CASTLETON UNIVERSITY
COMMUNITY COLLEGE OF VERMONT
NORTHERN VERMONT UNIVERSITY
VERMONT TECHNICAL COLLEGE

VERMONT STATE COLLEGES SYSTEM

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TO: Education, Personnel, and Student Life Committee
Jim Masland, Chair
Karen Luneau, Vice Chair
Janette Bombardier
Megan Cluver
Peg Flory
Jesse Streeter

FROM: Yasmine Ziesler, Chief Academic Officer

RE: EPSL Meeting on August 26, 2019

DATE: August 20, 2019

The EPSL Committee of the Board of Trustees is scheduled to meet from 10:00 a.m. to 12:00 p.m. at the Office of the Chancellor.

In addition to the regular business of the committee, the focus for the committee's discussion at this meeting will be a system-level review of academic programs and the status of online program delivery across the system. This focus is prompted by the input received this summer at outreach meetings by the Long Range Planning Committee members and the Chancellor. A summary and full details of the input received may be found in the Long Range Planning Committee meeting materials for August 26th and will be posted on the https://www.vsc.edu/board-of-trustees/securethefuture/ website.

In brief, the major themes and questions emerging from input sessions regarding academic programs included a consensus about the need to address program duplication. Questions and suggestions for exploration included sharing of programs, easier transfer pathways, better degree completion options for working-age students, and expansion of workforce-relevant, affordable postsecondary opportunities. Questions related to the challenges of becoming competitive in the online delivery marketplace were also identified. Below is an overview of the accompanying materials for the committee's discussion as they relate to this input.

Workforce Alignment of Existing VSCS Programs: The VSCS academic programs summary and program-level detail identifies all degree and certificate programs aligned with the McClure Foundation's Pathways to Promising Careers resource guide. Overall, 44% of VSCS students in Fall 2018 were enrolled in programs aligned with high-wage (median wage of at least $20/hour), high-growth career fields as defined by the Vermont Department of Labor.

Transfer Pathways: While all credits students earn in the VSCS are included in a single transcript, and board policy 106 ensures general education transferability specifically, VSCS institutions in recent years have worked together to create explicit "Direct Admissions"

transfer maps pathways from CCV to four-year programs. CCV has supported this work further by streamlining its program offerings into "metamajors" that provide flexibility and structure for students interested in a broad career field so that credits will be applicable to any major within that field. CCV metamajors and current published Direct Admissions pathways are indicated in the far left column of the detailed program list.

Program Duplication and Proliferation: The detailed program list is organized broadly using Classification of Instructional Programs (CIP) categories used by the National Center for Education Statistics, and then in descending order of program headcount enrollment. With the limited exception of program areas such as agriculture and science technologies provided by only one institution (Vermont Tech), most academic programs are duplicated across the system, both in areas with high overall enrollment (business, health professions, liberal studies, psychology) and fields with modest enrollments (English, History, Mathematics, Natural Resources).

It is important to note that this system-level presentation does not provide visibility into program organization, delivery strategies, or costs at individual institutions. At the institution level, an associate degree or certificate with limited enrollment may be delivered in the context of a larger baccalaureate program. Similarly, a small interdisciplinary major may be offered utilizing courses from a combination of other majors. Earlier this year, in part to address questions of duplication, cost, and quality, the Board approved a revision to Policy 102 that included adoption of a rubric to guide decision-making regarding new program development in the system, and a revision to Policy 109 that defines a minimum program size of 5 graduates or 25 active first majors.

Instructional Staffing: The instructional staffing summary provides an overview of staffing ratios. As a broad generalization, staffing across the VSCS is characterized by relatively low ratios of instructors to students, lower than comparable peer institutions. Unlike institutions which prioritize research activity, full-time faculty in the VSCS have a 24-credit annual teaching load, or the equivalent of four standard 3-credit courses per semester.

Status of Online Program Delivery in the VSCS: The final item in your materials is an overview presentation of online programs across the system, with a particular focus on those resources and functions that are shared versus those that are distinct and controlled at the individual institution level.

I can be reached directly at (802) 224-3025 if you have any questions.

Thank you.

Cc: VSC Board of Trustees
Council of Presidents
Chief Academic Officers
Student Affairs Council

Vermont State Colleges Board of Trustees
Education, Personnel, and Student Life Committee

August 26, 2019

AGENDA

1. Call to order
2. Approval of May 29, 2019 Meeting Minutes
3. Northern Vermont University Policy 102 New Program Proposal: B.S. in Data Science
4. Discussion of academic programs data
5. Discussion of online program delivery across the system
6. Other business
7. Comments from the public

MATERIALS

1. May 29, 2019 minutes
2. NVU Proposal for B.S. in Data Science
3. VSCS Academic Programs Data
4. Online Programs in the VSCS

Item 1:
Minutes of the May 29, 2019 Meeting

Minutes of the VSCS Board of Trustees Education, Personnel, and Student Life Committee meeting held Wednesday May 29, 2019 at the Chancellor's office, Conference Room 101, Montpelier, VT - UNAPPROVED

Note: These are unapproved minutes, subject to amendment and/or approval at the subsequent meeting.

The VSCS Board of Trustees Education, Personnel, and Student Life Committee met on Wednesday May 29, 2019 at the Chancellor's Office, Montpelier, Vermont.

Committee Members present: Jim Masland (Chair), Karen Luneau (Vice Chair), Janette Bombardier, Megan Cluver

Absent: Peg Flory, Jesse Streeter

Other Trustees Present: Churchill Hindes

Presidents: Elaine Collins, Joyce Judy, Pat Moulton, Karen Scolforo

Chancellor's Office Staff: Jeb Spaulding, Chancellor
Tricia Coates, Director of External & Governmental Affairs
Todd Daloz, Associate General Counsel
Doug Eastman, Director of Information Technology
Jen Porrier, Administrative Director
Sophie Zdatny, General Counsel
Yasmine Ziesler, Chief Academic Officer

From the Colleges: Nolan Atkins, Provost, Northern Vermont University
Jonathan Davis, Dean of Student Life, Northern Vermont University
Kate Gold, Director of Advising Resources, VSCUP President, Northern Vermont University
Laura Jakubowski, Chief Budget & Finance Officer, Castleton University
Gina Mireault, Professor, Northern Vermont University
Dennis Proulx, Castleton University
Sharron Scott, Dean of Administration, Northern Vermont University

1. Call to Order

Chair Masland called the meeting to order at 11:06 a.m.

2. Consent Agenda: Approval of March 23, 2019 Meeting Minutes

Trustee Bombardier moved and Trustee Luneau seconded the motion to approve the minutes. The motion was approved unanimously.

3. Northern Vermont University Policy 102 New Program Proposal: A.S. in Psychology

NVU Provost Nolan Atkins and Dr. Gina Mireault gave an overview of the proposed program for an A.S. in Psychology at Northern Vermont University. This program is in line with NVU's strategy of creating associate degrees as a pathway to a credential if a student is unable to reach a bachelor's degree. A related aim is retention of students from first to second year by providing a more affordable two-year goal and collaboration with NVU Online. This accessible credential is designed to help students get employment in the social services domain. There is no additional cost associated with delivering this program; it is a subset of the Psychology baccalaureate program. Trustee Bombardier asked about system approaches to supporting students to complete the associate degree, such as students being able to access courses closer to home at a sister institution. Dr. Mireault responded that the core courses are the same across the system and that there is clear, intuitive cross pollination across the system.

Trustee Luneau moved and Trustee Bombardier seconded the motion to recommend to the Board the approval of the A.S. in Psychology at NVU. The motion was approved unanimously.

4. Proposed Revisions and system review rubric for Policy 102

Chief Academic Officer Dr. Yasmine Ziesler explained that the recommended changes to Policy 102 will help to guide decision making about developing new program proposals. This revision to the policy reflects how to use the rubric when thoughtfully developing proposals for new programs across the VSCS.

Trustee Cluver moved and Trustee Bombardier seconded the motion to recommend to the Board to approval of the revisions to Policy 102. The motion was approved unanimously.

5. New policy proposal: Chosen Name Policy

Director of Information Technology Doug Eastman, Castleton University Dean of Students Dennis Proulx and Northern Vermont University Dean of Students Jonathan Davis discussed the proposal of the new VSCS Policy 315: *Chosen Name*. Mr. Eastman indicated that from a technical aspect, it is now possible to systematically reflect a chosen name on emails, class rosters and other similar school documents. Chosen Name is defined as the name by which a student would like to be referred. Mr. Proulx indicated that this is an important step towards a more inclusive environment. He shared that 300 schools nationally, including UVM, have a similar policy and this shows that the System values a student's chose name. This policy provides a way for people to establish their chosen name in the VSCS's central student

information system. There was further discussion about additional desired steps towards greater inclusivity, for example supporting the use of preferred pronouns.

Trustee Bombardier moved and Trustee Cluver seconded the motion to recommend to the Board the approval of Policy 315: Chosen Name Policy. The motion passed unanimously.

6. Administrative revisions to FERPA Compliance Policy 312

Associate General Counsel Todd Daloz discussed the administrative revisions to Policy 312 stating that the changes are mostly technical updates to the language. For example, the word "Institution" is now being used instead of "College." And with the likely adoption of Policy 315: *Chosen Name*, a student's Chosen Name is now being added to what is considered directory information (non-FERPA protected information). Aside from general format updating there are no further substantive changes to the policy.

Trustee Luneau moved and Trustee Bombardier seconded the motion to recommend to the Board the approval of the revisions to Policy 312 – Compliance with FERPA. The motion was approved unanimously.

7. Information update: May 22 System Academic Retreat and *Start to Finish* initiative

Dr. Ziesler gave a brief overview of the 2019 Academic Retreat, held at NVU-Lyndon. Academic affairs faculty and staff focused this year on topics such as retention, 15 credits per semester and degree maps. Trustee Luneau, who attended the retreat, expressed her gratitude and endorsement for an event she found timely and significant.

8. Other Business

There was no other business.

9. Comments from the public

There were no comments from the public.

Chair Masland adjourned the meeting at 12:05 p.m.

Item 2:
NVU Proposal for B.S. in Data Science

VERMONT STATE COLLEGES
POLICY 102 NEW PROGRAM PROPOSAL TEMPLATE

Part I: General Information

1. Institution:

   Northern Vermont University

2. Name of new program:

   Data Science

   a) Individual(s) with responsibility for program development:

      Gregory Petrics, *Associate Professor*, Mathematics, NVU-Johnson
      Bradley Beth, *Assistant Professor*, Computer Science, NVU-Lyndon

   b) Academic Department(s):

      Mathematics and Computer Science

3. Proposed start date of program:

   Fall 2020

4. Title of degree to be conferred (if applicable):

   Bachelor of Science in Data Science

5. Brief description of proposed program (150 words or less):

   Data Science is an emerging field which uses statistical computation to make data-based decisions, inferences, and predictions. The Data Science skill set is highly sought after in the labor market. The proposed program takes an interdisciplinary approach to Data Science, drawing on the liberal arts tradition of the Johnson Campus and the technical focus of the Lyndon Campus, to produce graduates who are skilled consumers, creators, and communicators of data and statistical analyses. Foundational technical skills are developed in a sequence of existing courses in the Mathematics and Computer Science Department, career skills are honed by selecting electives from existing courses in the Business or Behavioral Sciences Department, liberal skills are acquired through the existing NVU GEC, and data science-specific skills are developed through a proposed sequence of two new courses.

Part II: Rationale

1. How the program will strengthen the institution (refer to institutional mission, institutional priorities and existing institutional programs) and how the perceived interest in the program at the institution was determined:

The proposed Data Science baccalaureate program will synergistically increase enrollment in both degree and non-degree programs, innovate existing NVU programs into new, high demand areas of study, and position NVU as a pioneer in undergraduate and workforce development data education in Vermont.

The proposed Data Science program is a great example of what is possible by integrating the expertise that exists on the Johnson and Lyndon campuses. We could not offer this degree program with the resources and expertise that exists on one campus. It also serves to advance the four strategic priorities guiding the institution through its formative years: innovative education, exceptional community leadership, transformative student experience, and a vibrant thriving campus.

Innovative Education

A key component of the NVU mission is to provide innovative professional and liberal arts educational experiences that prepare students to be critical thinkers and engaged global citizens. The field of Data Science itself requires a mix of disparate analytical skills and domain-specific expertise difficult to develop in the traditionally siloed liberal arts or professional studies programs at other universities. As NVU's foundation is built upon bridging the divide between liberal and professional education, the field of Data Science is a good fit for the institution, directly borrowing from the two integrated areas of study at its core. The proposed Data Science program will advance an interdisciplinary line of study and bring together many existing NVU education assets such as statistics, analysis, and written, and oral communications skills education.

Community Leadership

The demand for data science and analytics (DSA) skills is disrupting the job market. By adding a Data Science baccalaureate degree program, NVU is proactively responding to the rising demand for analytics skills by employers and preparing students for the analytics-related roles of today and tomorrow. NVU's existing reputation as a leader in data-reliant fields such as business, atmospheric science, and computer information systems has paved the way for NVU's entrance into the Data Science field. The addition of the program will model to Vermonters the mainstream application of data as an accessible resource with everyday application.

Transformative Student Experience

The "age of big data" is transforming the tools and skills employees utilize in their jobs. Employees across job functions now require analytical aptitude. The addition of a Data Science degree program to NVU will provide students a foundational understanding of what data science and analytics is all about. This exposure serves students by transforming their understanding of data as a resource to improve their decision-making and a compliment to any area of study.

A Vibrant, Thriving Campus

Providing NVU students the opportunity to gain exposure and experience in the data sciences will ultimately increase their job prospects upon graduation, an excellent talking point in admissions and marketing materials aimed at student recruitment. It will also contribute to increased retention, an issue that persists in the VSC's 4-year institutions.

Ultimately, the addition of a Data Science program will help NVU achieve its mission by producing graduates who are ready to succeed in a global economy, who have a broad background from disparate disciplines, and who are prepared to use technology to solve today's complex problems.

The perceived interest in a Data Science program has been gauged through extensive market research from an independent third party and input from a boots-on the ground data analytics advisory team consisting of faculty, administrators, students, and Vermont employers. The high-demand for data science skills by Vermont employers coupled with higher than average starting salary level, and a high career growth trajectory will serve a lure function in driving both traditional undergrads and adult learners to the NVU program.

2. Specific student, educational and/ or employment need(s) to be addressed, including in-person, hybrid, low-residency, or distance mode(s) of program delivery, and whether these needs are local, state, regional, national or global (attach documentation of need in the form of supporting data from external or internal sources such as professional organizations, feedback from corporate partners, or market research):

The proposed Data Science baccalaureate program will be offered to residential students on both campuses. Courses will be taught in face-to-face, hybrid, and online delivery modes. We are also exploring offering this degree program through NVU Online to reach a more regional and non-traditional student population.

The Data Science Baccalaureate degree program tackles existing and forecasted needs in the workforce and higher education. Data scientist is among today's fastest-growing and highest-paid professions as organizations increasingly rely on data to drive strategic business and operational decisions. As demand for data science workers grows, this growth puts pressure on the supply of data science talent to grow in turn. However, there is growing concern that the supply of data science workers is lagging dangerously behind demand at the global, national, regional and state level.

Already the demand for data science skills far outpaces the supply:

- According to the U.S. Bureau of Labor Statistics, demand for mathematicians and statisticians tops the list at 33% growth through 2026. The need for operations research analysts is projected at 27%, and market research analyst growth is projected to see 23% growth.
- Growth predictions are routinely underestimate in this emerging field. Consulting firm McKinsey predicted that by 2018 there would be 2.8 million workers with either deep analytical talent or data-savvy skill sets on the national level. By 2015, however, there were already over 2,350,000 job listings for core Data Science and Analytics (DSA) jobs in the United States, and by 2020 the number of DSA job listings is projected to grow by nearly 364,000 listings, to about 2,720,000 openings.
- According to the 2017 joint study QUANT CRUNCH: HOW THE DEMAND FOR DATA SCIENCE SKILLS IS DISRUPTING THE JOB MARKET by Higher Education-Business Forum, IBM, and Burning Glass Research, 2480 data analytic job postings remained unfilled in the state of Vermont.
- Hiring difficulties are widespread for analytics roles, and many DSA jobs are among the hardest to fill in the entire market. On average, DSA jobs remain open for 45 days—five days longer than the market average.
- THE FEDERAL BIG DATA RESEARCH AND DEVELOPMENT STRATEGIC PLAN released in 2016 by the Subcommittee on Networking and Information Technology Research and Development, indicates that a key national strategic priority is to improve the national landscape for Big Data education and training to fulfill increasing demand for both deep analytical talent and analytical capacity for the broader workforce.

  > *"More university courses on foundational topics...are necessary to help transform the broader workforce into data-enabled citizens."*

Compounding this employer skill demand is that employees across multiple job functions in multiple industries now require analytical aptitude.

Data science is considered "disruptive" which influences three specific labor market characteristics: 1. High cost to hire 2. Strong need for new training programs and 3. High risk to future productivity. This translates directly into a parallel demand for additional data science education at the state college level to keep pace. For a state of fewer than one million, Vermont leans surprisingly heavily in the data science demand through its high tech industry. Currently technology accounts for 8-10% of overall employment in the private sector and a 2015 report on Vermont's Tech Employment projected that tech jobs would grow at a 7.5% annual rate from 2014 to 2022 (https://www.mastersindatascience.org/schools/vermont/)

There is a clear need and strong support from Vermont stakeholders for the proposed program to meet the growing skills demand. An advisory board including representatives from industries that would benefit from data science applications (Insurance, Healthcare, Finance, Manufacturing, Education, Government, and Retail) was formed in April 2019 to validate the need for a Data Science program and help inform the key skills to be included in a post-secondary curriculum. The Advisory Board members are:

1. Mat Barewicz - Economic & Labor Market Information Chief, Vermont Department of Labor
2. Jen Botzojourns - Superintendent, Kingdom East Supervisory Union
3. Heather Bouchey- Deputy Secretary, Vermont Agency of Education
4. Drew Bush- Postdoctoral Researcher, Department of Geography and School of Environment, McGill University
5. Jon Falabella - Business Value Director, Americas, Splunk Inc
6. Jim Kisch- CEO - Passumpsic Saving Bank
7. Mark McDonnell- COO, Vermont Mutual
8. Shawn Tester- CEO, NVRH

NVU as a regional post-secondary institution proposes to respond to both the higher education and workforce development needs. Based on the clear demand presented by the data and feedback from key Vermont employers, the NVU Data Science baccalaureate program will provide a meaningful education pathway for undergraduate students and working adults to acquire general analytical competencies in database architecture, data analysis, and data visualization, providing a strategy to prepare them for new and emerging job opportunities. We predict a cumulative enrollment in the new program of five new students per year.

Below is a list of research reports that highlight the demand for Data Science. The Quant Crunch report by Burning Glass accompanies this proposal as an illustrative example of the type of research that exists on data science demand. The other reports can be made available to the interested reader.

Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, on the Internet, at https://www.bls.gov/ooh/math/mathematicians-and-statisticians.htm , https://www.bls.gov/ooh/math/operations-research-analysts.htm and https://www.bls.gov/ooh/business-and-financial/market-research-analysts.htm (viewed online June 13, 2019). Cited projections may not reflect local and/or short-term economic or job conditions and do not guarantee actual job growth.

The Federal Big Data Research and Development Strategic Plan, Subcommittee on Networking and Information Technology Research and Development, Networking and Information Technology Research and Development (NITRD). The report is published by the Executive Office of the President, National Science and Technology Council, May 2016.

THE QUANT CRUNCH: HOW THE DEMAND FOR DATA SCIENCE SKILLS IS DISRUPTING THE JOB MARKET, Burning Glass Technologies 2017

Eduventure proprietary Emsi Data Cut for New England region using the keyword “Data Analytics.”

3. How the program will strengthen the System. If the program approximates existing programs within the System, describe why the development of an additional program will serve particular need(s). If it is a distinct program that expands System offerings, please describe what value it offers, any intended collaboration with other VSC colleges or organizations in planning or delivering this program, and, if appropriate, indicate specific benefits to the State of Vermont):

The inclusion of a dedicated Data Science field of study would be unique to the Vermont State College system, therefore expanding the system offerings.

The curriculum and delivery model for the Data Science program is in alignment with other programs in the VSCS to maximize enrollment and transfer opportunities for all types of students, including under-represented and under-served students and working adults.

The launch of Do North Coworking at NVU-Lyndon through the Center for Professional Studies in November 2018 has quickly given the university a reputation for digital smarts with multiple data savvy start-ups like WhiteOut Solutions and Northview Weather in residence. The coworking space already serves as a conduit to NVU for adults looking for continuing education. It also offers the potential for NVU students to work with these organizations as well as develop career prospects abound.

In this nascent stage of Data Science education at NVU through the certificate and undergraduate programs, we are mindful that maintaining agility and flexibility is necessary to ensure that cutting-edge concepts and modern techniques are being incorporated.

Along those lines, we are cognizant that it is essential that the pedagogy encourages the participation of women, underrepresented minorities, and persons with disabilities as the data-science programs grow at NVU. These populations are significantly underrepresented in computer science; therefore, NVU Data Science education should proactively develop and evolve to ensure broad participation. Research indicates that curricula that emphasize the role of Big Data for “social good” in both formal and informal education settings have demonstrated success at engaging greater proportions of women and underrepresented minorities (Prewitt, Kenneth; Mackie, Christopher D.; Habermann, Hermann, Civic Engagement and Social Cohesion: Measuring Dimensions of Social Capital to Inform Policy. National Academies Press, 2014.)

The hybrid nature of many data science jobs indicates that a Data Science program is particularly well suited to NVU which combines liberal arts and professional studies. The unique selling advantage of having a grounding in liberal arts and professional studies will also position NVU for success in the highly competitive post-secondary macro environment as few institutions have this combination of fields of study. The scope of institutional investment risk associated with launching and sustaining the new Data Science program is low for NVU. It makes use of existing resources and requires only four new courses to be developed. The proposed program can be offered with existing full-time faculty and a small complement of part-time faculty.

Part III: Program Description

1. Specific program objectives, including career and learning outcomes for students:
   - Students will be proficient consumers, creators and communicators of data, including the ability to summarize and visualize data for both technical and general audiences.
   - Students will be proficient in a computer programming language with extensibility.
   - Students will be able to apply foundational mathematics and computer science knowledge to problems in data science.
   - Students will be able to acquire, store and manage data in a variety of formats, and scale.

2. How the program will integrate professional, liberal and career study:

   This program is well-positioned to integrate professional, liberal, and career study through leveraging the consolidation of Lyndon and Johnson State Colleges into Northern Vermont University. Johnson has a strong liberal arts background focusing on a broad spectrum of skills supporting the development of life-long learners. Lyndon has a strong technical focus, oriented toward a narrower focus on developing the expertise required for a discipline.

   This degree plan is built through the lens of maintaining the focus of both campuses.

3. What peer programs or model curricula served as a basis for the proposal:

   University of Vermont
   St. Michael's College
   University of New England

4. How the program will assess its effectiveness in achieving student learning outcomes:

   Student Assessment Plan:

   A core assessment examination similar to what is currently used in the Mathematics Department will be administered near the end of the 2nd year to assess that students are developing the skills described in the Learning Objectives.

   A capstone project-based course will be completed at the end of the 3rd or at any time in the 4th year to assess that students are proficient or advanced at the skills described in the Learning Objectives.

   Program Evaluation Plan:

   We rely on Levin-Rozalis' (2003) explication of program evaluation as "intended to amass knowledge and understanding of a concrete activity… and investigate the mutual influences between a maximum number of variables at a given time and place." This requires a circular approach, "a cycle that begins and ends with the project" (p. 6).

As such, the program evaluation model can be considered primarily formative in nature, as it will provide ongoing feedback about activities and outcomes that program and other university staff can use to make improvements. A secondary summative evaluation, conducted at the completion of the program by its first graduates, will focus on overall program outcomes (e.g., graduates' proficiencies and competencies according to the desired student learning outcomes specified above in Part III. 1.) and sustainability (e.g., required human and other resources).

In general, an inductive approach will be used to assess inputs, activities, outputs, and outcomes (Funnell & Rogers, 2011) specified by a logic model designed by program stakeholders (e.g., e.g., university faculty and leadership; Frechtling, 2007). This model will be used to frame evaluation and address driving questions, such as "What is the value of the degree program to students, faculty, and the university?" An evaluation rubric will be designed by stakeholders to determine the evidence required to determine different levels of program quality (Davidson, 2005).

A mixed-method approach is planned. Data sources will include (a) surveys and/or focus groups with students, graduates, faculty, and university leadership, in order to afford the perspectives of all stakeholders; in addition to (b) institutional data (e.g., major counts and GPAs, time to degree completion). The project team will continue to administer (c) alumni surveys annually in order to track outcomes (e.g., employment) and improve the program.

Descriptive and analytic statistics will be used to assess quantitative data. Open-ended responses to survey and focus group questions will be analyzed thematically (Strauss & Corbin, 1990). Communication of evaluation findings will be structured to maximize their use by stakeholders. Data will be analyzed on a semesterly basis, with the program team meeting to review findings and discuss necessary improvements.

Davidson, E. J. (2005). Evaluation methodology basics: The nuts and bolts of sound evaluation. Thousand Oaks, CA: Sage.

Frechtling, J. A. (2007). Logic modeling methods in program evaluation. San Francisco: Jossey-Bass.

Funnell, S. C., & Rogers, P. J. (2011). Purposeful program theory: Effective use of theories of change and logic models. San Francisco: Jossey-Bass.

Levin-Rozalis, M. (2003). Evaluation and research: Differences and similarities. The Canadian Journal of Program Evaluation, 18 (2), 1-31.

Strauss, A., & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Thousand Oaks, CA: Sage.

5. How the program incorporates current standards and/or emerging directions in the field, and what the program will require to maintain licensure, certification, or accreditation standards with external entities, if any.

The program follows a standard approach being used by many data science baccalaureate programs in the United States today by combining mathematical, statistical, and computational coursework to create a foundation for a data scientific career in industry. To this end, the program adheres to current standards. There are no known licensure, certification or accreditation standards with external entities.

6. Program outline; include brief descriptions of all new courses:

Course Name & Number	**Credits**	**New or Existing?**
MAT-1531 Calculus I	4	Existing
†MAT-2021 Statistics	3	Existing
MAT-3210 Linear Algebra	3	Existing
BUS-1210 Business Software and Spreadsheets	3	Existing
†CIS-2271 Java Programming	3	Existing
CIS-3025 Advanced Object-Oriented Programming	3	Existing
CIS-3050 Data Structures and Algorithms	3	Existing
CIS-2330 Database Systems	3	Existing
The Visual Display of Quantitative Information	3	New
Statistical Computing in R	3	New
Data Science I	4	New
Data Science II	4	New
Data Science Elective 1	3-4	Existing
Data Science Elective 2	3-4	Existing

MAT-4930 Senior Project in Mathematics and Computer Science	3	Existing

†Counts for GEC *Mathematics and Computing in the World*

Brief Descriptions of new courses:

The Visual Display of Quantitative Information: A contemporary review of the classical work of the same name by Edward Tufte. Students will review classical visual displays of quantitative information, and acquire and use foundational skills to create their own. The course has no prerequisite. This course is open to students in all majors.

Statistical Computing in R: This course is a continuation of Statistics MAT-2021, and covers implementation of both elementary and advanced statistical methods in the R statistical computing program. Topics include data import, tidying, the transform/visualise/model loop, and best practices for communicating data. MAT-2021 is a prerequisite. This course is open to students in all majors.

Data Science I: This course is designed to introduce the core concepts of data science to students. Content is focused at a high level, with an emphasis on outcomes of the application of data science to broad problems. This course highlights (1) exploratory analysis as an approach to defining problems and goals, (2) the application of statistic to knowledge discovery using general techniques in data science, such as classification, clustering, regression analysis, and association rule mining, and (3) the usage of these techniques to generate contextualized models in a variety of domains. Students will use the statistical programming language R for analyses.

Data Science II: This course is designed to integrate the requisite mathematical and computational knowledge with skills in data science to model and solve well-specified problems. Students will apply data science techniques to generate inferences from data in a variety of formats from noisy, complex data sets. Inferences will be summarized and communicated to an audience using narrative and visualizations. This course will include a strong quantitative reasoning, statistics, and computer programming components using the statistical programming language R.

Topical Seminar in Data Science: This course explores new topics and current developments in the discipline. The seminar emphasizes student research, presentation and discussion. To be offered as needed.

Data Science Electives -- Choose 2 with the guidance of your advisor:

BUS-2010 Project Management (3cr)
ACC-2121 Financial Accounting (4cr)
BUS-2230 Principles of Marketing (3cr)
BUS-4030 Market Research (3cr)

CRJ-3085 Research Design and Analysis (3cr)
ANT-3120 Science, Research Methods & Ethics (3cr)
POS-3025 Research Design & Analysis (3cr)
MAT-2532 Calculus 2 (4cr) or MAT-2533 Calculus 3 (4cr) but not both
MAT-3240 Probability Theory with Statistics (3cr)
Topical Seminar in Data Science (1-3cr) (new)

The proposed program leverages the expertise and previous work of two NVU faculty.

- Dr. Gregory Petrics is an Associate Professor of Mathematics at Northern Vermont University (NVU), and has been a member of the faculty since 2011. Prior to joining the faculty at NVU, Dr. Petrics completed a Ph.D. in Mathematics at Dartmouth College on applications of sub-Riemannian geometry to neuroscience. Dr. Petrics has over a decade of experience teaching courses on mathematics, statistics and technical computing to students from all disciplines.

  In addition to his work on the faculty at NVU, Dr. Petrics has been a consultant and instructor at the Vermont Mathematics Initiative for 4 years, a Masters program supporting highly effective mathematics instruction. Dr. Petrics also has experience doing institutional research and data analytics in higher education, and is the author of several white papers. Dr. Petrics is an advocate of open-source academic materials, and recently authored an open-source book on calculus which embeds dynamic interactive applets into the content.

- Prior to starting his position at NVU, Professor Bradley Beth was Data Analytics Developer for EDUCAUSE, a nonprofit association and community of technology, academic, industry, and campus leaders advancing higher education through the use of IT. Professor Beth and his team collected, analyzed, and reported institutional, faculty, and student usage data from thousands of academic institutions worldwide.

  Professor Beth has 19 years of experience in the field of computer science education. His research interests include Natural Language Processing—applying data science and machine learning techniques to textual analysis—and best practices in teaching computer science.

7. TOTAL CREDITS in proposed program: ___48–50___

8. TOTAL GENERAL EDUCATION CREDITS beyond those in the program: ___40–42___

9. TOTAL CREDITS for the degree: ___120___

10. For associate and baccalaureate degree programs, provide a 2- or 4-year degree map showing intended semester-by-semester sequence of courses including program courses, general education

requirements, and electives. For graduate degree programs, describe the intended timeframe and sequence for completion of the degree.

	Fall	Spring
Year 1	†MAT-2021 Statistics (3) GEC *First-Year Seminar* (3) GEC *Being in the World* I (3) GEC *Communicating in the World* I (3) Elective (3) _____ 15 credits	Statistical Computing in R (3) †CIS-2271 Java Programming (3) GEC *Communicating in the World* II (3) GEC *Creativity in the World* I (3) The Visual Display of Quantitative Information (3) _____ 15 credits
Year 2	CIS-3025 Adv Object-Oriented Prog. (3) GEC *Diversity in the World* I (3) Data Science I (4) GEC *Being in the World* II (3) Elective (3) _____ 16 credits	BUS-1210 Bus. Software & Spreadsheets (3) GEC *Creativity in the World* II (3) MAT-1531 Calculus I (4) Elective (3) Elective (3) _____ 16 credits
Year 3	MAT-3210 Linear Algebra (3) CIS-2330 Database Systems (3) GEC *Natural and Physical World* (4) Elective (3) Elective (3) _____ 16 credits	CIS-3050 Data Structures & Algorithms (3) GEC *Diversity in the World* II (3) Data Science Elective (3) Elective (3) Elective (3) _____ 15 credits

Year 4	Data Science II (4) GEC *Enriched Course* [NCCSE] (3) Data Science Elective (3) Elective (3) Elective (3) _____ 16 credits	Data Science Capstone (3) Elective (3) Elective (3) Elective (3) _____ 12 credits

†Counts for GEC *Mathematics and Computing in the World*

Part IV: Budget Considerations

1. Expenditures for the proposed program:

	Year One (F20–S21)	**Year Two**
Faculty	**$20,056 (four sections taught as overload or by part-time faculty)**	**$41,472 (eight new sections taught as overload or by part-time faculty)**
Admin/Other Staff	**$0**	**$0**
Facilities/Equipment	**$0**	**$0**
Library/Other Materials	**$0**	**$0**
Other Costs (e.g. accreditation/licensure expenses)	**$0**	**$0**

TOTAL COSTS:	$20,056	$41,472

2. Revenue/sources to meet new expenditures

	Year One	Year Two
Tuition (includes tuition and fees less institutional aid)	**$54,075**	**$111,395**
Reallocation	**$0**	**$0**
Other Sources (course fees)	**$250**	**$1000**
TOTAL REVENUES:	$54,325	$112,395

Part V: Enrollment, Marketing and Public Relations Considerations

1. Projected enrollment for new program:

	Year One	Three Years Out
Full-Time	**5**	**15**
Part-Time	**0**	**0**
In-State	**4**	**12**

Out-of-State	**1**	**3**

2. Describe how you arrived at these projections:

Expense:
Faculty expense is based on the number of new sections we need to offer per year at part-time pay grade 3.

Revenue:
As we will begin offering this program F20, we anticipate modest enrollment of five full-time students in year one, growing by five students each year in years two and three. Tuition revenue includes fees, less institutional aid. There will also be modest course fee revenue ($25 per course per student) to offset ongoing technical expenses.

3. Describe the marketing strategies for the new program.

External branding firm Vision Point undertook a marketing analysis for the Data Science certificate program in Spring 2019 for Center for Professional Studies. They identified two favorable adult market segments :

Educator to Consumer (E2C) market
Educator to Business (E2B) market

For the sake of cost effectiveness and to maximize the return on investment (ROI), the assets generated for the certificate program will be repurposed for the degree program in order to reach the adults and business markets.

To attract the traditional undergraduate market, the new degree program will be announced on the NVU website, incorporated into the NVU marketing materials, and included in templated NVU marketing materials.

4. Competition:

a) In state and region:

- University of Vermont: Data Science (B.S.)

Note- While UVM has a dedicated Complex Systems Center and offer undergraduate and graduate curriculums, many of the skills that are essential for working with Big Data include basic competency in data preparation, simple data visualization, basic descriptive statistics, and data characterization. According to the Federal Big Data Study, such essential skills, which sometimes occupy 70–80% of the time involved in analyzing Big

Data, are often overlooked in data analysis programs. There is a specific demand for workforce trained to collect, record, extract, clean, and annotate data. These neglected skill sets will be incorporated into the curriculum of the proposed NVU program and provide the program a distinct and unique comparative advantage.

- St. Michael's College: Data Science (B.S.)
  Average Net Price: $57,560/year

  The St. Michael's College Data Science major is composed of courses from the Mathematics, Computer Science, and Statistics departments with two specialized courses in Data Science. The program culminates in a Data Science Capstone course. Much like UVM, the program is heavily focused on technical aspects of data science without explicit coursework in communicating inferences generated through data analysis. By contrast, the proposed NVU major utilizes existing courses and four new data science courses to construct a degree program that focuses on integrating data analysis techniques and theory with communication skills through narrative and visualization.

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b) Online:

Enrollment trends indicate that online learning is in demand. There are many online certificates, executives, undergraduate and graduate level programs in the field of Data Science. The list below provides a set of strong comparables:

Bay Path University – Longmeadow, Massachusetts
Business Analytics Online
Average Net Price: $18,257/year
Focus: business foundation along with the skillset to mine data, analyze data, use data to make effective business decisions

Rasmussen College – Rockford, Illinois
Data Analytics Bachelor's Degree Online
Average Net Price: $17,861/year
Focus: Students learn valuable skills like data extraction, data manipulation, data analysis, and data visualization. The curriculum allows students to work toward industry certifications in areas like SAS and Tableau.

SNHU: Bachelor of Science in Data Analytics; Total credits: 120; Modality: 100% Online; Focus: combines facets of business, information technology and mathematics using data mining, simulation and optimization

5. How the program will impact enrollments in existing programs at the College:

Data Analytics is a complement to ALL existing degree programs at NVU and provides opportunity for students to double major or add a certificate as they become available. This is inline with the labor market demands where employers are increasingly requiring workers across job functions to demonstrate analytical aptitude and fluency in data manipulation. Data Science majors will help to fill sections of advanced math classes such as Calc I and Linear Algebra that are typically taken by Math or Atmospheric Science students.

6. How the program will impact enrollments in existing programs at other VSC colleges:

The closest credential in the System is the Business Analytics Certificate at Castleton University (CU). It is not expected that the proposed program would impact enrollment in the CU certificate, or vice versa.

First, the certificate at CU is not a stand-alone degree program. Instead it is designed to complement another CU undergraduate degree, or as personal/professional enrichment. By contrast, the proposed program is a complete baccalaureate degree program.

Furthermore, the certificate at CU is a business-focused course sequence heavily focused on decision making in the business setting. By contrast, the proposed program is broader in scope, focusing on not only business decision making, but also communication skills, technical proficiency, and foundational content knowledge.

7. How the program will impact existing and/ or future external relations:

We foresee many corollary benefits to the institution and VSC system by offering the Data Science degree program. UVM best illustrates recognized opportunity as they have seen increased investment in the university specific to data sciences. For example, Mass Mutual gifted $5m to UVM for the development of the Vermont Complex Systems Center.

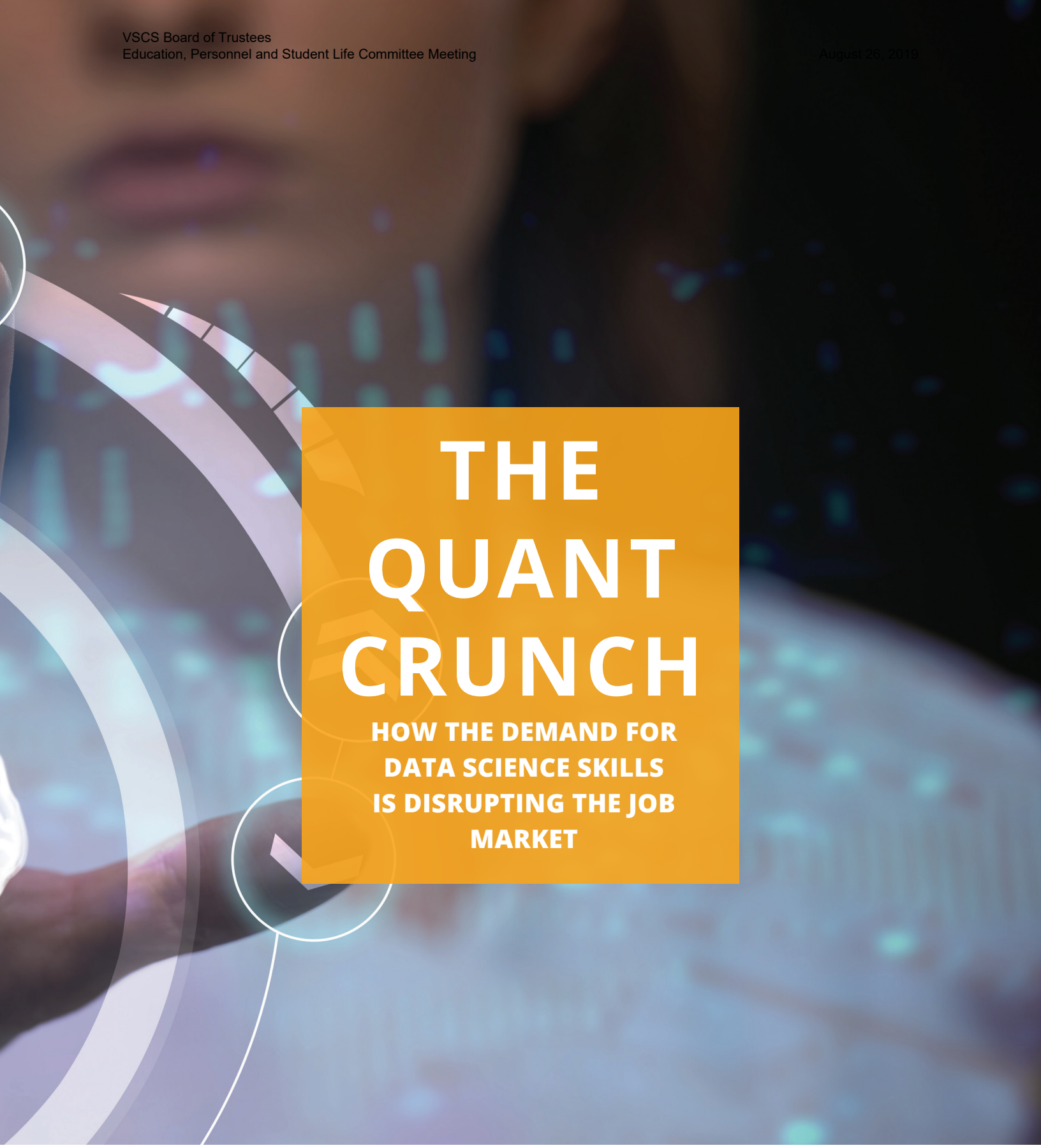
We are currently exploring opportunities to work with leading Vermont businesses who will benefit from the cultivation of data analytic skills for the Vermont workforce as well as research and innovation organizations specializing in data science whose core mission is to generate significant economic, social, and scientific value from data.

We are optimistic that new sources of external funding and enhanced external relations will result from the addition of Data Science at NVU as the benefits to firms that embrace analytics are well documented. Research by Andrew McAfee and Erik Brynjolfsson from MIT states, “companies in the top third of their industry in the use of data-driven decision making were, on average, 5% more productive and 6% more profitable than their competitors.” Given this direct correlation, we anticipate a positive response by donors, sponsors, and grantors in support of the new NVU program.

POLICY 102
RUBRIC FOR STEP 1 PRELIMINARY REVIEW OF NEW PROGRAM PROPOSALS

	CONTRA-INDICATION	CONCERN / FOR FURTHER DEVELOPMENT	STRENGTH
1. What are the regional market needs and initial enrollment projections for the program?	Unclear, unsubstantiated, or anecdotal.	Information doesn't exist to support robust projection.	Identified regional market partners with concrete, grounded projections.
2. How likely is the program to achieve enrollment of 25+ students within five years?	Not likely based on enrollments in comparable programs.	Enrollment yield dependent on multiple, uncontrollable, or unknown factors.	Clear demand from early analyses or experience in comparable programs.
3. Does the enrollment projection include any anticipated internal enrollment shifts and academic program restructuring at the institution?	Program's impact on other programs within the institution likely and/or not evaluated.	Potential for impact recognized but not discussed.	No evidence of potential impact, or any potential impacts are recognized and program implementation planning addresses them.
4. Is the program serving any unmet state or regional needs?	No, and the program would not be recognized as adding any other value/benefit for Vermont or the region.	The program defines a potential need that is not yet, or not widely recognized.	Yes, there is a clear need and strong support from stakeholders for the proposed program to meet the need.
5. Is the curriculum and delivery model in alignment with other programs in the VSCS to maximize enrollment and transfer opportunities for all types of students, including low-income dual enrollment/early college students and working adults?	No, the curriculum design or other factors would preclude transfer opportunities within the system.	The program anticipates transfer pathways, but these do not maximize access for a diverse population of potential students.	The program anticipates transfer pathways and delivery modalities that maximize access for all students, including low-income students and working adults.
6. What are the likely enrollment competition risks within the system?	There is a similar program in the system serving a similar population of students currently at risk of not sustaining minimum size.	The program is likely to result in some competition, with students able to exercise choice (i.e. based on location, cost, delivery modality, campus culture), but overall enrollments likely to be sustained above	No competition risk or risk not significant enough to threaten other programs sustaining a minimum size.

		minimum size for both programs.	
7. Is the program the best fit (mission, scope, capacity to deliver) within the system for the institution that is proposing it?	The program appears to have potential stronger fit with a different VSC institution, or a similar program already exists where there is a clear best fit.	Best fit is unclear, or there are multiple institutions within the system with potential fit.	The institution proposing the program is the clear best fit.
8. What are the likely corollary benefits to the institution and system (e.g., new sources of external funding, enhanced external relations) of adopting the program?	There are no clear benefits, as the program raises external relations concerns or is not projected to generate net new enrollments at the system level.	Benefits to the system are unclear and may be offset by other risks.	The program is likely to elevate the profile of the system as a whole, attract new funding, and/or generate net new enrollments at the system level.
9. What is the scope of institutional investment risk associated with launching the program?	The program requires immediate institutional investment, regardless of initial revenue projections, that is substantial (total cost, multi-year commitment needed, etc.)	The program requires moderate or substantial investment but is supported by conservative revenue projections.	The program requires minimal or discretionary investment.
10. What is the scope of institutional commitment necessary to sustain the program?	The program will require a high level of ongoing resource commitment that cannot be sustained based on conservative case revenue projections.	The level of ongoing resource commitment needed is sustainable with conservative revenue projections.	Conservatively projected revenues will be sufficient to generate a net contribution margin for the institution, inclusive of direct and indirect expenses.



THE QUANT CRUNCH

HOW THE DEMAND FOR DATA SCIENCE SKILLS IS DISRUPTING THE JOB MARKET

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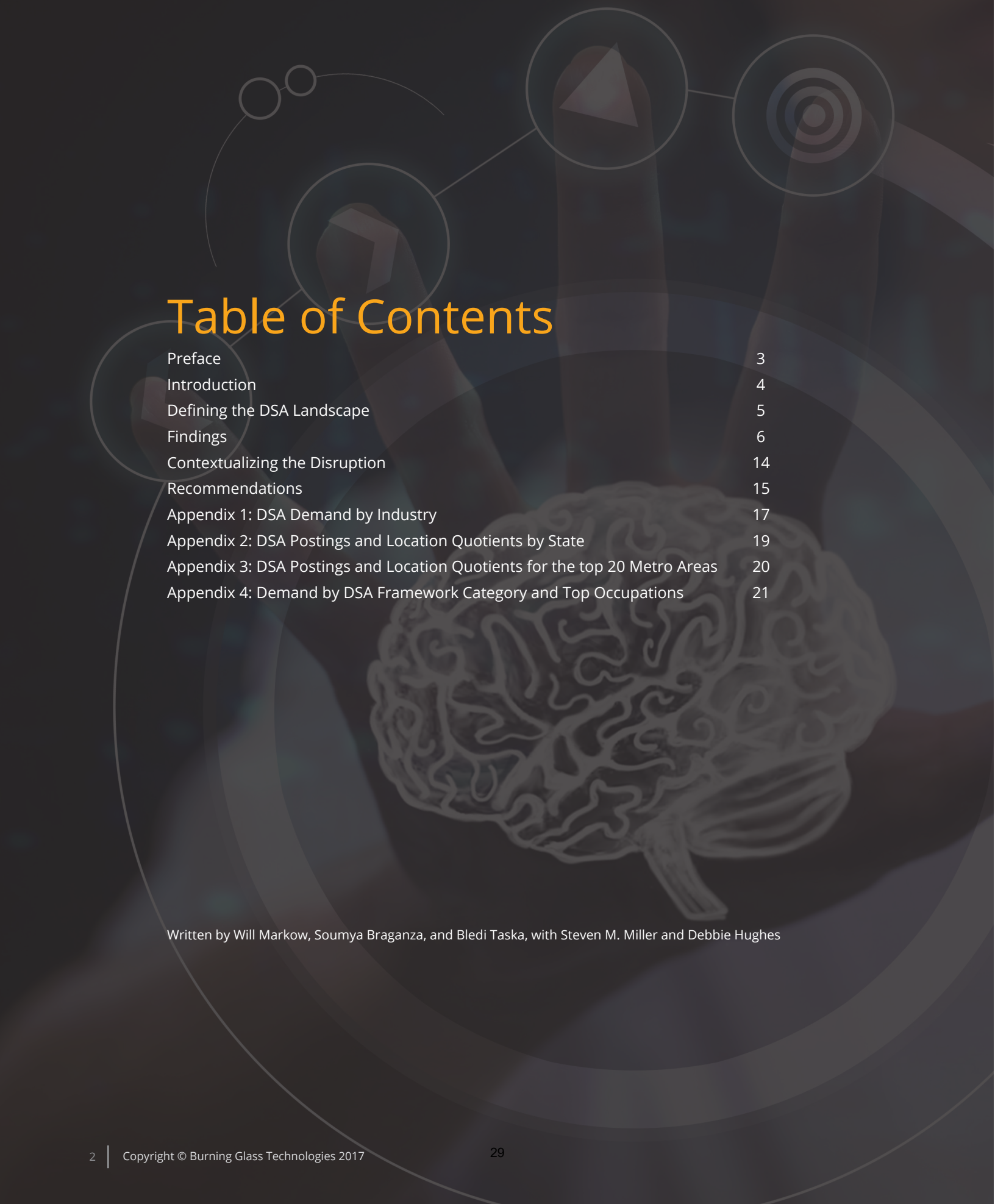

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Written by Will Markow, Soumya Braganza, and Bledi Taska, with Steven M. Miller and Debbie Hughes

PREFACE

In 2016 the number of job postings specifically for a data scientist (+5%) or data engineer (-2%) shifted slightly. The bigger finding is that certain skills transcend the position. These data-centered skills saw significant growth in 2016:

Clinical Data Analysis:	**+54%**
Data Science:	**+40%**
Quantitative Data Analysis:	**+38%**
Data Visualization:	**+31%**
Data Engineering:	**+28%**
A/B Testing:	**+22%**
Machine Learning:	**+17%**

Jobs specifying machine learning skills pay an average of $114,000. Advertised data scientist jobs pay an average of $105,000 and advertised data engineering jobs pay an average of $117,000

STEVEN MILLER
Global Leader, Academic Programs and Outreach
IBM Analytics

DEBBIE HUGHES
Vice President, Higher Education and Workforce
Business-Higher Education Forum

The democratization of data is transforming our world. Sensors are everywhere. Cities are measuring and acting upon a wide variety of data sources. Governments at all levels are opening their data to their citizens. Old businesses are being transformed by data. Dynamic new businesses are powered by data. Anyone with a smart phone now carries with them a sensor platform generating data.

In response, workforce needs have shifted rapidly. Demand for a new breed of professionals skilled in data, analytics, machine learning, and artificial intelligence requires a requisite response from both higher education and workforce development. To help guide workforce development programs, IBM and Business-Higher Education Forum partnered with Burning Glass to develop a deep understanding of current job market demand shifts.

We project that by 2020 the number of positions for data and analytics talent in the United States will increase by 364,000 openings, to 2,720,000. In 2020, job openings for data scientists and similar advanced analytical roles will reach 61,799. This is a significant number, but it represents just 2% of the projected demand across all job roles requiring data and analytics skill.

To close the gap, workforce development and higher education must look beyond the data scientist to develop talent for a variety of roles, such as data engineer, data governance and lifecycle and data privacy and security specialist, and data product developer. Data democratization impacts every career path, so academia must strive to make data literacy an option, if not a requirement, for every student in any field of study.

Demand for data-driven decision makers, such as data-enabled marketing managers, will comprise one-third of the data savvy professional job market, with a projected increase of 110,000 positions by 2020. To lead analytics teams or craft a company's digital strategy, executives will need a foundational understanding of data and analytics.

To meet this explosive demand, businesses need to rethink hiring, training, and partnerships. Higher education needs to be nimble and responsive, and its bachelor's, graduate, certificate, and executive-level programs have to be responsive to workforce needs.

INTRODUCTION

Data Science and Analytics are no longer just buzzwords- they are essential business tools. Every day, 2.5 quintillion bytes of data are created,[1] and IDC estimates that by 2019 the Big Data Analytics market—just one slice of the larger Data Science and Analytics (DSA) market—will grow to over $187 billion.[2] The benefits to firms that embrace analytics are well documented. Research by Andrew McAfee and Erik Brynjolfsson from MIT states, "companies in the top third of their industry in the use of data-driven decision making were, on average, 5% more productive and 6% more profitable than their competitors."[3]

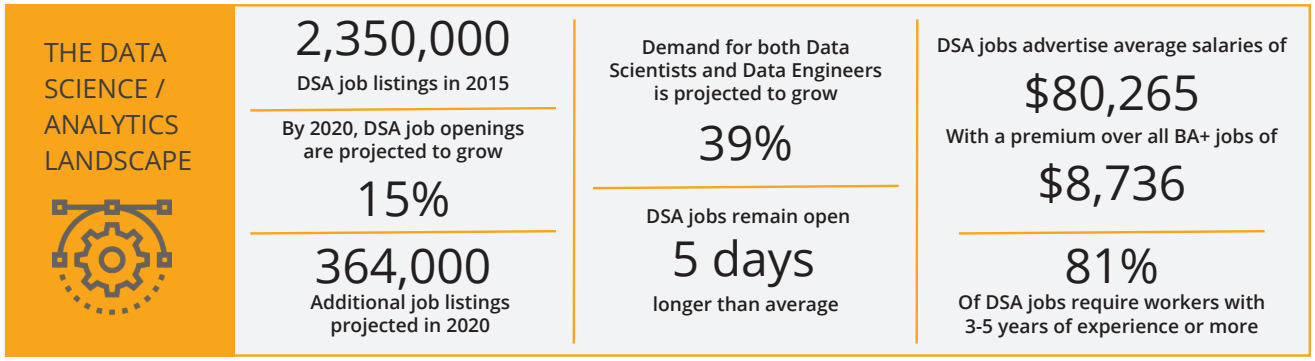
As DSA technologies and methods make a dent in the economy, so too are they making a dent in the job market. The Age of Big Data has transformed the tools and skills employees utilize, and workers across job functions now require analytical aptitude. In 2011, McKinsey predicted that by 2018 there would be 2.8 million workers with either deep analytical talent or data-savvy skillsets.[4] By 2015, however, there were already over 2,350,000 job listings for core Data Science and Analytics (DSA) jobs in the United States, and by 2020 the number of DSA job listings is projected to grow by nearly 364,000 listings, to about 2,720,000 openings. If McKinsey's predicted supply of 2.8 million analytically savvy workers is accurate, then nearly every one of these workers must change jobs annually to fill open DSA positions.

As demand for DSA workers grows, this growth puts pressure on the supply of DSA talent to grow in turn. However, there is growing concern that the supply of DSA workers is lagging dangerously behind demand. The Networking and Information Technology Research and Development program (NITRD), for example, argues that we must "improve the national landscape for Big Data education and training to fulfill increasing demand for both deep analytical talent and analytical capacity for the broader workforce." If stakeholders do not act, the supply of DSA talent is in danger of lagging behind growth in demand for DSA workers.

This could bring the productivity gains from Big Data to a grinding halt. Employers are already struggling to fill DSA jobs, as evidenced by the length of time unfilled roles remain open. On average, DSA jobs remain open for 45 days—five days longer than the market average. Some more senior or sophisticated roles, such as Directors of Analytics and Data Scientists, take far longer to fill. Compounding the skill shortage is the hybrid nature of many DSA jobs, which require a mix of disparate analytical skills and domain-specific expertise that may be difficult to develop in traditional training programs. Marketing Analytics Managers, for example, must combine advanced analytical techniques with deep marketing knowledge, but both skillsets may take years to develop.

To mitigate this talent shortage, organizations across the analytics ecosystem must build a detailed understanding of their talent needs. This will enable them to invest strategically in DSA talent pipeline development.

Similarly, educators and training providers must proactively respond to the rising demand for analytics skills with programs that prepare students for the analytics-related roles of today and tomorrow, while existing workers must continuously monitor in-demand analytics technologies and update their skillsets accordingly. If these actions are not taken, the DSA skills gap is in danger of widening, which would continue to undercut the promise of Big Data.



1 Zikopoulos, Paul, et al. "Harness the Power of Big Data: The IBM Big Data Platform" (New York: McGraw-Hill Professional, 2012).
2 International Data Corporation, Worldwide Semiannual Big Data and Analytics Spending Guide (Framingham, MA: IDC, 2016).
3 McAfee, Andrew, et al. Big data: The management revolution. Harvard Bus Rev 90.10 (2012): 61-67.
4 Manyika, James, et al. Big Data: The Next Frontier for Innovation, Competition, and Productivity (New York: McKinsey & Co., 2011).
5 NITRD, NCO. The Federal Big Data Research and Development Strategic Plan (2016).

DEFINING THE DSA LANDSCAPE

The mismatch between supply and demand in the DSA job market is compounded by a lack of a common framework and vernacular for DSA jobs and skills. The Bureau of Labor Statistics—the federal agency tasked with tracking the labor market's key metrics—does not have a clear definition of DSA jobs, and many new and emerging DSA jobs, such as Data Scientists and Data Engineers, are not currently tracked at all. Moreover, job titles are not consistent across many of these positions; an employee called a "Data Scientist" at one company may have a distinctly different skill profile than a "Data Scientist" at another firm, making it difficult to analyze broadly the Data Scientist profile. The lack of traditional labor market data for DSA roles creates an information gap that undercuts educators, employers, and policymakers as they attempt to build a workforce with the skills needed across the DSA landscape.

To overcome this lack of traditional labor market data, Burning Glass mined its database of over 130 million unique current and historical job listings and worked with IBM and Business-Higher Education Forum (BHEF) to identify the key roles and skills that make up the DSA jobs ecosystem. First, Burning Glass identified a set of over 300 analytical skills that represent the key DSA-related tools and competencies requested in the labor market. These skills range from such general analytical competencies as database architecture, data analysis, and data visualization to specific technologies used to perform DSA-related tasks, such as R, Hadoop, and Tableau.

Next, Burning Glass identified occupations that commonly require some mix of these analytical skills, and grouped them in six job categories based upon similarities in skillsets and functional roles within the broader DSA landscape. These categories include Data Scientists and Advanced Analysts, Data Analysts, Data Systems Developers, Analytics Managers, Functional Analysts, and Data-Driven Decision Makers. The final two categories, Functional Analysts and Data-Driven Decision Makers, are less analytical than the other four categories, and may be thought of as data-enabled, rather than pure analytics, roles. Nonetheless, they require many overlapping skillsets with other analytics roles, and are important for organizations consuming and interpreting data. Table 1 shows descriptions and sample occupations for each job category.

Roles within each DSA framework category may vary in terms of required skill and experience, but are grouped together based on their function within an organization. Data Scientists and Economists, for example, belong to the Data Scientists and Advanced Analysts category. Although these roles entail different skillsets, offer different salaries, and require different experience, employees in both are expected to create sophisticated analytical models, work with large datasets, and derive insights from data. The context in which a Data Scientist performs these tasks may differ from that of an Economist, but both roles serve similar high-level functions within an organization and may require similar levels of analytical rigor.

Table 1. Description of DSA Jobs

Analytical Rigor

DSA Framework Category	Functional Role	Sample Occupations
Data Scientists & Advanced Analytics	Create sophisticated analytical models used to build new datasets and derive new insights from data	Data Scientist Economist
Data Analysts	Leverage data analysis and modeling techniques to solve problems and glean insight across functional domains	Data Analysts Business Intelligence Analyst
Data Systems Developers	Design, build and maintain and organization's data and analytical infrastructure	Systems Analyst Database Administrator
Analytics Managers	Oversee analytical operations and communicate insights to executives	Chief Analytics Officer Marketing Analystics Manager
Functional Analysts	Utilize data and analytical models to inform specific functions and business decisions	Business Analyst Financial Analyst
Data-Driven Decision Makers	Leverage data to inform strategic and operational decisions	IT Project Manager Marketing Manager

FINDINGS

In 2015, there were 2,352,681 job listings for all DSA categories (see Table 2). The demand for DSA jobs is projected to grow by 15% over the next five years, which translates to nearly 364,000 new job postings expected nationally by 2020. The fastest-growing roles are Data Scientists and Advanced Analysts, which are projected to see demand spike by 28% by 2020. This category and Analytics Managers are arguably the most visible DSA categories, yet they are also the least demanded in terms of total job postings. However, some of the roles within these categories are among the hardest-to-fill and fastest-growing DSA jobs, raising concerns about building an adequate talent pool for these positions.

Hiring difficulties are widespread for analytics roles, however, and many DSA jobs are among the hardest to fill in the entire market. On average, DSA jobs remain open for 45 days—five days longer than the market average. Among the core DSA job categories, Data Systems Developers—which includes roles such as Database Architects—are the hardest to fill DSA roles on average, with an average posting duration of 50 days. Specific roles, such as Director of Analytics and Systems Analysts, remain open far longer, with average posting durations well over 50 days.

The difficulty employers have filling DSA roles drives up salaries, and relative to other jobs, DSA jobs pay quite well. On average, they advertise an annual salary of $80,265—a premium of $8,736 relative to all bachelor's and graduate-level jobs. Some DSA jobs, such as Data Scientists and Data Engineers, demand salaries well over $100,000. While this is encouraging for prospective DSA workers, this makes it costly for employers to fill open roles.

Table 2. Summary Demand Statistics

DSA Framework Category	Number of Postings in 2015	Projected 5-Year Growth	Estimated Postings for 2020	Average Time to Fill (Days)	Average Annual Salary
All	2,352,681	15%	2,716,425	45	$80,265
Data-Driven Decision Makers	812,099	14%	922,428	48	$91,467
Functional Analysts	770,441	17%	901,743	40	$69,162
Data Systems Developers	558,326	15%	641,635	50	$78,553
Data Analysts	124,325	16%	143,926	38	$69,949
Data Scientists & Advanced Analysts	48,347	28%	61,799	46	$94,576
Analytics Managers	39,143	15%	44,894	43	$105,909

Exacerbating the talent shortage for many DSA roles are the heightened education and experience requirements for many new and emerging positions. Overall, 81% of all DSA job postings request workers with at least three years of prior work experience. The strong demand for experienced candidates, combined with the strong growth of many DSA roles, creates a chicken-and-egg problem within the DSA job market: there aren't many opportunities for workers to gain the DSA-related experience that employers are requesting.

Compounding this pipeline problem are the heightened education requirements for some DSA roles, especially Data Scientists and Advanced Analysts (see Table 3). Overall, 39% of Data Scientists and Advanced Analysts require a master's or Ph.D. These degrees take additional years of schooling to complete, so it will take a significant time investment to train a larger pool of workers. Therefore, because these roles are already undersupplied and projected to grow rapidly, the skills shortage is in danger of worsening.

Table 3. Workforce Entry Requirements

DSA Framework Category	Postings Requesting Experienced Workers (at least 3 Years Prior Work Experience)	Postings Requiring Master's or Higher
All	81%	6%
Data-Driven Decision Makers	88%*	5%
Functional Analysts	71%	6%
Data Systems Developers	84%	3%
Data Analysts	76%	6%
Data Scientists & Advanced Analysts	78%	39%
Analytics Managers	94%*	11%

*Note: Although certain managerial jobs are classified as entry level, these numbers typically reflect the years of managerial experience required, as opposed to the overall years of work experience required.

DSA DEMAND DIFFERS ACROSS SECTORS

The business need for Data Science and Analytics varies significantly across different industries, and some sectors are embracing DSA jobs and skills faster than others. The greatest demand for DSA jobs is in Finance and Insurance, Professional Services, and IT; together, these three industries alone account for 59% of all DSA job demand. DSA jobs factor most prominently in the Finance and Insurance industry, where they account for 19% of all openings in that sector. The Professional Services and IT industries follow with 18% and 17% relative demand for DSA jobs, respectively. [6]

Investigating demand for DSA jobs across sectors provides insight into the main industries that drive big data demand nationally. Table 4 presents the percentage of jobs within each framework category that fall into each of the top industries, and shows that the Finance and Professional Services industries are the primary drivers of DSA demand. Together, these industries account for over half of all DSA jobs.

6 See Appendix 1 for complete DSA demand data by industry.

Table 4. Share of DSA Category Demand by Industry

DSA Framework Category	Professional Services	Finance & Insurance	Manufacturing	Information	Health Care & Social Assistance	Retail Trade
Data-Driven Decision Makers	23%	17%	16%	10%	6%	6%
Functional Analysts	23%	34%	9%	5%	8%	4%
Data Systems Developers	41%	14%	14%	10%	5%	3%
Data Analysts	34%	25%	9%	6%	7%	3%
Data Scientists & Advanced Analysts	31%	23%	12%	10%	6%	4%
Analytics Managers	21%	41%	9%	9%	6%	3%

Key 41+% 31-40% 21-30% 11-20% 6-10% 0-5%

Differences in salary and hiring difficulty also arise across industries. As shown in Table 5, the Finance industries consistently offer higher pay for DSA jobs than other industries. Possibly related to these above-average salaries, DSA jobs in Finance remain open for far shorter time periods, on average. By contrast, DSA jobs in Professional Services are consistently harder to fill than in other industries. On average, DSA jobs in Professional Services remain open for 53 days, eight days longer than the overall DSA average.

Table 5. Time-to-Fill by Industry

DSA Framework Category	Top Industries (by Demand Volume)	Average Time to Fill (Days)	Average Annual Salary
Data-Driven Decision Makers	Professional Services	50	$96,845
	Finance & Insurance	37	$98,131
	Manufacturing	43	$93,641
Functional Analysts	Finance & Insurance	35	$71,937
	Professional Services	48	$69,135
	Manufacturing	39	$72,571
Data Systems Developers	Professional Services	51	$82,447
	Finance & Insurance	35	$87,039
	Manufacturing	43	$81,138
Data Analysts	Professional Services	47	$74,917
	Finance & Insurance	31	$83,209
	Manufacturing	41	$72,742
Data Scientists & Advanced Analysts	Professional Services	51	$97,457
	Finance & Insurance	43	$106,610
	Manufacturing	45	$92,543
Analytics Managers	Finance & Insurance	38	$113,754
	Professional Services	53	$107,185
	Manufacturing	40	$106,926

DSA SKILLS DIFFER ACROSS THE MARKET

Just as the nature of DSA job categories differs across industries, the nature of the individual skills and competencies required for these roles varies across the analytics landscape. The DSA framework groups together jobs requiring analytical expertise, but these roles fall along a spectrum of analytical capability, with some roles requiring familiarity with a far greater range of core analytical skills than others. To distinguish between the types of analytical competencies required within the DSA landscape, Burning Glass scored individual jobs from 0 to 100 based upon their level of analytical rigor.

Jobs were assessed based on the proportion of jobs calling for analytical skills and the relative value of these skills in the market. Analytical skills were identified from Burning Glass's taxonomy of 15,000 skills, of which more than 300 are core analytical skills. These skills may cut across multiple job categories—such as SQL, Data Analysis, and Business Intelligence—while others are more specialized and are primarily confined to very specific roles, such as Machine Learning and Apache Hadoop for Data Scientists, and Financial Modeling and SAS for Financial Quantitative Analysts. The resulting analytical scores are shown in Table 6 for the top analytical jobs in 2015.

Table 6. Top Analytical Occupations

DSA Framework Category	Occupation	Analytical Score (2015)
Data Scientists & Advanced Analysts	Data Scientist	100
Data Scientists & Advanced Analysts	Data Engineer	98
Data Scientists & Advanced Analysts	Biostatistician	91
Data Systems Developers	Database Architects and Developers	91
Data Scientists & Advanced Analysts	Statistician	88
Analytics Managers	Human Resources Analytics Manager	87
Analytics Managers	Chief Analytics Executives	87
Analytics Managers	Directors of Analytics/ Data	86
Data Scientists & Advanced Analysts	Financial Quantitative Analyst	86
Data Systems Developers	Database Administrator	86

Data Scientists are the most analytical roles in the market. They require proficiency with a large range of specialized analytical skills and tools, such as Machine Learning, Apache Hadoop, and Data Mining, in addition to generalized DSA skills like SQL, R, and Data Analysis. Data Engineers and Biostatisticians—which also fall into the Data Scientists and Advanced Analysts category—round out the top three analytical roles in the market. Multiple Analytics Managers also are among the most analytical roles, and these positions must combine analytical abilities with strong managerial experience. Chief Analytics Executives, for example, is an emerging c-suite role that must incorporate executive responsibilities with deep analytical knowledge.

While the analytical scores provide insight into skills requirements and the extent to which DSA skills drive the demand in each occupation, they also illustrate how skill requirements can differ markedly across the DSA landscape. To dig deeper into specific analytics skills valued by the market, and how they are combined with other domain-specific competencies, the top skills across the market were evaluated. Table 7 shows the key analytics and specialized skills demanded across each DSA category.

Although some analytics skills span multiple DSA categories—such as data analysis and SQL—each category is defined by a unique combination of skills. Data Scientists and Advanced Analysts, for instance, must be familiar with sophisticated analytical methods and tools—such as Machine Learning and Apache Hadoop—

while Functional Analysts require more general Data Analysis and Business Intelligence skills. There is also a divide between DSA jobs that require more established analytics skills, such as SQL, and newer disruptive skills, such as Hadoop. Data Scientists and Advanced Analysts, for example, fall into the latter camp of jobs that requires skills on the vanguard of DSA technologies, while Data Analysts still are more likely to require SQL, Business Intelligence, and other legacy DSA skillsets. Data Systems Developers, on the other hand, must balance a need for both older and newer analytical skillsets as IT departments grapple with the need to adopt newer technologies while maintaining existing infrastructure.

Table 7. Top Analytical and Specialized Skills by DSA Framework Category

DSA Framework Category	Occupation	Analytical Score (2015)
Analytics Managers	Financial Analysis SQL SAS Data Analysis Business Intelligence	Budgeting Project Management Risk Management Accounting Financial Planning
Data Analysts	Data Analysis SQL Business Intelligence Data Warehousing SAS	Project Management Microsoft Access Business Process SAP Business Analysis
Data Systems Developers	SQL Database Administration Extraction, Transformation, and Loading Data Warehousing Apache Hadoop	Project Management LINUX Software Development UNIX JAVA
Data Scientists & Advanced Analysts	Apache Hadoop Machine Learning Big Data R Data Science	Python JAVA Economics C++ Project Management
Data-Driven Decision Makers	SQL Financial Analysis Data Analysis Data Management Data Validation	Budgeting Project Management Accounting Supervision Product Management
Functional Analysts	Financial Analysis SQL Data Analysis Data Management SAS	Budgeting Accounting Business Analysis Business Process Economics

Some DSA jobs require a mix of deep domain-specific expertise and general competence across a broad range of functions—a so-called "T-shaped" skill distribution. This is true of Analytics Managers, who must not only have knowledge of a specific functional domain—such as Human Resources or Marketing—but also must possess analytical skills, project management skills, and financial planning and budgeting skills. Preparing workers for these roles is problematic, since these skills cut across a diverse mix of functional areas.

Hybrid jobs that require deep expertise in multiple functional areas also present unique challenges for employers and training providers. These roles often require a mix of deep analytical expertise and strong

domain-specific knowledge, both of which may take years to develop. Marketing Analytics Managers, for example, require analytics skills such as SQL, Big Data, and Predictive Modeling along with expertise in marketing, product management, and market strategy. Candidates with all these skills are rare, so new training methods to prepare workers for these roles must be developed.

Although the range of analytics skills requested throughout the market makes it difficult for training providers and employers to isolate specific competencies to address with training and recruiting resources, they can direct these resources by focusing on the most critical skills across the DSA ecosystem. To pinpoint these skills, this study identifies the most demanded, fastest growing, highest paying, and hardest to fill analytics skills.

Table 8. Top Analytical Skills Within the DSA Landscape

Skill Name	Total Postings in 2015
SQL	338,555
Data Analysis	166,285
Financial Analysis	155,331
Data Management	113,807
Mathematics	107,297
Data Warehousing	97,797
SQL Server	93,630
Database Administration	92,256
Business Intelligence	88,603
Extraction, Transformation, and Loading (ETL)	82,920

Table 9. Fastest Growing Analytical Skills (with at Least 7,500 Postings)

Skill Name	Predicted 2-Year Growth
Data Science	93%
Machine Learning	56%
Tableau	52%
Big Data	50%
Data Visualization	44%
R	41%
Apache Hive	41%
Predictive Analytics	39%
Apache Hadoop	35%
Pivot Tables	34%

Table 8 shows that analytics skills that cut across DSA-related job categories—this includes skills such as SQL, Data Analysis, and Business Intelligence—are in the most demand, but data infrastructure skills—such as Data Warehousing, Database Administration, and ETL—are also among the most-demanded analytics skills.

Although the skills listed in Table 8 are the most important analytics skills in terms of sheer volume of demand, the analytical skills projected to grow the fastest are in greater danger of facing widening skill gaps. The skills projected to grow the fastest include advanced analytical competencies—such as Data Science and Machine Learning—as well as Data Visualization–related skills and basic analytical tools, such as Pivot Tables in Excel, that are increasingly required across job categories (see Table 9).

Identifying the highest-paying analytical skills will interest students and existing workers who want to maximize their earning potential. These highly lucrative analytical skills include advanced analytical and Big Data skills, such as MapReduce, Machine Learning, Apache Hadoop, Data Science, and MongoDB, all of which have average salaries above $100,000 (see Table 10).

Table 10. Highest Paying Analytical Skills (with at Least 7,500 Postings)

Skill Name	Average Salary
MapReduce	$115,907
PIG	$114,474
Machine Learning	$112,732
Apache Hive	$112,242
Apache Hadoop	$110,562
Big Data	$109,895
Data Science	$107,287
NoSQL	$105,053
Predictive Analytics	$103,235
MongoDB	$101,323

Table 11. Hardest-to-Fill Analytical Skills (with at Least 7,500 Postings)

Skill Name	Predicted 2-Year Growth
Enterprise Data Management	69
Database Schemas	69
Data Governance	59
Database Architecture	59
Apache Hive	56
Big Data	56
MapReduce	55
SAP Analytics	55
Online Analytical Processing (OLAP)	54
Apache Pig	53

For employers, it is critically important to know which skills are the hardest to fill, and how long it will take to find workers with these skills, so as to mitigate hiring difficulties. Across all analytics skills, those taking the longest for employers to hire include data infrastructure and management skills, such as Enterprise Data Management and Database Architecture; Big Data–related skills, such as Apache Hive and Pig; and Data Governance (see Table 11).

Understanding where and how these skills manifest in the market is critical for developing a pool of workers possessing the key competencies needed for the most important and hardest-to-fill DSA jobs. Table 12 shows that some roles, such as Data Scientists and Data Engineers, require combinations of skills that individually are hard to find—such as Data Science and Machine Learning for Data Scientists, or Apache Hadoop and Python for Data Engineers. Finding candidates with all these skills compounds the difficulty for employers.

Moreover, context matters when it comes to hiring difficulty. In some roles, an analytical skill may be a common or assumptive skill, but in others it is rarely found. The statistical programming language R, for example, is one of the most commonly requested skills for Data Scientists; for Finance and Risk Analytics Managers, however, it is less common, making it both harder to find and one of the highest-paying skills for Finance and Risk Analytics Managers.

Analytical skills are not just confined to the core DSA jobs included in the framework, however. Extending the analytical scoring analysis to jobs outside of the DSA framework shows that demand for analytical skills is spreading to disparate corners of the job market, and employers must source analytically literate workers for a variety of roles. In some cases, existing roles are absorbing new analytical skills—as is the case when Graphic Designers are expected to have data visualization skills or IT workers to understand Big Data and database infrastructure. In other cases, roles such as Engineers and Scientists, which have always had a quantitative focus, are utilizing newer analytical tools and methods.

The Finance industry has already recruited Physicists and workers from other highly quantitative disciplines for positions as Financial Quantitative Analysts. Similarly, Engineers and Scientists may represent an untapped pool of talent for Data Scientists and Advanced Analysts or other advanced analytics roles. Directing workers from these back grounds into the DSA talent pipeline could help alleviate hiring difficulties for many of the hardest-to-fill DSA roles (see Table 13).

Table 12. Key Skills and High-Paying Skills by Occupation

Occupation	Key Skills	High-Paying Skills
Data Scientist	Data Science Machine Learning Python R Apache Hadoop	Pattern Recognition Database Schemas Quantitative Analysis Object-Oriented Analysis and Design Database Administration
Data Engineer	Data Engineering Big Data Apache Hadoop JAVA Python	Spark Programming Oozie Predictive Models Apache Flume PIG
Finance and Risk Analytics Manager	Risk Management Financial Analysis and Planning Forecasting and Financial Modeling Project Management SQL	MATLAB Mergers and Acquisitions Data Warehousing Project Management R

Table 13. Analytical Scores and Key Analytical Skills in non-DSA Occupation

Occupation		Analytical Score	Key Analytical Skills
Science	Epidemiologist	80	SAS Data Analysis Biostatistics
	Physical Scientist	75	Advanced Mathematics Data Analysis MATLAB
Engineering	Biomedical Engineer	68	Advanced Mathematics Data Validation MATLAB
	Optical / Laser Engineer	67	MATLAB Data Validation Data Analysis
IT	Computer Scientist	70	Advanced Mathematics Data Analysis Machine Learning
	Network Administrator	67	VMware SQL Database Administration
	Software Developer	67	SQL Database Design Data Management
Design	UI / UX Designer / Developer	56	SQL Web Analytics Data Visualization
	Graphic Designer	32	Data Visualization Data Validation SQL

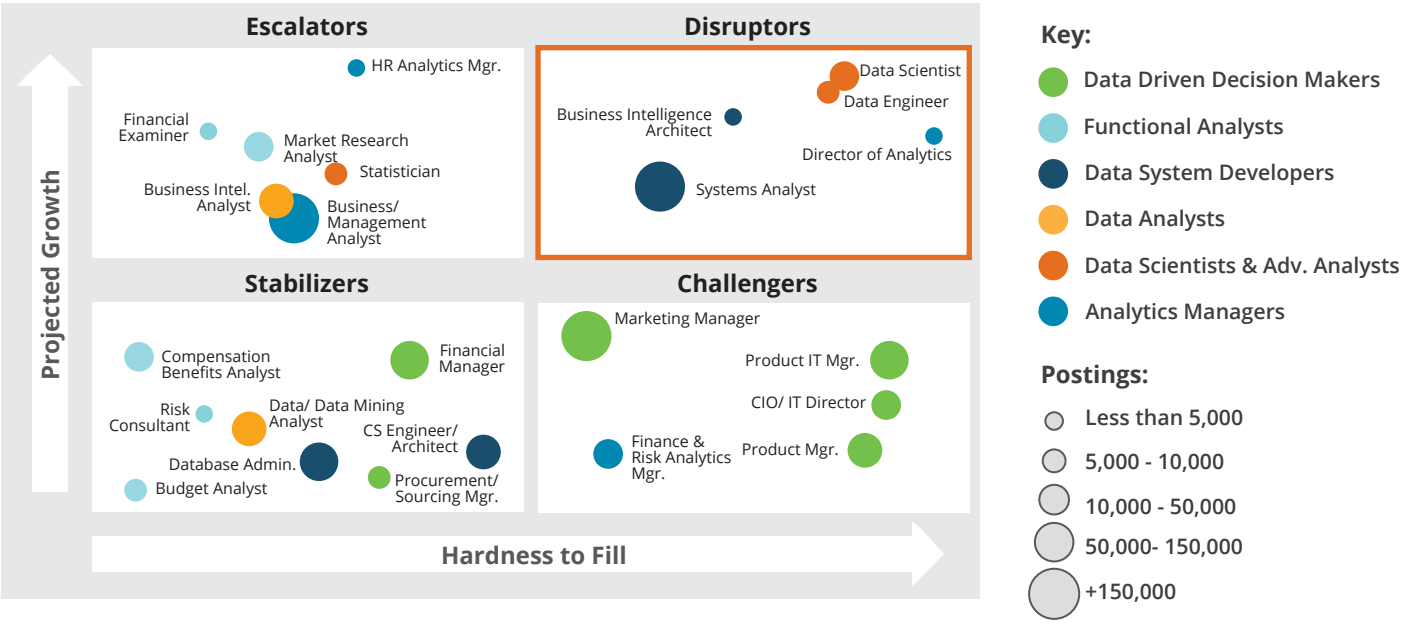
CONTEXTUALIZING THE DISRUPTION

Identifying the hardest-to-fill and fastest growing DSA jobs and skills is critically important for employers, educators, and other stakeholders, but this information does not, in and of itself, suggest where resources should be directed. To contextualize how jobs and skills should be prioritized for workforce development initiatives, this study creates a 2x2, four-category matrix of DSA jobs and skills (Figure 1). The matrix is organized by growth and hardness to fill. The four categories are Disruptors, Escalators, Challengers, and Stabilizers.

Figure 1. DSA Job and Skill Matrix

At the top right of the matrix are the Disruptors—jobs that are projected to grow at a high rate, and at the same time are the most difficult to fill. Disruptors present the biggest concern; in the near future, they are the jobs most likely to suffer from supply shortages, which could prevent firms from utilizing Big Data to its full potential. Key Disruptors jobs include Data Scientists, Data Engineers, and Directors of Analytics. Escalators and Challengers are also in danger of eroding the gains that firms can realize from Big Data. Key jobs in Escalators are Business Intelligence Analysts and Human Resources Analytics Managers, and key jobs in Challengers are Finance and Risk Analytics Managers and Marketing Managers (see Figure 2).

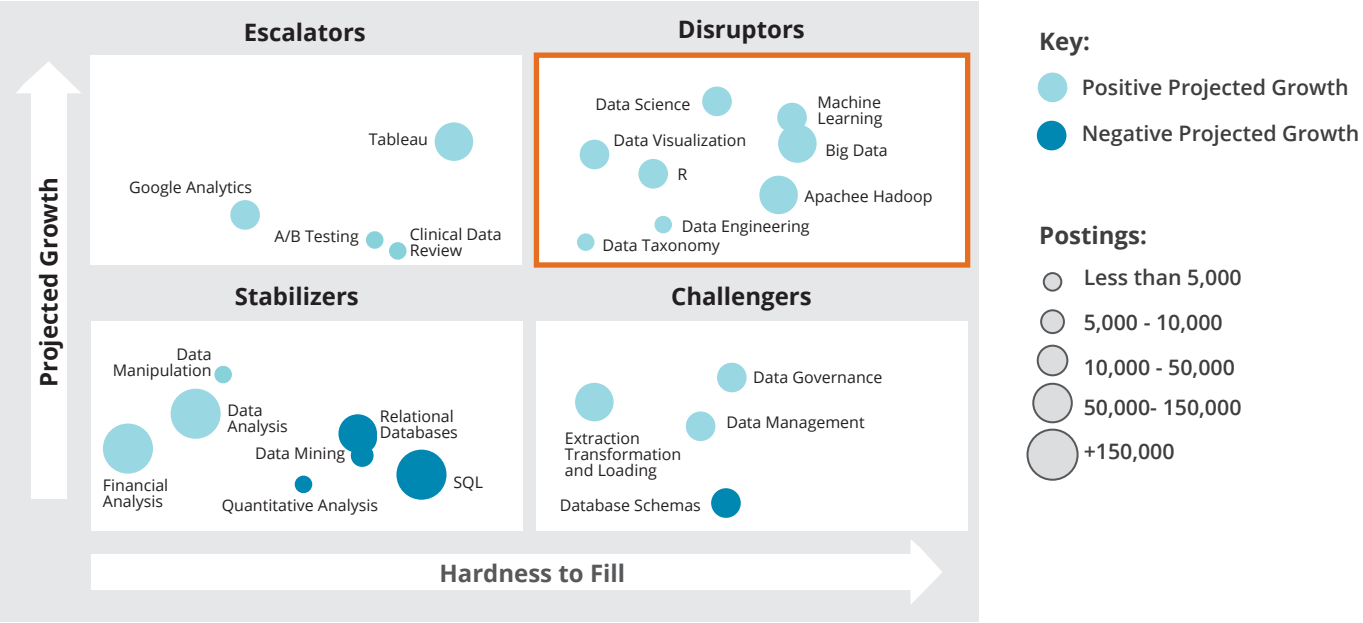
Figure 2. DSA Jobs Matrix



Focusing on skills, important Disruptors include Apache Hadoop, Machine Learning, and Data Engineering. Escalators include skills such as A/B Testing, Google Analytics, and Clinical Data Review; this reflects the growing demand for both digital marketing skills and data-driven approaches to clinical care. Key Challengers include skills related to enterprise-wide data management, such as Data Architecture and Data Governance (see Figure 3).

The jobs and skill matrices pinpoint the gaps in the current DSA market that warrant the greatest attention from employers, training providers, and workforce development officials. If these gaps are not mitigated, the consequences include higher costs for organizations as they struggle to find adequate talent for the roles that are most in demand, and more turnover as workers move to firms and industries where these skills are most highly valued. DSA jobs are already heavily concentrated in select industries, and if this trend continues then there is a threat of an "analytical capabilities divide." The majority of the destabilizing jobs and skills identified require significant time and effort to develop, so if they are not addressed immediately the talent shortage is in danger of persisting indefinitely.

Figure 3. DSA Skills Matrix



RECOMMENDATIONS

Mitigating these gaps will take a concerted effort from all the stakeholders, and there is no one-size-fits-all solution. The following, however, are a few actions that could alleviate the DSA talent shortage.

Data Literacy for Everyone: Data and analytics skills are spreading to new corners of the job market, and the torrents of information that firms are collecting will enable workers at all levels to make better data-driven decisions. However, organizations will only benefit from their data if workers across the value chain possess at least foundational data literacy. Otherwise, potential insights and innovations will go unnoticed, or even worse, misinterpretation of data will lead to poor decisions.

To achieve widespread data literacy, next generation students must be exposed to data and its relevance and applicability early. Ideally, students graduating from high school should already have reached a baseline data literacy that they can then apply across college and university departments. For those already in post-secondary education or in the workforce, data literacy can be factored into degree programs, online learning, or employer programs.

New DSA-Focused Education Programs: Education or experience requirements are particularly high for many emerging DSA roles, such as Data Scientists and Data Engineers. Data Scientist positions, for instance, require 42% of candidates to have a graduate degree, and more than 20% of candidates are expected to have more than six years of experience. Such demanding employer requirements block the talent pipeline for these roles by preventing a steady flow of new workers into the talent pool.

Accelerated development of new learning pathways which are specifically targeted at preparing candidates for DSA roles are needed. A variety of pathways are needed to match individual needs. These include new DSA degree programs, boot camps, or internal training programs. All programs must focus on competencies and mastery.

Continuous developments of competences and skills: Technologies change quickly. This reality requires a new type of workforce and attitude from both employers and employees around continuous learning and mastering skills that will enable employees to be prepared for not-yet-arrived jobs of the future. It is clear from the data that closing the DSA talent gap will require new strategies for up-skilling and re-skilling the incumbent workforce. New graduates alone will not close this gap. Whenever possible, employers should pair new graduates of emerging DSA education programs with experienced mentors to speed career development.

Initiate data labs: Data labs are creative spaces bringing together learners, experts from industry and academia, open data, and data systems to collaborate on challenging problems. Data labs can exist anywhere. Their purpose is to support the needs of a community, which could be a university, a city, a company, or a coalition of organizations. Data labs bring together the human capital, technology, and data to serve as a central resource whose mission is to help the community become data-driven and more importantly speed talent development. Academic data labs that serve the broader community exist, such as at the University of Edinburgh, which acts as a public/private co-laboratory for Scotland. Many more are needed to foster development of data-savvy professionals.

Top-down action plans for organizations: Organizations should define the DSA job roles and requisite skills for each, then analyze existing workforce readiness. Key steps include naming a chief data and/or analytics officer, identifying talent already well suited for DSA roles, identifying those ready for up-skilling initiatives, and identifying organizational gaps to prioritize recruiting efforts. Leaders can also go further and create learning pipelining programs to support staff progression. For example, pipeline programs could be tailored to individual employee needs by focusing on key workforce segments: such as employees new to an organization, new to an industry, new to data and analytics, or ready to reach the next level of analytical mastery.

APPENDIX

Appendix 1: DSA Demand by Industry

Industry	Industry Job Openings that Fall within the DSA Framework
Finance and Insurance	19%
Professional, Scientific, and Technical Services	18%
Information	17%
Management of Companies and Enterprises	13%
Manufacturing	12%
Utilities	10%
Wholesale Trade	9%
Mining, Quarrying, and Oil and Gas Extraction	9%
Public Administration	7%
Other Services (except Public Administration)	6%
Agriculture, Forestry, Fishing and Hunting	6%
Educational Services	5%
Real Estate and Rental and Leasing	5%
Administrative and Support and Waste Management and Remediation Services	5%
Arts, Entertainment, and Recreation	4%
Retail Trade	3%
Transportation and Warehousing	3%
Construction	3%
Accommodation and Food Services	3%
Health Care and Social Assistance	3%

Appendix 2: DSA Postings and Location Quotients by State

	Data-Driven Decision Makers		Functional Analysts		Data Systems Developers		Data Analysts		Data Scientists & Advanced Analysts		Analytics Managers	
	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ
AK	1,123	0.6	1,351	0.7	679	0.5	109	0.4	40	0.3	58	0.6
AL	4,686	0.4	5,454	0.5	4,602	0.6	566	0.3	186	0.3	131	0.2
AR	3,165	0.5	3,339	0.5	2,193	0.5	532	0.5	132	0.3	100	0.3
AZ	18,477	1.2	19,748	1.4	15,003	1.4	3,199	1.4	532	0.6	803	1.1
CA	134,201	1.5	103,547	1.2	84,739	1.4	19,868	1.4	11,407	2.1	5,978	1.4
CO	19,979	1.4	18,747	1.4	17,000	1.7	2,735	1.2	762	0.9	930	1.3
CT	13,229	1.4	13,598	1.5	9,656	1.4	2,577	1.7	729	1.3	926	2.0
DC	10,321	2.6	14,299	3.8	10,822	4.0	1,974	3.2	1,335	5.6	562	2.9
DE	2,901	1.1	4,347	1.8	2,733	1.6	760	1.9	285	1.9	461	3.7
FL	34,353	0.7	35,188	0.8	24,583	0.8	4,907	0.7	1,031	0.4	1,347	0.6
GA	25,561	1.1	24,854	1.1	19,917	1.2	4,555	1.2	1,050	0.7	1,194	1.0
HI	1,464	0.4	1,457	0.4	750	0.3	134	0.2	36	0.2	28	0.2
IA	6,356	0.7	8,130	1.0	4,534	0.7	1,406	1.0	289	0.5	294	0.7
ID	1,998	0.5	1,771	0.5	1,074	0.4	225	0.4	65	0.3	46	0.3
IL	45,128	1.3	44,084	1.3	27,827	1.2	7,323	1.4	2,149	1.0	2,263	1.4
IN	9,653	0.6	8,673	0.5	5,723	0.5	1,417	0.5	395	0.4	258	0.3
KS	4,504	0.6	4,441	0.6	3,385	0.6	699	0.6	133	0.3	142	0.4
KY	5,484	0.5	5,596	0.5	3,235	0.4	684	0.4	97	0.2	211	0.4
LA	4,285	0.4	3,816	0.4	2,176	0.3	376	0.2	79	0.1	128	0.2
MA	29,229	1.5	26,090	1.4	17,992	1.3	4,006	1.3	3,064	2.6	1,590	1.6
MD	14,243	0.9	17,289	1.2	16,312	1.6	2,436	1.0	1,364	1.5	618	0.8
ME	2,099	0.6	2,285	0.7	1,310	0.5	357	0.7	52	0.3	117	0.7
MI	20,119	0.8	19,817	0.9	16,436	1.0	3,237	0.9	775	0.5	671	0.6
MN	17,771	1.1	19,229	1.2	12,541	1.1	3,262	1.3	620	0.6	742	0.9
MO	10,142	0.6	10,591	0.7	7,903	0.7	1,812	0.7	593	0.6	378	0.5
MS	2,012	0.3	1,743	0.3	873	0.2	191	0.2	48	0.1	54	0.2
MT	1,365	0.5	1,195	0.5	648	0.4	140	0.3	41	0.3	65	0.5
NC	21,440	0.9	22,758	1.0	18,819	1.1	4,849	1.3	1,196	0.8	1,201	1.0
ND	867	0.3	900	0.4	394	0.2	86	0.2	11	0.1	24	0.2
NE	3,417	0.6	4,053	0.8	2,486	0.6	539	0.6	148	0.4	148	0.5
NH	2,255	0.6	1,990	0.6	1,832	0.7	328	0.6	63	0.3	111	0.6
NJ	38,944	1.7	35,216	1.6	25,575	1.6	5,835	1.7	2,736	2.0	2,117	1.9
NM	1,978	0.4	2,109	0.5	1,248	0.4	214	0.3	71	0.3	55	0.2
NV	4,583	0.6	3,827	0.6	2,617	0.5	425	0.4	101	0.2	224	0.6

Appendix 2: DSA Postings and Location Quotients by State (Continued)

	Data-Driven Decision Makers		Functional Analysts		Data Systems Developers		Data Analysts		Data Scientists & Advanced Analysts		Analytics Managers	
	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ
NY	70,405	1.3	66,106	1.3	35,316	1.0	10,375	1.3	5,757	1.8	6,078	2.4
OH	29,281	0.9	27,380	0.9	18,248	0.9	4,152	0.9	1,027	0.6	1,092	0.7
OK	3,342	0.4	3,377	0.4	2,321	0.4	572	0.4	64	0.1	119	0.3
OR	14,302	1.4	13,485	1.4	8,940	1.3	1,868	1.2	610	1.0	478	1.0
PA	26,735	0.8	24,083	0.8	16,155	0.7	3,864	0.8	1,631	0.8	1,167	0.7
RI	3,736	1.3	3,257	1.2	2,226	1.2	537	1.3	136	0.8	372	2.8
SC	5,478	0.5	4,959	0.5	3,635	0.5	668	0.4	154	0.2	138	0.3
SD	2,197	0.9	2,221	1.0	880	0.5	299	0.8	56	0.4	73	0.6
TN	10,575	0.6	10,548	0.7	6,982	0.6	1,582	0.6	291	0.3	365	0.5
TX	56,792	0.8	54,641	0.8	38,874	0.8	8,409	0.8	1,969	0.5	2,286	0.7
UT	6,411	0.8	5,823	0.8	3,884	0.7	773	0.6	411	0.9	201	0.5
VA	22,071	1.0	28,901	1.4	27,654	1.9	3,916	1.2	1,629	1.3	1,269	1.2
VT	1,046	0.6	811	0.5	483	0.4	75	0.3	24	0.2	31	0.4
WA	25,977	1.5	18,109	1.1	14,127	1.2	3,126	1.2	2,066	2.0	947	1.1
WI	12,250	0.8	11,779	0.8	6,734	0.6	1,755	0.7	244	0.3	418	0.5
WV	988	0.2	1,154	0.3	701	0.2	99	0.2	22	0.1	17	0.1
WY	547	0.3	426	0.3	244	0.2	31	0.1	19	0.2	21	0.3

Note: LQ is the location quotient, representing the concentration of demand relative to national demand.

Appendix 3: DSA Postings and Location Quotients for the Top 20 Metro Areas

	Data-Driven Decision Makers		Functional Analysts		Data Systems Developers		Data Analysts		Data Scientists & Advanced Analysts		Analytics Managers	
	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ	Postings	LQ
New York, NY	92,865	1.7	84,389	1.7	50,311	1.4	13,855	1.7	7,565	2.4	7,347	2.9
San Francisco, CA	43,529	3.4	30,682	2.5	22,705	2.6	6,931	3.5	5,533	7.2	2,478	4.0
Los Angeles, CA	42,441	1.3	35,106	1.1	27,408	1.2	6,016	1.2	2,184	1.1	1,590	1.0
Chicago, IL	42,008	1.6	40,731	1.6	25,028	1.4	6,691	1.7	2,091	1.3	2,145	1.7
Washington, DC	30,448	1.7	40,478	2.4	37,510	3.1	5,555	2.1	3,506	3.3	1,801	2.1
Dallas, TX	26,895	1.4	25,500	1.4	19,808	1.5	4,602	1.5	913	0.8	1,241	1.3
Boston, MA	26,733	1.7	23,872	1.6	16,829	1.6	3,698	1.6	2,919	3.2	1,482	2.0
Seattle, WA	22,696	2.1	14,695	1.4	11,968	1.6	2,833	1.7	1,948	3.1	844	1.6
Atlanta, GA	21,708	1.5	20,630	1.5	17,496	1.7	4,014	1.8	946	1.1	1,052	1.5
San Jose, CA	20,491	3.4	12,322	2.2	16,636	4.1	3,327	3.6	2,225	6.3	1,042	3.6
Philadelphia, PA	19,822	1.2	19,200	1.3	12,866	1.2	3,301	1.3	1,661	1.7	1,301	1.7
Phoenix, AZ	15,808	1.4	16,931	1.6	12,956	1.7	2,848	1.7	434	0.7	710	1.3
Minneapolis, MN	14,918	1.3	16,420	1.6	10,996	1.4	2,955	1.7	547	0.8	675	1.3
Denver, CO	15,202	1.9	14,419	1.9	12,662	2.3	2,261	1.8	576	1.2	739	1.9
Houston, TX	13,944	0.8	14,558	0.9	7,805	0.7	1,792	0.7	461	0.4	572	0.7
Detroit, MI	12,708	1.1	13,470	1.3	12,117	1.6	2,460	1.4	548	0.8	512	0.9
Miami, FL	13,113	0.9	12,269	0.9	7,636	0.8	1,728	0.8	342	0.4	568	0.8
Charlotte, NC	10,949	1.7	11,739	1.9	10,097	2.2	3,222	3.2	364	0.9	797	2.5
Portland, OR	11,374	1.8	11,192	1.8	7,652	1.7	1,624	1.7	534	1.4	376	1.2
Cincinnati, OH	10,433	1.7	9,723	1.7	5,307	1.3	1,522	1.6	419	1.2	361	1.2

Appendix 4. Demand by DSA Framework Category and Top Occupations

Framework Category	Occupation	Number of Postings in 2015	Projected 5-Year Growth	Average Time to Fill (Days)	Postings Requiring Master's or Higher	Postings Requesting Experienced Workers (at Least 3 Years Prior Work Experience)	Average Annual Salary
Analytics Managers	Analytics Product Manager	1,812	14%	50	9%	90%	NA
	Chief Analytics Executives	457	16%	NA	13%	95%	NA
	Director of Analytics/Data	1,662	26%	73	4%	98%	NA
	Finance and Risk Analytics Manager	23,623	12%	40	13%	94%	$102,568
	Human Resources Analytics Manager	848	44%	NA	5%	96%	$111,095
	IT Manager - Data & Analytics	6,067	18%	37	6%	92%	$99,051
	Marketing Analytics Manager	4,674	16%	46	15%	97%	$123,591
Data Analysts	Business Intelligence Analyst	58,116	19%	37	6%	80%	$72,859
	Data / Data Mining Analyst	66,209	13%	38	7%	72%	$67,396
Data Analysts	Business Intelligence Architect	4,366	27%	47	2%	53%	$99,970
	Computer Systems Engineer / Architect	117,979	11%	46	4%	88%	$86,883
	Data Warehousing Specialist	32,025	12%	43	5%	87%	$77,911
	Database Administrator	152,470	11%	43	3%	84%	$74,657
	Database Architects and Developers	46,255	20%	39	5%	89%	$89,611
	Systems Analyst	205,231	19%	58	3%	81%	$73,811
Data Scientists & Advanced Analysts	Biostatistician	5,416	22%	51	68%	78%	$83,588
	Data Engineer	9,911	39%	46	4%	88%	$108,808
	Data Scientist	14,394	39%	48	43%	82%	$105,676
	Economist	3,097	12%	45	51%	65%	$80,865
	Financial Quantitative Analyst	5,653	6%	43	47%	70%	$103,620
	Statistician	9,876	20%	43	36%	71%	$69,265
Data-Driven Decision Makers	Chief Executive Officer	28,643	2%	39	20%	92%	$97,391
	Chief Information Officer / Director of IT	35,242	14%	56	5%	95%	$102,928
	Compensation and Benefits Manager	13,716	6%	40	3%	86%	$81,992
	Financial Manager	122,798	16%	41	5%	89%	$88,805
	Human Resources Manager	70,929	14%	40	3%	89%	$86,529
	IT Project Manager	175,661	15%	60	4%	92%	$94,164
	Marketing Manager	153,117	16%	45	6%	89%	$92,225
	Operations Manager	48,906	15%	39	63%	71%	$83,513
	Procurement Manager	19,711	8%	42	3%	93%	$83,446

Appendix 4. Demand by DSA Framework Category and Top Occupations (Continued)

Framework Category	Occupation	Number of Postings in 2015	Projected 5-Year Growth	Average Time to Fill (Days)	Postings Requiring Master's or Higher	Postings Requesting Experienced Workers (at Least 3 Years Prior Work Experience)	Average Annual Salary
Data-Driven Decision Makers	Product Manager	64,453	12%	55	5%	89%	$100,124
	Quality Control Systems Managers	39,207	5%	43	3%	90%	$89,980
	Supply Chain / Logistics Manager	30,736	9%	41	3%	82%	$83,857
	Talent Acquisition / Recruiting Manager	8,980	18%	36	2%	81%	$83,146
Functional Analysts	Actuary	13,456	9%	54	3%	74%	$94,719
	Budget Analyst	5,769	5%	32	9%	65%	$66,921
	Business / Management Analyst	297,455	18%	40	5%	76%	$72,483
	Clinical Analyst / Clinical Documentation and Improvement Specialist	14,384	14%	42	1%	71%	$72,690
	Clinical Data Systems Specialist / Manager	30,162	24%	49	4%	78%	$72,399
	Compensation / Benefits Analyst	48,674	15%	36	2%	65%	$57,015
	Credit Analyst / Authorizer	17,663	16%	31	5%	60%	$63,143
	E - Commerce Analyst	17,192	16%	47	2%	78%	$74,619
	Financial Analyst	129,310	16%	40	4%	69%	$67,892
	Financial Examiner	4,629	24%	34	4%	71%	$70,580
	Fraud Examiner / Analyst	3,815	13%	31	2%	49%	$53,014
	Geographer / GIS Specialist	15,657	15%	36	6%	68%	$63,230
	HRIS Analyst / Specialist	4,324	18%	46	0%	74%	$66,239
	Human Resources Analyst	4,507	12%	44	2%	72%	$65,586
	Logistics / Supply Chain Analyst	20,288	14%	38	2%	70%	$64,013
	Market Research Analyst	38,829	23%	40	9%	64%	$69,893
	Operations Analyst	25,322	30%	37	5%	65%	$66,940
	Pricing Analyst	6,471	13%	40	2%	71%	$65,319
	Researcher / Research Associate	31,899	12%	42	27%	54%	$50,321
	Risk Analyst	12,116	14%	26	9%	74%	$78,528
	Risk Consultant	4,161	13%	19	5%	84%	$91,063
	Search Engine Optimization Specialist	12,509	17%	54	7%	62%	$70,402
	Security / Defense Intelligence Analyst	7,063	9%	44	7%	78%	$80,560
	Social Science Researcher	1,852	10%	40	23%	64%	$63,746
	Survey Researcher	2,934	7%	37	22%	63%	$50,443

ABOUT THE PROJECT PARTNERS

The research partnership between Burning Glass Technologies, BHEF, and IBM was motivated by the need to close the data science and analytics skills gap through data driven insights and increased collaboration between higher education and industry.

About Burning Glass Technologies

Burning Glass Technologies is an analytics software company that has cracked the genetic code of an ever-changing labor market. Powered by the world's largest and most sophisticated database of jobs and talent, we deliver real-time data and breakthrough planning tools that inform careers, define academic programs, and shape workforces.

About BHEF

The Business-Higher Education Forum (BHEF) is the nation's oldest membership organization of Fortune 500 CEOs, college and university presidents, and other leaders dedicated to the creation of a highly skilled future workforce. BHEF members collaborate and form strategic partnerships to build new undergraduate pathways; improve alignment between higher education and the workforce; and produce a diverse, highly skilled talent pool to meet demand in emerging fields.

About IBM

Data is transforming industries and professions. IBM offers data and analytics solutions designed for the new data professional. IBM is taking a leading role helping transform education to build a workforce pipeline of data literate professionals and new specialties such as the citizen analyst, data scientist, data engineer, and chief data officer.

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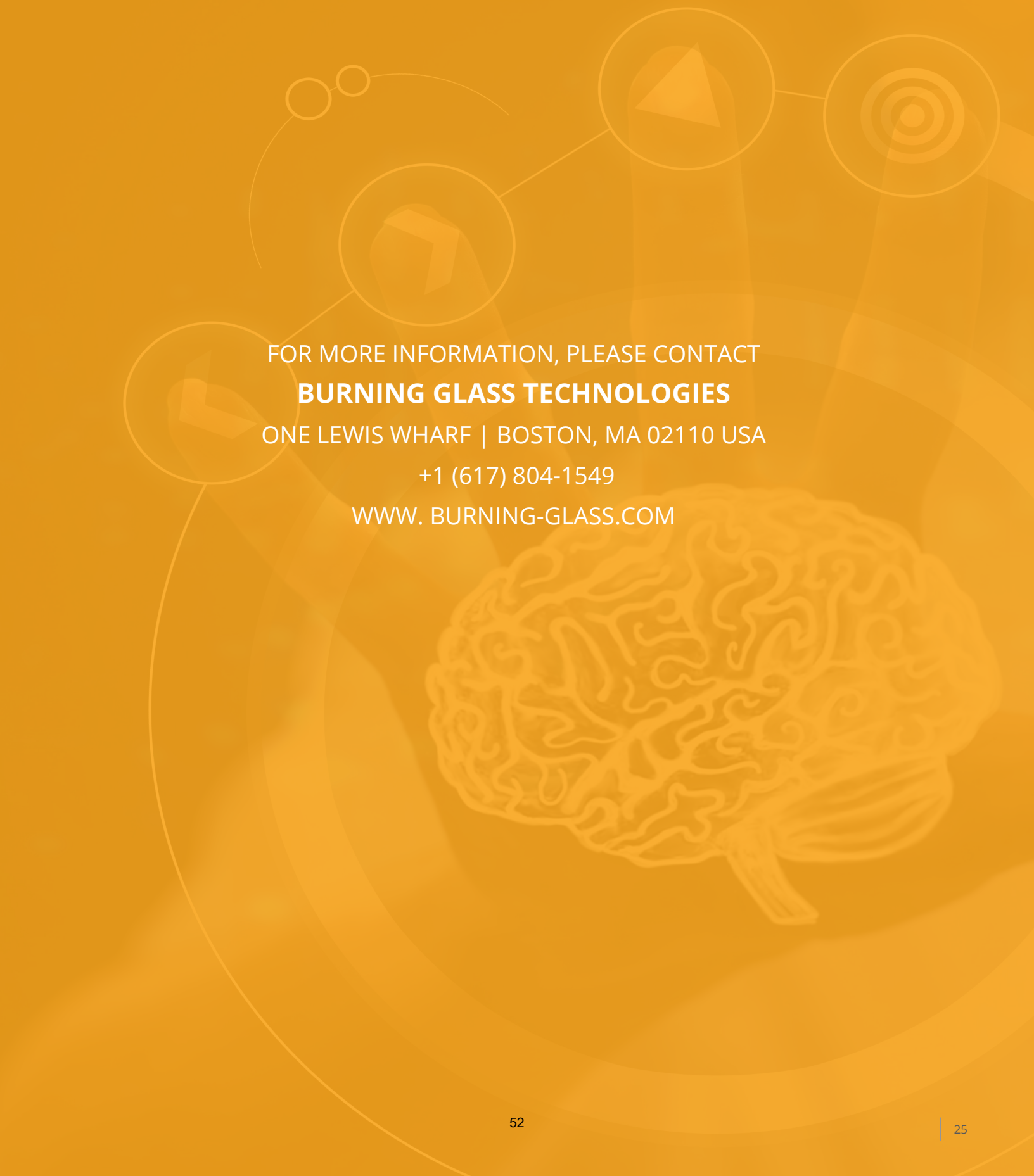

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Item 3:
VSCS Academic Programs Data

Enrollment Overview by Academic Program Area

	Fall 2018 Headcount					
	Community College of Vermont	Castleton University	Northern Vermont University	NVU Online	Vermont Technical College	System Total
% Total Headcount in McClure Pathways Programs	**43%**	**42%**	**38%**	**17%**	**64%**	**44%**
Accounting, Business, Management, Marketing	500	368	297	73	120	1358
Agriculture					56	56
Biological and Physical Sciences	192	219	259	81		751
Communication and Journalism		50	64			114
Computer Information Sciences, Technologies, and Support	124	31	45		122	322
Education	287	148	230	4		669
Engineering and Engineering Technologies					332	332
English Language & Literature		27	55			82
Health Professions and Related Programs	442	310			475	1227
History, Political Science, Global Studies		75	54	1		130
Law Enforcement, Security, and Related Protective Services		66	65		12	143
Liberal Arts & Sciences, Humanities, General Studies	1127	154	143	105	60	1589
Mathematics & Statistics		37	21			58
Mechanic and Repair Technologies					73	73
Multi/Interdisciplinary Studies		99	17	33		149
Natural Resources & Conservation	61	46	39		2	148
Psychology, Social Science, and Human Services Professions	334	204	300	120		958
Science Technologies, Technicians					164	164
Visual and Performing Arts	111	82	309	1		503
Total	**3178**	**1916**	**1898**	**418**	**1416**	**8826**

VSCS Academic Programs Fall 2018

	Institution	Program	Credential	HC	Listed in McClure Pathways?
Accounting, Business, Management, Marketing				**1,358**	
Business Metamajor	Community College of Vermont	Business	Associate's	291	Yes
DA Bus Pathway	Castleton University	Business Administration	Bachelor's	193	Yes
Accounting Metamajor	Community College of Vermont	Accounting	Associate's	124	Yes
	Northern Vermont University	Business	Bachelor's	111	Yes
DA Bus or Acc	Vermont Technical College	Business	Bachelor's	74	Yes
	Northern Vermont University	Mountain Recreation Management	Bachelor's	73	
	Community College of Vermont	Administrative Management	Associate's	68	
	NVU Online	Business	Bachelor's	68	Yes
	Castleton University	Sport Management	Bachelor's	49	
	Castleton University	Management	Bachelor's	48	
	Northern Vermont University	Business Administration	Bachelor's	43	Yes
DA Bus Pathway	Castleton University	Sports Administration	Bachelor's	33	
	Northern Vermont University	Accounting	Bachelor's	30	Yes
	Northern Vermont University	Sports Management	Bachelor's	26	
	Castleton University	Marketing	Bachelor's	22	
	Vermont Technical College	Business	Associate's	18	Yes
DA Acc Pathway	Castleton University	Accounting	Bachelor's	15	Yes
DA any CCV degree	Vermont Technical College	Applied Business Management	Bachelor's	15	Yes
	Community College of Vermont	Bookkeeping	Certificate	13	
	Northern Vermont University	Business Administration	Associate's	9	
DA Acc or Bus	Vermont Technical College	Entrepreneurship	Bachelor's	7	
	Vermont Technical College	Entrepreneurship	Associate's	6	
	NVU Online	Accounting	Bachelor's	5	Yes
	Castleton University	Accounting	Master's	4	
	Castleton University	Business Administration	Associate's	4	
	Community College of Vermont	Essential Workplace Skills	Certificate	4	
	Northern Vermont University	Sport Leadership	Bachelor's	3	
	Northern Vermont University	Business Management	Associate's	2	

Agriculture				**56**	
	Vermont Technical College	Equine Studies	Associate's	15	
	Vermont Technical College	Dairy Farm Management	Associate's	14	
	Vermont Technical College	Diversified Agriculture	Bachelor's	11	
	Vermont Technical College	Landscape Contracting	Associate's	10	
	Vermont Technical College	Agribusiness Management	Associate's	6	
Biological and Physical Sciences				**751**	
STEM Metamajor	Community College of Vermont	STEM Studies	Associate's	186	
	NVU Online	Wellness & Altern Medicine	Bachelor's	81	
	Castleton University	Health Science	Bachelor's	79	Yes
	Northern Vermont University	Atmospheric Sciences	Bachelor's	64	
	Castleton University	Exercise Science	Bachelor's	64	
DA Stem Pathway	Castleton University	Biology	Bachelor's	61	
	Northern Vermont University	Exercise Science	Bachelor's	57	Yes
	Northern Vermont University	Biology	Bachelor's	44	
	Northern Vermont University	Health Science	Bachelor's	42	Yes
	Northern Vermont University	Wellness & Altern Medicine	Bachelor's	31	
	Northern Vermont University	Natural Science	Bachelor's	17	Yes
DA Stem Pathway	Castleton University	Chemistry	Bachelor's	11	
	Community College of Vermont	STEM Studies	Certificate	6	
	Northern Vermont University	Climate Change Science	Bachelor's	4	
	Castleton University	Geology	Bachelor's	4	
Communication and Journalism				**114**	
	Castleton University	Media & Communication	Bachelor's	50	Yes
	Northern Vermont University	Electronic Journalism Arts	Bachelor's	31	
	Northern Vermont University	Media Arts	Bachelor's	22	Yes
	Northern Vermont University	Communications Community Media	Bachelor's	5	
	Northern Vermont University	Journalism	Bachelor's	3	Yes
	Northern Vermont University	Electronic Journalism Arts	Associate's	2	
	Northern Vermont University	Prof. Media Communications	Bachelor's	1	

Computer Information Sciences, Technologies, and Support				**322**	
IT Metamajor	Community College of Vermont	Information Technology	Associate's	118	Yes
DA Stem Pathway	Vermont Technical College	Computer Software Engineering	Bachelor's	62	Yes
	Northern Vermont University	Computer Information Systems	Bachelor's	44	Yes
DA Stem Pathway	Vermont Technical College	Computer Info Tech	Bachelor's	35	Yes
	Castleton University	Computer Information Systems	Bachelor's	31	Yes
	Vermont Technical College	Computer Software Engineering	Associate's	12	Yes
	Vermont Technical College	Computer Software Engineering	Master's	6	Yes
	Community College of Vermont	Web Site Design	Certificate	6	Yes
	Vermont Technical College	Computer Info Tech	Associate's	3	Yes
	Vermont Technical College	Software Development	Certificate	3	
	Northern Vermont University	Computing	Associate's	1	
	Vermont Technical College	Web Development	Certificate	1	Yes
Education				**669**	
Early Childhood Metamajor	Community College of Vermont	Early Childhood Education	Associate's	261	
	Northern Vermont University	Childhood Education	Bachelor's	56	
	Northern Vermont University	Elementary Education	Bachelor's	54	
	Castleton University	Practice of Physical Education	Bachelor's	52	
	Northern Vermont University	Education	Master's	48	
	Castleton University	Education	Master's	45	Yes
	Northern Vermont University	Outdoor Education	Bachelor's	39	
	Castleton University	Athletic Leadership	Master's	32	
	Community College of Vermont	Childcare	Certificate	26	
	Northern Vermont University	Early Childhood Education	Bachelor's	25	
	Castleton University	Physical Education	Bachelor's	19	
	Northern Vermont University	Curriculum and Instruction	Master's	5	
	NVU Online	Childhood Education	Bachelor's	4	
	Northern Vermont University	Education	Certificate	2	
	Northern Vermont University	Special Education	Associate's	1	
Engineering and Engineering Technologies				**332**	
	Vermont Technical College	Electromechanical Engr Tech	Bachelor's	63	
	Vermont Technical College	Electrical Engineering Techn	Bachelor's	44	Yes

	Vermont Technical College	Mechanical Engineering Techn	Associate's	40	Yes
	Vermont Technical College	Computer Engineering Tech	Bachelor's	31	
	Vermont Technical College	Civil & Environmntl Engr Techn	Associate's	30	Yes
	Vermont Technical College	Architectural Engr Technology	Bachelor's	28	
	Vermont Technical College	Electrical Engineering Techn	Associate's	27	Yes
DA Stem Pathway	Vermont Technical College	Manuf Engineering Tech	Bachelor's	25	
DA Stem Pathway	Vermont Technical College	Renewable Energy	Bachelor's	23	
	Vermont Technical College	Arch & Bldg Engineering Tech	Associate's	10	
	Vermont Technical College	Computer Engineering Tech	Associate's	7	Yes
	Vermont Technical College	General Engineering Tech	Associate's	4	Yes
English Language & Literature				**82**	
	Northern Vermont University	Creative Writing	Bachelor's	29	
	Castleton University	English	Bachelor's	27	
	Northern Vermont University	English	Bachelor's	26	
Health Professions and Related Programs				**1,227**	
Health Science Metamajor	Community College of Vermont	Allied Health Preparation	Certificate	283	Yes
	Castleton University	Nursing	Bachelor's	221	Yes
	Vermont Technical College	Practical Nursing	Certificate	157	Yes
	Vermont Technical College	Nursing	Associate's	131	Yes
	Community College of Vermont	Medical Assisting	Associate's	120	
	Vermont Technical College	Dental Hygiene	Bachelor's	85	Yes
	Castleton University	Kinesiology (formerly Athl Trng)	Bachelor's	81	
	Vermont Technical College	Nursing	Bachelor's	69	Yes
	Community College of Vermont	Medical Billing and Coding	Certificate	38	
	Vermont Technical College	Respiratory Therapy	Associate's	33	
	Castleton University	Health Promotion	Bachelor's	8	
	Community College of Vermont	Health Information Specialist	Certificate	1	
History, Political Science, Global Studies				**130**	
DA Liberal Studies	Castleton University	History	Bachelor's	40	
	Northern Vermont University	Political Science	Bachelor's	23	
	Northern Vermont University	History	Bachelor's	21	
	Castleton University	Political Science	Bachelor's	18	

DA Liberal Studies	Castleton University	Global Studies	Bachelor's	17	
	Northern Vermont University	Global Studies	Bachelor's	10	
	NVU Online	History	Bachelor's	1	
Law Enforcement, Security, and Related Protective Services				**143**	
	Northern Vermont University	Criminal Justice	Bachelor's	64	Yes
	Castleton University	Criminal Justice	Bachelor's	63	Yes
	Vermont Technical College	Paramedicine	Certificate	12	
(DA Pending)	Castleton University	Criminal Justice	Associate's	3	
	Northern Vermont University	Criminal Justice	Associate's	1	
Liberal Arts & Sciences, Humanities, General Studies				**1,589**	
Liberal Arts Metamajor	Community College of Vermont	Liberal Studies	Associate's	707	
	Community College of Vermont	Undeclared	Associate's	420	
	Castleton University	Undeclared	Bachelor's	145	
	NVU Online	Professional Studies	Bachelor's	105	
	Northern Vermont University	Undeclared	Bachelor's	94	
	Vermont Technical College	Undeclared	Bachelor's	60	
	Northern Vermont University	Explorations	Bachelor's	26	
	Northern Vermont University	General Studies	Associate's	21	
	Castleton University	Philosophy	Bachelor's	4	
	Castleton University	General Studies	Associate's	3	
	Northern Vermont University	Liberal Studies	Master's	2	
	Castleton University	Spanish	Bachelor's	2	
Mathematics & Statistics				**58**	
DA Stem	Castleton University	Mathematics	Bachelor's	37	
	Northern Vermont University	Mathematics	Bachelor's	21	Yes
Mechanic and Repair Technologies				**73**	
	Vermont Technical College	Automotive Technology	Associate's	36	
	Vermont Technical College	Diesel Power Technology	Associate's	34	Yes
	Vermont Technical College	Diesel Power Technology	Certificate	3	
Multi/Interdisciplinary Studies				**149**	

DA Liberal Studies	Castleton University	Multidisciplinary Studies	Bachelor's	99	
	NVU Online	Interdisciplinary Studies	Bachelor's	33	
	Northern Vermont University	Interdisciplinary Studies	Bachelor's	17	
Natural Resources & Conservation				**148**	
	Community College of Vermont	Environmental Science	Associate's	61	Yes
	Northern Vermont University	Environmental Science	Bachelor's	34	Yes
	Castleton University	Ecological Studies	Bachelor's	25	Yes
	Castleton University	Environmental Science	Bachelor's	21	Yes
	Northern Vermont University	Sustainability Studies	Bachelor's	5	Yes
	Vermont Technical College	Forestry	Associate's	2	
Psychology, Social Science, and Human Services Professions				**958**	
Behavioral Sciences Metamajor	Community College of Vermont	Behavioral Science	Associate's	318	Yes
	NVU Online	Psychology	Bachelor's	120	
DA Pending	Castleton University	Psychology	Bachelor's	96	
	Northern Vermont University	Psychology	Bachelor's	88	
	Northern Vermont University	Applied Psych & Human Services	Bachelor's	87	Yes
	Northern Vermont University	Counseling	Master's	87	Yes
DA Pending	Castleton University	Social Work	Bachelor's	50	Yes
	Castleton University	Sociology	Bachelor's	29	
	Northern Vermont University	Anthropology & Sociology	Bachelor's	28	
	Castleton University	Psychology	Master's	16	Yes
	Community College of Vermont	Substance Abuse Services	Certificate	16	Yes
	Castleton University	Social Science	Bachelor's	12	
	Northern Vermont University	Social Science	Bachelor's	8	
	Northern Vermont University	Applied Behavioral Analysis	Certificate (GR)	2	
	Castleton University	Social Studies	Bachelor's	1	
Science Technologies, Technicians				**164**	
	Vermont Technical College	Veterinary Technology	Associate's	60	
	Vermont Technical College	Professional Pilot Technology	Bachelor's	45	
	Vermont Technical College	Construction Management	Bachelor's	36	Yes
	Vermont Technical College	Construction Management	Associate's	23	Yes

Visual and Performing Arts				**503**	
Visual Arts Metamajor	Community College of Vermont	Design & Media Studies	Associate's	111	Yes
	Northern Vermont University	Music Business and Industry	Bachelor's	80	
	Northern Vermont University	Art	Bachelor's	38	
	Northern Vermont University	Animation/Illustration	Bachelor's	37	
	Northern Vermont University	Graphic Design	Bachelor's	44	Yes
	Castleton University	Theater	Bachelor's	24	
	Northern Vermont University	Studio Art	Bachelor's	24	
	Northern Vermont University	Cinema Production	Bachelor's	23	
DA Art	Castleton University	Art	Bachelor's	21	
	Castleton University	Music Education	Bachelor's	13	
DA Art	Castleton University	Graphic Design	Bachelor's	12	Yes
	Northern Vermont University	Music	Bachelor's	12	
	Northern Vermont University	Theater & Drama	Bachelor's	11	
	Northern Vermont University	Musical Theater	Bachelor's	10	
	Northern Vermont University	Woodworking & Furniture Design	Bachelor's	8	
	Castleton University	Music	Bachelor's	8	
	Northern Vermont University	Technical Theater	Associate's	7	
	Northern Vermont University	Studio Art	Master's	7	
	Castleton University	Music Education	Master's	4	Yes
	Northern Vermont University	Music Education	Bachelor's	3	Yes
	Northern Vermont University	Photography	Associate's	3	
	Northern Vermont University	Music Business and Industry	Associate's	2	
	NVU Online	Music	Bachelor's	1	

Data Notes: Fall 2018 Enrollment Census Date (Oct. 15th) enrollments. Where programmatic changes have occurred for 2019, these are reflected in program titles, preserving 2018 enrollments associated with the program change. For example, CCV's new Behavioral Science metamajor includes enrollments in its Criminal Justice and Human Services programs from Fall 2018.

Instructional Staffing in the VSCS

VSCS Institutions 2016-2017

	CCV	Castleton	Johnson	Lyndon	Vermont Tech	Total
Total 12-month FTE Enrollment	3247	2040	1224	1135	1386	9032
Instructional staff FTE Fall 2017	203	121	82	70	115	591
Full-Time Faculty Fall 2017		90	44	50	79	
Instructional staff/FTE student ratio	16.0	16.9	14.9	16.2	12.1	15.3
FT Faculty /FTE student ratio		22.7	27.8	22.7	17.5	

IPEDS Institutional Comparison Groups 2016-2017

	CCV	Castleton	Johnson	Lyndon	Vermont Tech	Total
Total 12-month FTE Enrollment	2751	2216	2109	2216	2233	11525
Instructional staff FTE Fall 2017	147	131	130	131	124	663
Instructional staff/FTE student ratio	18.7	16.9	16.2	16.9	18.0	17.4

Source: 2018 IPEDS Data Feedback Report (reflects 2016-2017 data) FTE enrollment for Johnson includes online/EDP students.

VSCS Institutions 2017-2018

	CCV	Castleton	NVU	Vermont Tech	Total
Total 12-month FTE Enrollment	2748	1903	2140	1276	8067
Instructional staff FTE Fall 2018	173	101	132	112	518
Full-Time Faculty Fall 2018		75	78	78	
Instructional staff/FTE student ratio	15.9	18.8	16.2	11.4	15.6
FT Faculty /FTE student ratio		25.4	27.4	16.4	

Source: IPEDS 12-month enrollment and HR Survey data submitted February 2019. 2019 Data Feedback Report with comparison groups not available until October 2019. NVU data includes NVU Online.

Item 4:
Online Programs in the VSCS

Online Programs in the VSCS

Education, Personnel, & Student Life Committee

August 26, 2019

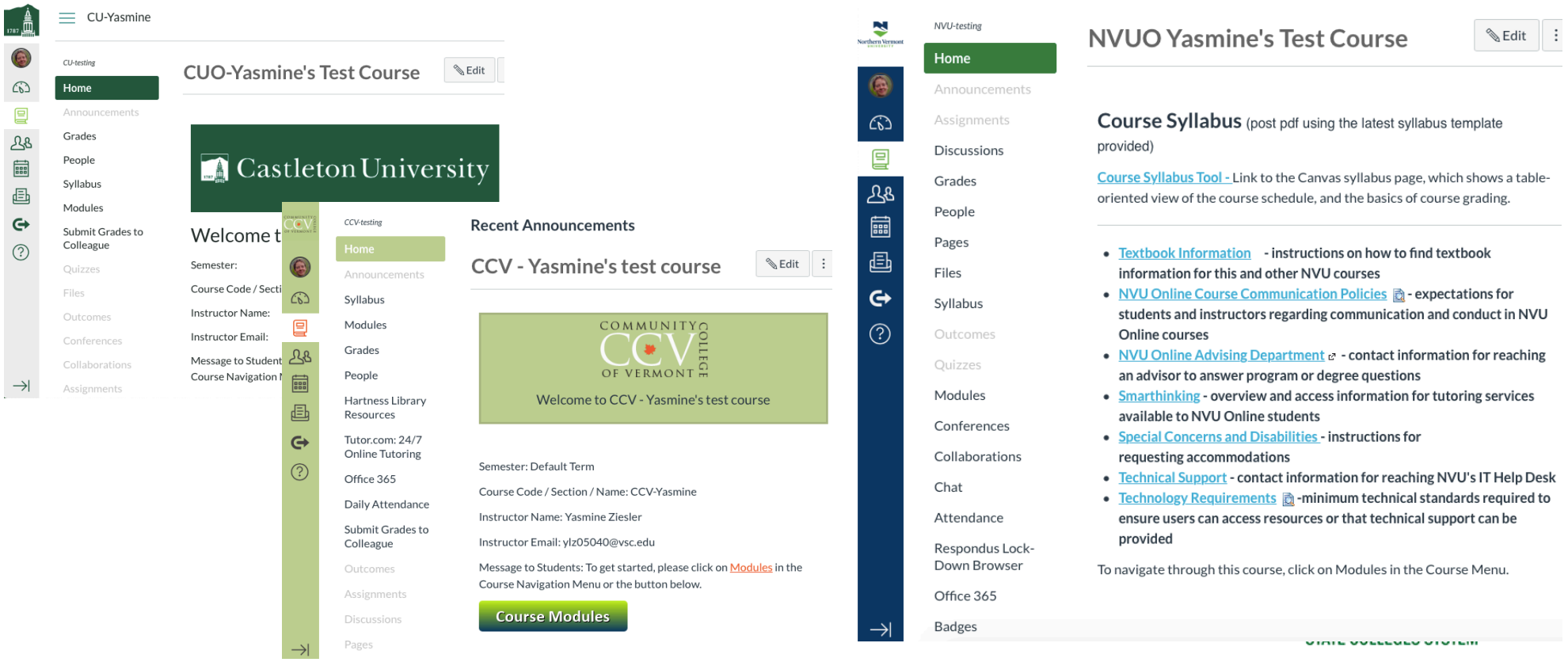
System-wide platforms and policies

- Canvas Learning Management System (new for Fall 2019)
  - with 24/7/365 live phone, chat, and email help support for students and faculty
- Aviso Student Advising (retention support, analytics) platform (February 2020)
- New "self service" website for registration, billing, financial aid (Fall 2020)
- Single academic transcript
- Board policy 106 ensuring general education transferability

Control by individual institutions

- Admissions, Registration, Tuition and Financial Aid
- Academic programs & student supports
  - faculty appointments
  - curriculum design & delivery
  - student advising and academic support services
  - library resources for program
  - career and alumni connections
- Branded, configured learning environments

Institutional Branding in Canvas



Current Online Programs

CCV

$271/cr

Associate Degrees:
Accounting
Business
Allied Health Prep
STEM Studies
Liberal Studies
Behavioral Science
Early Childhood Ed
Information Technology

Certificates:
Bookkeeping
Childcare
Med. Billing & Coding
Workplace Skills
Web Development

NVU Online

$350/cr undergrad
$588/cr grad

Bachelor's:
Accounting
Business
Criminal Justice
Early Childhood Ed (90% online)
Interdiscip. Studies
Professional Studies
Psychology
Wellness & Alternative Medicine

Master's:
Leadership Studies (new)
Certificates:
Small Business Mgmt
Sustainability

Vermont Tech

$596/cr online

Bachelor's:
Applied Business Mgmt
Dental Hygiene
Nursing (RN to BSN)

Castleton

$615/cr undergrad
$643/cr grad

Bachelor's
Nursing (RN to BSN)

Master's
M.B.A. (new)
Accounting
Athletic Leadership
School Psychology

Collaboration Strengths

- Library resources access
  - VSCS Library Council peer-to-peer sharing of online delivery strategies
- Faculty development and support with instructional design
  - System-wide “Teaching & Learning Technologies Group”
  - System-wide Canvas Admins Team

Technically feasible, not implemented

- Aggregated pool of individual online course offerings, easily searchable for students
- Consortium management of course offerings in duplicated programs