							
X					4	Not Specified	Literature and the Humanities
X					4	Not Specified	The Aesthetic Experience
X					4	Not Specified	Philosophy & Cultures of the World
X					4	Not Specified	Perspectives on the Cultures & Experiences of the US
X					4	Not Specified	Perspectives on World Culture
X					4	Not Specified	Foundations of Human Adaptations and Behavior
X					4	Not Specified	Patterns & Connection in the Natural World
X					4	Not Specified	Applications of Natural Science
X					4	Not Specified	Fundamental Disciplines of Physical & Biological Science
		X			3	ADMG 201/301	Introduction to Business
		X			4	ADMG 271/317	Business Math
		X			5	ADMG 302	Financial Analysis
		X			3	ADMG 310	Professional Development
		X			4	ADMG 371	Administrative Management
		X			3	ADMG 372	Leadership & Supervision
		X			5	ADMG 374	Project Management
		X			5	ADMG 385	Business Communication & Report Writing
		X			4	RMT 366	Customer Relationship Management
		X			5	IT 260/360	Integrated IT Applications
		X			3	IT 359	Advanced Spreadsheet Applications
		X			4	ADMG 424	Administrative Management Policy
		X			4	ADMG 471	Contemporary Issues
		X			3	ADMG 485	Managerial Communication
		X			7	ADMG 490	Summer Internship
36	**0**	**62**	**0**	**0**	98		
71	**57**	**72**	**0**	**0**	**200**		
22	**36**	**0**	**0**	**0**	**58**	**Total for BAS**	
44	**81**	**0**	**0**	**0**	**125**	**Total for AAS-T to BAS pathway**	

* Indicates situations where the specific course taken may be selected from a small group of courses.

Table B.3. Completion Curriculum Example

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Quinsigamond Community College AS in Manufacturing Technology							
X					3	ENG 101	English Composition and Literature I
X					3	ENG 102	English Composition and Literature II
X					3	CIS 111	Introduction to Computer Applications
X					3	MAT 123	College Mathematics I: Precalculus
X					3	MAT 124*	College Mathematics II: Trigonometry
X					4	PHY 101	Physics I
X					4	PHY 102	Physics II
X					3	Not Specified	Liberal Arts Elective
	X				3	MNT 110	Manufacturing Processes I
	X				4	ELT 103	Electronics I
	X				3	MNT 101	Mechanical CAD I
	X				4	MNT 105	Geometric Tolerancing and Blueprint Reading
	X				3	MNT 103	Solid Modeling
	X				3	MNT 115	Instrumentation in Manufacturing
	X				3	MNT 217	Process Automation & Robotics
	X				4	MNT 215	Fundamentals of Computer-Aided Manufacturing
	X				4	MNT 216	Manufacturing Processes II
	X				3	MNT 218	Lean Manufacturing & Six Sigma
	X				3	MNT 299*	Cooperative Work Experience and Seminar
	X				3	Not Specified	Program Elective
26	**40**	**0**	**0**	**0**	**66**	**Total for AS**	

Table B.3. Completion Curriculum Example (continued)

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Assumption College , BS in Social Science (BA in Humanities)							
X					3	ENG 204E*	Effective Business Writing
X					3	THE 100E	The Bible
X					3	PHI 100E	Introduction to Philosophy
X					3	Not Specified	Philosophy or Theology Elective
X					3	Not Specified	Survey History
X					3	Not Specified	Natural Science or Foreign Language
X					3	Not Specified	Natural Science or Foreign Language
				X	3	Not Specified	Concentration Course
				X	3	Not Specified	Concentration Course
				X	3	Not Specified	Concentration Course
				X	3	Not Specified	Concentration Course
				X	3	Not Specified	Concentration Course
				X	3	Not Specified	Concentration Course
			X		6	Not Specified	Requisite Open Electives to Meet 63 Credit Requirement
				X	3	Not Specified	Multidisciplinary Capstone Course
21	**0**	**0**	**6**	**27**	54	**Total for BS / BA**	
47	**40**	**0**	**6**	**27**	**120**	**Total for AS to BS/BA Pathway**	

* Indicates situations where the specific course taken may be selected from a small group of courses.

Table B.4. Hybrid Curriculum Example

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Idaho State University, AAS in Energy Systems Electrical Engineering Technology							
X					3	ENGL 1101	English Composition
X					3	COMM 1101	Principles of Speech
X					3	MATH 1153	Introduction to Statistics
X					4	PHYS 1101	Elements of Physics
X					3	Not Specified	"Goal 6, 7, 9, 10A, 11, or 12"
	X				4	ELTR 0141	Applied Mathematics I
	X				4	ELTR 0142	Applied Mathematics II
	X				1	ESET 0100	Engineering Technology Orientation
	X				10	ESET 0101	Electrical Circuits I and Lab
	X				10	ESET 0102	Electrical Circuits II and Lab
	X				1	ESET 0212	Electrical Systems Documentation and Standards
	X				2	ESET 0220	Thermal Cycles and Heat Transfer
	X				2	ESET 0221	Boiler, Reactor, and Turbine Principles
	X				3	ESET 0222	Process Control Theory
	X				1	ESET 0226	Process Control Devices Lab
	X				12	ESET 0292	Electrical Engineering Technology I and Lab
	X				9	ESET 0293	Electrical Engineering Technology II and Lab
	X				1	TGE 0158	Employment Strategies
	X				1	TGE 0257	Ethical Issues in Technology
16	**61**	**0**	**0**	**0**	**77**	**Total for AAS** ***(50 academic credits transfer, plus 16 general education)***	

Table B.4. Hybrid Curriculum Example (continued)

General Education	Technical	Management	Open Electives	Other Academic Coursework	Number of Credits	Course Number	Course Name
Idaho State University, Bachelor's of Applied Technology							
X					18	Not Specified	Requisite Additional General Education for BAT
	X				12	Not Specified	Minimum Credits that "must support…AAS… coursework"
			X		24	Not Specified	"Academic Coursework"
				X	8	Not Specified	Presumed Open Electives to Meet 128 Credit Minimum
18	**12**	**0**	**24**	**24**	62	**Total for BAT**	
34	**73**	**0**	**24**	**24**	**139**	**Total for AAS to BAT**	

* Indicates situations where the specific course taken may be selected from a small group of courses.

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