IT SKILL STANDARDS 2020 AND BEYOND

RESOURCES

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COLLIN COLLEGE

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NOTE: If you're not intending to develop a comprehensive set of skill standard products (KSA+Ts, employability skills, key performance indicators, and student learning outcomes), you may want to refer to the "Implementing the BILT Model of Business Engagement." Use the QR code below. That document focuses solely on using the Business and Industry Leadership Team (BILT) Model to work with employers. The BILT helps educators keep curriculum aligned with workforce needs through frequent meetings and annual KSA prioritizations.

**QR CODE
FOR BILT HOW TO**

**QR CODE
FOR ITSS PRODUCTS**

A MESSAGE FROM ANN BEHELER

Ann Beheler, PhD
Principal Investigator
IT Skill Standards 2020 and Beyond

Dear Colleagues:

This Resource Guide is a companion piece for the "ITSS Skill Standards 2020 and Beyond" Impacts book. It contains details about how the grant created and implemented processes working with 265 employers nationally for the most critical IT Job Clusters and gives you the steps to implement the process for any technical discipline at any college. Awarded in 2018, the grant created comprehensive, employer-led skill standard content to help educators better align curriculum with IT workforce needs and to assist employers (especially small and medium-sized employers) develop appropriate job descriptions. This guide provides the reader with strategies and resources needed to implement the ITSS process for any technical program.

As I said in my letter for our Impacts book (which you can reference using the QR code on the "Table of Contents" page), the ITSS project convened IT industry leaders, both executives and technicians alike, from across the country for numerous in-person and virtual meetings. We used their expertise to create concrete, actionable data on what students need to know going forward. The robust output of this material – which includes knowledge, skills, abilities, and tasks; employability skills; key performance indicators/criteria; and student learning outcomes – has been posted on the ITSS website and disseminated at educator workshops and conferences nationwide. We're most proud of the fact that the ITSS material was adopted and approved by the Texas Skill Standards Board (TSSB) for use across the state. Our materials are posted on the TSSB web page and are available nationwide.

Notably, the ITSS skill standard process is powered by the "BILT Model." The Business and Industry Leadership Team (BILT) concept was first developed at the National Convergence Technology Center (CTC), which was also funded by a National Science Foundation grant from 2012 to 2023. The BILT Model provides a framework for educators to better engage employers by making them co-leaders of a technical program through frequent meetings and an annual prioritization vote and discussion of entry-level job skills. When employers feel valued and can see that their feedback is helping improve a program, they become extremely invested in a school's faculty and students.

We are grateful for the dedicated involvement of both the 265 subject matter expert employers and educators from partner institutions at the Allison Group (Washington), Lake Washington Institute of Technology (Washington), Lone Star College (Texas), and Suffolk County Community College (New York). I want to offer special thanks for the ongoing generosity and support of our host institution, Collin College.

I hope you can use this document to make lasting change for hundreds of thousands of students in the future.

Ann Beheler, PhD
Principal Investigator
IT Skill Standards 2020 and Beyond

INTRODUCTION AND OVERVIEW

Why are skill standards important?

1. Skill standards **provide a blueprint** for how the technical knowledge and skills in high-performance workplaces are organized and how the roles of workers contribute to the success of the enterprise.

2. Skill standards **make careers more accessible to students and employers** because they provide transparency regarding the tasks, knowledge, skills, and abilities (KSA+Ts) as well as the performance specifics needed for success in the job market.

3. Business and Industry want to hire **students who can integrate products**, not just one-vendor experts. This often means understanding foundational skills rather than vendor interfaces.

Who uses skill standards?

Educators use skill standards to create curriculum that is relevant, current, and future-facing to better prepare students to meet employers' job requirements. **Employers** use skill standards to improve communications about job openings so they hire the most qualified candidates to address both current and emerging needs. Employers can also use skill standards to improve their internal training and development.

How does one develop skill standards?

The skill standards process described in this manual has been updated and finalized by the "IT Skill Standards 2020 and Beyond" (ITSS) National Science Foundation project grant. Note that ITSS built on previous work done by the Northwest Center for Emerging Technologies (2003), the Skills Standards Board (early 2000s), and the Convergence Technology Center's Business and Industry Leadership Team (BILT) model (2011-2023).

This skill standards process can be used for **any technical discipline** to create new programs or modify existing programs to make them more current and aligned with what businesses want in entry-level new hires for the future. Note, however, that the full skill standards process is not recommended for defining skills for emerging technologies and/or fields whose skills have not yet reached even broad concurrence among business representatives nationally.

Creating skill standards requires more steps than the typical BILT, which provides results that are more comprehensive than what a typical business advisory council delivers. The work of ITSS is powered by best practices of the BILT, which was developed by the National Science Foundation-funded National Convergence Technology Center and uses a structured, repeatable process to put employers in a co-leadership role and ensure curriculum aligns with industry needs. See the next page for an illustration of the BILT annual cycle. Learn more by downloading the "Implementing the BILT Model of Business Engagement" PDF: https://tiny.cc/BILTlegacy. Note also that the ITSS process can be considered a "BILT-plus" approach in that it creates additional skill standard resources (key performance indicators, employability skills, and student learning outcomes) beyond the KSA+Ts that a traditional, "original recipe" BILT develops.
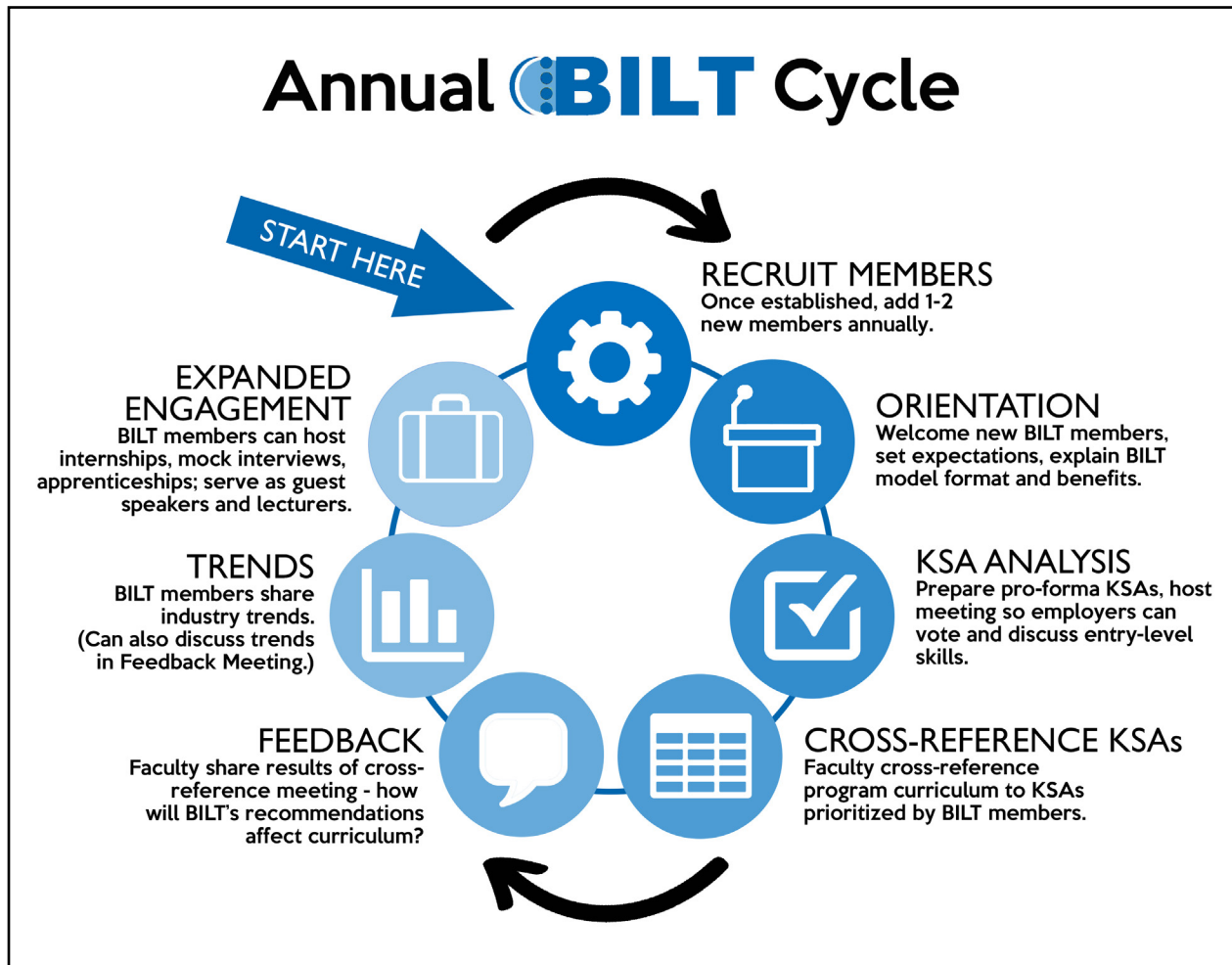
Figure 1: BILT annual cycle.

This manual will explain how to develop four specific skill standard products:

Employer Subject Matter Experts (SMEs) create:
KSA+Ts with numerical averages of prioritized votes.

Technical Project Management Tasks and KSAs		
Tasks SPECIFIC THINGS an entry level person would BE EXPECTED TO PERFORM on the job WITH LITTLE SUPERVISION.		
Project Plan		Avg
T-1	Follow project plans, including defining scope and time requirements.	2.9
T-2	Identify information technology project resource requirements.	3.2
T-3	Follow guidelines for system implementation.	2.2
T-4	Perform needs analysis to determine opportunities for new and improved business process solutions, and participate in determining opportunities for new and improved business process solutions.	2.5

Figure 2: Excerpt from sample finalized Tasks and KSA table.

Key Performance Indicators (KPIs) for Tasks.

Technical Project Management Key Performance Indicators		
For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with		
	Task	**Key Performance Indicators**
Project Plan		
T-1	Follow project plans, including defining scope and time requirements.	Criteria for satisfying stakeholder needs are identified. The size and the specifics of the project are documented accurately and completely. Appropriate stakeholders and decision-makers are identified in a timely manner. Tasks requiring long lead times are identified to avoid project delays. Escalation procedures are clearly identified and agreed upon. Detailed task list is developed (work breakdown structures). Time requirements are realistic and accommodate the time for the management approved process. Estimates of time, materials, and capabilities needed are accurately identified. Activities dependent upon other activities are sequenced appropriately.
T-2	Identify information technology project resource requirements.	
T-3	Follow guidelines for system implementation.	
T-4	Identify interdependencies.	
T-5	Analyze data to identify trends or relationships among variables.	
T-6	Contribute contingency plans regarding project risks.	
T-7	Provide input on project costs, design concepts, or design changes.	
T-8	Verify that appropriate Service-Level Agreements (SLAs) and underpinning contracts have been defined that clearly set out for the customer a description of the service and the measures for monitoring the service.	Approval points, milestones, and go/no go decision points are defined to allow for project review, evaluation, postponement, and cancellation. Task priorities are assigned. The constraints and potential conflicts are accurately identified.

Figure 3: Excerpt from sample finalized KPI table.

Levels of Key Employability Skills.

Technical Project Management Employability Skills	
Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers. Level 2 - Employee demonstrates commitment, enthusiasm and supports team members. Employee follows up on assigned tasks and leads by example.

Figure 4: Excerpt from sample finalized Employability Skills table.

Educator SMEs (building on the Employer SME work) create:
Student Learning Outcomes to help create/update curriculum.

Technical Project Management Student Learning Outcomes	
Knowledge	**Student Learning Outcomes**
K-15 — Knowledge of standard operating procedures regarding project plan evaluation, resource allocation and availability, as well as project reviews and changes.	Define the systems view of project management, share how it applies to information technology (IT) projects, and discuss key elements of the project management framework, including project stakeholders, standard operating procedures, common tools and techniques, and project success.
K-6 — Knowledge of resource management principles and techniques.	
K-9 — Knowledge of the organization's enterprise information technology (IT) goals and objectives.	
K-23 — Knowledge of project management terminology (specifically definitions and roles of Product Manager, team roles, stakeholders, Program Manager and Project Manager).	
K-24 — Knowledge of project management frameworks and principles.	
K-7 — Knowledge of business and management principles involved in strategic planning, resource allocation, coordination of human resources modeling, leadership technique, production methods, and coordination of people and resources.	Articulate and explain the management principles involved in strategic planning, resource allocation, and leadership techniques along with demonstrating a solid understanding of business operations in project management contexts.
K-8 — Knowledge of system life cycle management principles, including software security and usability.	Demonstrate the use of waterfall and agile methodologies (Scrum framework) in designing a system life cycle project, including software security and usability.
K-19 — Knowledge of agile methodologies (iterative/adoptive).	
K-20 — Knowledge of waterfall methodology.	
K-21 — Knowledge of the elements of a Scrum board and how they operate.	
K-2 — Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	Identify and mitigate technical risks through proactive risk management strategies and contingency planning.
K-5 — Knowledge of Risk Management Framework (RMF).	
K-13 — Knowledge of risk/threat assessment.	
K-3 — Knowledge of benchmarking.	Discuss different project management software and planning tools, including tracking, milestones, and the importance of documentation.
K-12 — Knowledge of project management software and planning tools, including tracking and milestones.	
K-22 — Knowledge of documentation mechanisms and procedures.	

Figure 5: Excerpt from sample finalized SLOs table.

The ITSS project developed skill standards at a national level; it convened SMEs from across the country to look at multiple in-demand IT job clusters (groups of similar jobs). Some of the steps that were important for this national skill standards work will not be relevant for more regional/local skill standards work looking at a single technical discipline.

Below are the skill standard process steps that help identify and validate skills needed by businesses for entry-level employees in a specific discipline. This manual will work through these seven steps one by one.

Step 1: Identify Leadership and Personnel.
Step 2: Gather Labor Market Demand Data.
Step 3: Convene Thought Leaders >>This step is only for creating skills standards on a national level.
Step 4: Job Cluster SME Meetings.
Step 5: Verification SME Meeting.
Step 6: Student Learning Outcomes.
Step 7: Mapping to Curriculum >>This step is only for local college application.

STEP 1: IDENTIFY LEADERSHIP AND PERSONNEL

First define the roles and responsibilities for each person involved in the skill standards process. Note that some roles below may be combined and performed by a single person. An initial planning meeting can help define responsibilities.

All time commitments below are based on ITSS' unique national scope. Regional efforts likely won't require as much time.

Responsibilities and Roles

Lead - This person has the skills of a project manager and experience facilitating discussions. It is helpful but not required for this person to be a subject matter expert (SME).

• Time commitment – approximately 40 or more hours per cluster to plan and prepare in addition to attending and managing the Job Cluster SME meetings.
• Guides the work for the Job Cluster.
• Often recruits Employer SMEs from business and industry to participate along with others for the college.
• Compiles the pro forma list of Tasks, Knowledge, Skills, and Abilities (KSA+Ts).
• Leads the Employer SME meetings (includes Thought Leader meetings, Job Cluster meetings, and Verification meetings) and sticks to the timeframe.
• This work can be handled by three different people if needed (e.g., a facilitator, a SME recruiter, and a pro forma KSA+T creator/compiler).

Skill Standards Coordinator – This person provides invaluable administrative and logistical support to the skill standard process.

• Time commitment - approximately 100 to 200 hours per cluster.
• Schedules both internal planning and SME meetings.
• Sends out meeting invitations, reminders, and other messages to Employer and Educator SMEs, tracks attendance and participation.
• Creates electronic KSA+T voting forms from the pro forma KSA+T list.
• Coordinates the synthesis and creation of key skill standard output products.
• Helps the Lead create the pro forma list of KSA+Ts.
• Annotates the KSA+Ts vote spreadsheet in real time to capture changes and comments (not to replace any web meeting recording transcripts) made by the Employer SMEs.

Employability Skills Lead – This person coordinates the effort in creating the employability skills product. "Employability skills" are defined as the non-technical skills that Employer SMEs see as necessary for an entry-level employee. These skills are sometimes called "soft skills" or "professional skills." An example of employability skills can be found on page 25. Note that some use the Abilities (As of KSA+Ts) for employability skills as an alternative.

- Time commitment – approximately 40 hours initially per cluster in addition to attending and participating in the Job Cluster SME meetings.
- Creates and finalizes employability skills list.
- Explains the employability skills concept and the voting process at the Job Cluster SME meetings.

Key Performance Indicator (KPI) Lead – KPIs are also known as Key Performance Criteria. This person coordinates the effort in creating the KPI skill standards product. "KPIs" help answer the question "How do we know when a task is performed well enough?" These are employer-led, qualified definitions of the key desired outcomes for job tasks (not knowledge, skills, or abilities). An example of KPIs can be found on page 29.

- Time commitment – approximately 20-40 hours per cluster in addition to attending and participating in the Job Cluster SME meetings.
- Coordinates the creation of the key performance indicators (KPI).

Note that KPIs were required by the State of Texas and may not be necessary for all skill standard projects. KPIs are typically not needed for a single college's purpose.

Student Learning Outcomes (SLO) Lead – This person coordinates the effort in creating the SLO skill standards product. "SLOs" are statements that specify what students will know, be able to do, or be able to demonstrate when they have completed or participated in a course. SLOs align with the knowledge, skills, and abilities in the prioritized KSA+Ts. An example of SLOs can be found on page 32.

- Time commitment – approximately 8 hours per cluster in addition to attending and participating at least in the Job Cluster SME meetings for which SLOs are being created.
- Coordinates the creation of student learning outcomes based on the KSA+Ts (which have been prioritized by Employer SMEs).
- Note that the ITSS grant paid two educators for eight hours of work to develop national SLOs per cluster to ensure agreement.

Employer Subject Matter Experts (SMEs) – These are employers familiar with KSA+Ts expected of entry-level new hires in a specific job cluster. SMEs are expected to look 12-36 months into the future when evaluating and prioritizing skill standards.

- Time commitment – approximately 5 hours per cluster attending and participating in the Job Cluster SME and Verification meetings.
- Determines the most important KSA+Ts for the job and shares that insight through prioritized voting and discussions.
- Provides examples on how these KSA+Ts can be used on the job.
- Verifies the Key Performance Indicators (KPIs) and the combined KSA+Ts (both metrics and combined discussion) if there are multiple Job Cluster SME meetings.

Educator Subject Matter Experts (SMEs) – These are faculty members who teach the content in a specific job cluster.

- Time commitment – approximately 5 hours per cluster attending, participating in the Job Cluster SME meetings, and adapting the SLOs. Time for creating a new program varies and is usually more.

- Attends Job Cluster SME meetings as "active listeners."
- Provides feedback on existing programs as needed regarding what (and how) knowledge and skills are already taught.
- Performs curriculum mapping as described in Step 7 "Mapping to Curriculum." This process is sometimes also called the "gap analysis."
- Updates curriculum (labs, lectures, slides, etc.) as appropriate to align with prioritized KSA+Ts and other skill standard products to ensure students are learning what the workforce needs them to know.

STEP 2: GATHER LABOR MARKET DEMAND DATA

Labor market data can obviously help determine potential new fields of study and employment in the college's service area. Labor market data can also support an existing program by helping determine if that program is still viable. More specifically, if that existing program is still growing and evolving, it may need changes to curriculum and instruction to keep it aligned with workforce needs.

This step is typically completed by the Skill Standards Coordinator with assistance by the Lead.

Gather data on Labor Market Demand for hardest-to-fill jobs. (A report like this can be downloaded from a labor market analytic company like Lightcast - https://lightcast.io/. Lightcast was formed by the merger of EMSI and Burning Glass. Note that these companies often require a paid subscription.) Before creating a new program or updating an existing program, examine labor market data to support the time dedicated to updating curriculum. Labor Market data may also be obtained from local Chambers of Commerce, Workforce Commissions, and other such organizations. Local or regional data is mandatory for local college justification.

If a college wants to consider updating a group of programs based on labor market data, pick the top 10-15 hard-to-fill jobs for which to gather more information. Factors to consider are growth, job postings, and the percentage of job postings remaining unfilled at the end of the past six months.

An example of this kind of information can be found below – slides like this were developed by ITSS staff based on the raw data provided by the labor market research company. These slides were presented at the Thought Leader meetings to spark discussion. Examples of raw data provided by labor market analytics companies (which was used in making the slide below) can be found in **Appendix A.**
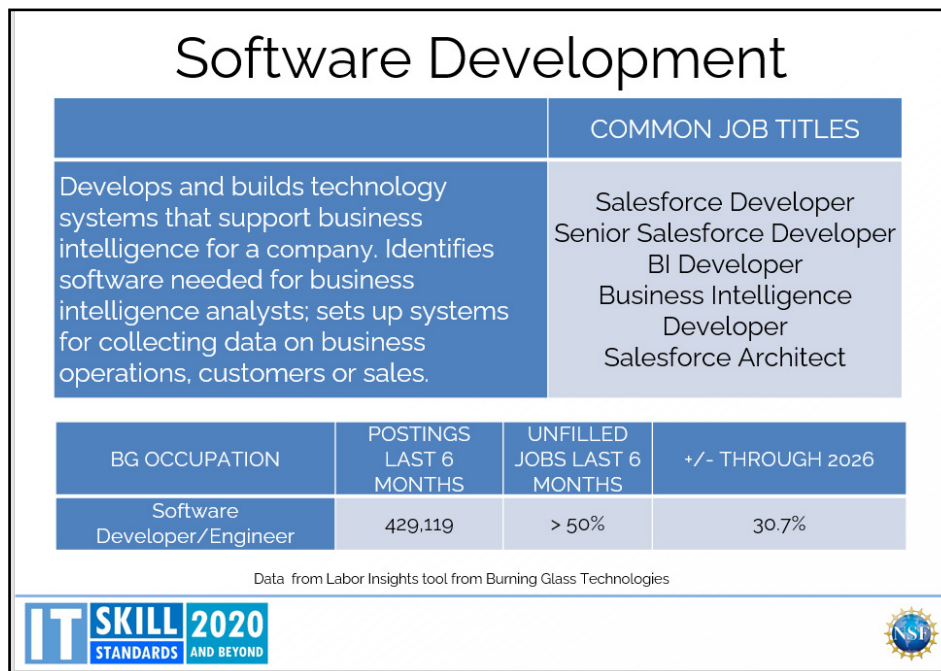

Figure 6: Sample slide for Thought Leader meeting (job posting data).

This information is useful to

- Help college administrators justify creating a new degree and/or new curriculum.
- Determine which businesses are hiring in the area and may be having trouble finding qualified candidates.
- Provide a starting point for Thought Leaders (as described in Step 3 "Convene Thought Leaders").

STEP 3: CONVENE THOUGHT LEADERS

"Thought Leaders" are national or regional leaders who provide big picture perspectives. Thought Leaders are typically CTOs, CIOs, CISOs, or other visionary individuals responsible for "seeing the future" to keep their companies in business. Across several meetings, using labor market data collected in Step 2 "Gather Labor Market Demand Data," Thought Leaders help identify the most critical and difficult-to-fill job clusters for the future. Skill standard staff members (Skill Standards Coordinator and Lead) synthesize the results of those meetings and manage the verification process.

This step is needed only for projects with larger scopes (e.g., the ITSS project needed help identifying the most in-demand job clusters in all of IT nationwide).

If focusing on a single regional discipline or program, skip this process and go from Step 2 "Gather Labor Market Demand Data" to Step 4 "Job Cluster SME Meetings" below.

Thought Leader meetings are used to identify job clusters to be considered for national or regional skills standards. Because of their experience, expertise, and standing in their chosen field, they should have a good idea of trends in the industry, how a job cluster has changed over time, and an understanding of the direction the field is going.

Preparing for the Thought Leader Meeting

- Determine what type of meeting is needed. There are two kinds:
    - Identification Meeting – In this meeting, Thought Leaders will be asked to help identify the job cluster areas to be covered. As mentioned, information gathered on labor market data can be used to help better inform the Thought Leaders and fuel their discussion.
    - Clarification Meeting – This is a follow-up to the Identification Meeting seeking clarification and asking questions on anything the Thought Leaders recommended in the Identification Meeting(s). This meeting is optional and may not be required if no clarification is needed.
- Identify the ideal characteristics of the individuals wanted. Remember members of this team should be operating at a high technical level in their company.
    - C-suite Executive with technical knowledge.
    - A person in charge of keeping the company ahead of the competition.
- Choose dates for the meetings.
    - It is essential to hold multiple meetings to obtain broader input. Some Thought Leaders will be available only at certain times of days or certain day(s) of the week. Try to get on their calendar as soon as possible. The more advance notice provided, the more likely it is that they will be able to commit.
    - Keep the attendance for each meeting capped at 20-25 to make it easier to handle the discussion and to ensure that everyone has an opportunity to provide input.
- Create an elevator/value pitch - How will you persuade people to attend your meetings?
    - Stay mindful of the "WIIFM." What is in it for them?
    - Be clear on time commitment. Typically, Identification meetings to establish the clusters can take 2 hours, while the Clarification Meetings can run 1-1.5 hours.
    - Always focus on the impact on students and the future workforce.

Recruiting the Thought Leaders

- These resources are a good place to start with Thought Leader recruitment:
    - Personal contacts - Always start with employers you know. Ask them to recommend other employers. "Network with your network."
    - Industry associations – Associations have large groups of members they can connect with.
    - Posts on social media or websites – Posting on social media platforms like LinkedIn can connect you to other employers.
    - On LinkedIn, search for possible Thought Leaders using keywords and send recruitment messages. (Request a LinkedIn Premium subscription so you can message people to whom you're not already connected.)
- Send personalized emails – Mail merge is a great way to send a large number of personalized emails simultaneously.
    - Do not use "BCC" mass emails; it reduces the chances of emails being received.
    - Also be aware that the firewall at some companies filters out Constant Contact-style marketing emails.
    - Provide meeting registration links in the email.
    - See **Appendix D** for recruiting samples.
- Create a follow-up schedule – An email follow-up should be sent out about one to two weeks after the original recruitment email to those who have not responded. A phone call follow-up is also a good idea. The goal is to get a yes/no answer from everyone.
- Send calendar appointments (e.g., Outlook) to those who have registered via your online RSVP link.

Planning Meeting Logistics

Note that many of these meeting logistics are the same as described in Step 4 "Job Cluster SME Meetings." This duplication is intentional.

- Identify a facilitator host – This should be someone with facilitation skills who can guide participatory discussion, but redirect when the discussion gets off track. This is usually the Lead.
- Choose dates for the meetings. It is often helpful to hold multiple meetings to ensure that at least one viable meeting date and time exists for the Employer SMEs identified to participate. Cap the attendance for each meeting at 20-25 to allow for participation and feedback from as many businesses as possible. Be sure to allow attendees plenty of time to provide verbal input.
- Create a registration form – use free apps like Google.
    - Registration must require information like name, email, and company.
    - Also be sure to ask some variation of "Can we use your name, company, industry in publications?" so their participation can be publicized later.
- Send calendar appointments (e.g., Outlook) to those who have registered to get the meeting on their calendar.
    - Phone those who have not responded and extend the invitation again. This phone call can happen about a week after the invitation goes out.
    - One week in advance of the meeting, email a reminder again to everyone who's RSVPd and to those who have not yet responded. That is, everyone gets a reminder except those who have declined to attend.
- Remind again one day prior to the meeting: email a reminder to everyone who's RSVPd and to those

who have not yet responded. Include the meeting agenda and directions on how to participate (campus map for in-person meetings, web log-in details for virtual meetings).
- Create a PowerPoint deck to help explain the purpose and process of the work and to share any labor market data collected as described in Step 2 "Gather Labor Market Demand Data."
- Facilitator prepares questions to encourage discussion.
- Arrange web meeting logistics (e.g., Zoom, WebEx, Teams). If hosting this meeting in person, be sure to also provide a web element for those who need to participate remotely.
- Identify one additional person to take notes as a supplement to the web meeting recording. This extra person can also monitor the "Chat" and make sure those online voices are "heard" during the meeting by interjecting when appropriate and reading the messages. (If the meeting is 100% in-person, two people may be needed to take notes.)

Hosting the Meeting

All Thought Leader meetings are virtual meetings. Because these leaders are dispersed across the country, this is a convenient way to meet and allows business representatives to participate from any location. Be sure to keep in mind time zone differences when picking a meeting time.

- Launch the web meeting 15 minutes earlier than the meeting's scheduled start time.
- Have a welcome slide on the screen and play some soft music in the background. This helps participants know their equipment is working because they can hear the music versus complete silence.
- Start the meeting promptly at the scheduled time. (Stay aware of the clock; never take more time than asked for.)
- The host introduces himself/herself and runs through the slide presentation to explain the purpose of the meeting and set the stage.
- Share labor market data (see **Appendix A** for the raw data provided by labor market analytics companies) and allow plenty of time at each slide to open the discussion with the employers.
- Use the exact same data in each meeting; do not sway any of the discussion with changes offered by one individual.
- Provide contact information in case someone thinks of something after the meeting.

Wrapping the Meeting

- Synthesize the meeting minutes from all meetings to identify areas of consensus.
- Take those synthesized findings and turn them into an online voting form using Google. This voting will confirm that what was said in the meetings was accurately captured. For example, if 10 items were presented but only six items dominated the Thought Leader discussion, the vote would focus on details of just those six.
- Send the synthesis voting form out to those who attended the Thought Leader meetings as verification that what they said was captured. Note that it's possible consensus will take more than one survey, much as how a Delphi study is conducted. Learn more here: https://en.wikipedia.org/wiki/Delphi_method.
- Send a follow-up email to let them know what was done with the information they provided.
- A final "synthesis" meeting may need to be scheduled (1-1.5 hours) to discuss the results of the survey and ask the Thought Leaders any final clarifying questions.

STEP 4: JOB CLUSTER SME MEETINGS

Once job cluster information has been gathered and analyzed through Step 2 "Gather Labor Market Demand Data" and/or Step 3 "Convene Thought Leaders," the next step is to convene a KSA+T analysis meeting with Employer subject matter expert (SMEs) representatives for each job cluster for which you are seeking to identify KSA+Ts.

As mentioned, the work of ITSS is powered by best practices of the Business and Industry Leadership Team ("BILT") model, which was developed by the National Science Foundation-funded National Convergence Technology Center and uses a structured, repeatable process to put employers in a co-leadership role and ensure curriculum aligns with industry needs. See page 4 for an illustration of the BILT annual cycle. Learn more by downloading the "Implementing the BILT Model of Business Engagement" PDF: https://tiny.cc/BILTlegacy.

The ITSS process can be considered a "BILT-plus" approach in that it develops additional skill standard resources beyond the KSAs that a traditional, "original recipe" BILT develops.

Preparing for Job Cluster SME Meetings

- Choose dates for the meetings. It is often helpful to hold multiple meetings to ensure that at least one viable meeting date and time exists for the Employer SMEs identified to participate. Cap the attendance for each meeting at 20-25 to allow for participation and feedback from as many businesses as possible. Ensure attendees have plenty of time to provide verbal input. Note that a single meeting is sufficient if work is for one college or even for one discipline in a region.
- Ensure a non-biased facilitator – typically the Lead – is available to help run the meetings.
- Create the "pro forma list." Never start with a blank wall. Employer SMEs need to have a list from which to work. This "pro forma" list of KSA+Ts represents a "best guess" at the competencies required for right-skilled graduates 12-36 months into the future. Do not assume you know what employers want in graduates. Limit the total number of items to 100-150. For new programs, this may be mostly a list of knowledge areas. To develop this list...
    - Talk to trusted Employer SMEs.
    - Read contemporary articles about program areas.
    - Look for industry certifications that might include job skill categories or competencies.
    - Research lists from industry associations.
    - Identify similar programs at other colleges and review their course outcomes.
    - Consult resources like Career One-Stop (https://www.careeronestop.org/) or U.S. Bureau of Labor Statistics (https://www.bls.gov/). However, this data is not future-facing.
- If multiple sources are used for the "pro forma" list, be sure to remove duplicate items. The format of each pro forma item should reflect the KSA+T "category." That is, for example, all the Ks should begin "Knowledge of" and all the Ss should begin "Skill in."
- Convert that final "pro forma list" into a KSA+Ts list that will later be converted into an electronic voting form. For more information on setting up the voting form (including screenshot examples), see **Appendix B.** This voting form is what Employer SMEs will use to prioritize the individual items. Be sure to test the form prior to the meeting. Results of that form will automatically populate a spreadsheet that will display the vote results in real time.

Tasks, Knowledge, Skills and Abilities (KSA+Ts) are developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

Task: Specific things an entry level person would be expected to perform on the job with little supervision.

Knowledge: Knowledge focuses on the understanding of concepts. It is theoretical. An individual may understand a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.

Skills: The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course on investing in financial futures, and therefore has knowledge of it. But getting experience in trading these instruments adds skills.

Abilities: Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.

- The image below shows the KSA+T spreadsheet following the vote – note the vote tally columns D, E, F, and G (showing the number of votes cast for "1" through "4") and then KSA+T average in column H.

B	C	D	E	F	G	H
Infrastructure, Connectivty, Management and Engineering Job Cluster		**# votes (4 = most important)**				
		4	3	2	1	Avg
T-1	Configure network, routers, and switches (e.g., higher-level protocols, tunneling).	6	4	1	0	3.45
T-2	Diagnose network connectivity problem.	4	6	1	0	3.27
T-3	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware) which would include patch network vulnerabilities to safeguard information.	6	5	0	0	3.55
T-4	Install or replace network, routers, and switches.	8	2	1	0	3.64
T-22	Troubleshoot hardware/software interface and interoperability problems.	3	5	2	1	2.91
K-75	Knowledge of Auto Scaling and Load Balancing.	3	5	3	0	3.00
K-76	Knowledge of the differences between Cloud vs. On-Premises.	9	2	0	0	3.82
K-77	Knowledge in preparing and deploying a cloud database solution that meets application requirements.	0	5	3	2	2.30
K-78	Knowledge of database management systems, query languages, table relationships, and views.	1	4	3	3	2.27
K-79	Knowledge of Azure.	3	7	1	0	3.18
K-80	Knowledge of AWS.	3	8	0	0	3.27

Figure 7: Excerpt from sample Tasks and KSA voting spreadsheet during an SME meeting.

- Create an explanatory PowerPoint orientation for Employer SMEs: https://bit.ly/BILTorientation. This presentation will introduce the voting process to them and share the vision for the work.
  - Explain the purpose of the project and why it matters.
  - Provide directions for the voting, which includes explaining that Employer SMEs have the chance to ask questions to clarify the purpose of the votes and process.
- Develop the Employability Skills table.
  - The Employability Skills Lead convenes a committee of up to three people from business and industry who have an understanding and/or experience with the types of employability skills that are used by entry-level employees.
  - Locate existing verified employability skills from places like…
    - Association of American College and Universities.
    - NSF ATE IT skill standards projects.
    - State organizations like the Washington State Board for Community and Technical Colleges or the Texas Skill Standards Board.
- This employability skills committee – led by the Employability Skills Lead – will select those most relevant skills for the skills standard being developed and create a draft of employability skills.
- Proficiency ratings (e.g., Beginning, Intermediate, and Advanced levels) for the employability skills need to be specified for each level.
- Recruit people to review and verify the employability skills draft, then convert that into an electronic voting form. See **Appendix C** for a sample survey.

Employability skills are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic; Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

Recruiting Employers for Job Cluster SME Meetings

- Identify the ideal characteristic of the Employer SMEs wanted to attend. All must be technical experts in the specific job cluster.
  - High-level technical executives who are responsible for keeping their companies competitive – In general, recruit those who have a "future focus" to help identify job skills needs 12-36 months from now.
  - First-line hiring managers.
  - The best "current" technicians are often those who recently graduated from your college in a similar program because they can bridge communication between educators and employers.
  - If Thought Leaders participated as mentioned in Step 3 above, note that those people can also serve as Job Cluster SMEs.
  - Human resource executives are not ideal because their information is often second-hand from the technicians and managers.
- Compile a list of Employer SME prospects.
  - Target companies who are representative of those who hire your graduates.
  - Strive for different sizes and types of companies so results are broadly applicable.

- Where to find new members:
  - Research which companies are hiring in your region.
  - Get referrals from those you know (i.e., current employer council members).
  - LinkedIn connections.
  - Community organizations like Chambers of Commerce, Economic Development Corporations, workforce boards, or trade associations.
- Create a registration form – use free programs like Google Forms.
  - Registration must require information like name, email, and company.
  - Also be sure to ask some variation of "Can we use your name, company, industry in publications?" so their participation can publicized later.
- Develop a sales/value pitch – this can be a written letter or a verbal "elevator pitch."
  - How will you entice people to attend your meetings?
  - Understand their "WIIFM" – "What is it in for me?" This varies by individual, but most employers want a wider pipeline of qualified future job candidates.
  - Be clear on time commitment. This process is quite efficient and can be accomplished in no more than 5-7 hours.
  - "Elevator pitches" are short in-person value propositions. Keep them 4-5 sentences long. Elevator pitches should cover these elements:
    - Your program.
    - Why Employer SMEs are needed and why they need your program.
    - What they need to do and how long it will take.
    - Potential WIIFM for them.
    - Next steps – what they need to do to participate.
  - Before making your pitch, brainstorm possible objections and proactively develop responses to be better prepared.
  - Customize your pitch for each prospect.
  - Example of a written invitation script and verbal elevator pitch for employers can be found in **Appendix D.**
- Deliver sales pitch to prospects – Personalized e-mails (or old-fashioned stamped and mailed letters) work, but nothing works better than picking up the phone, especially if it's a new contact.
    - Mail merge is a great way to send a large number of personalized emails simultaneously.
    - How to perform a mail merge: https://support.microsoft.com/en-us/office/video-mail-merge-507b5468-f771-485d-9ef0-27857168a266#:~:text=On%20the%20MAILINGS%20tab%2C%20click,select%20Use%20the%20current%20document
    - Avoid using BCC; it reduces the chances of emails being received.
    - Be aware that Constant Contact-style mass messages are sometimes filtered out by a company's firewall/spam filter.
  - Create a follow-up schedule and stick to it – An email follow-up should be sent out 1-2 weeks after the original email to those who have not responded. It is also good to follow up with a phone call as well. Do not assume that an email got through to the prospect and was read.
- Note that sales pitches may need to be delivered to internal and external college stakeholders as well. This effort may require recruiting people other than Employer SMEs.

Invitation Follow-Ups

- Send calendar appointments (e.g., Outlook) to those who have registered to get the meeting on their calendar.

- Phone those who have not responded and extend the invitation again. This phone call can happen about a week after the invitation goes out.
- One week in advance of the meeting, email a reminder again to everyone who's RSVPd and to those who have not yet responded. That is, everyone gets a reminder except those who have declined to attend. In this reminder, include the meeting agenda and directions on how to participate (campus map for in-person meetings, web log-in details for virtual meetings).
- Do the same thing one day prior to the meeting: email a reminder to everyone who's RSVPd and to those who have not yet responded.

Hosting Job Cluster SME Meetings

- Logistics – Hybrid meetings are ideal allowing Employer SMEs to be flexible; they can attend in person or join online.
    - Verify AV capabilities well in advance (e.g., screens, sound system and microphones, web-sharing platform like Zoom, wireless internet access).
    - Have the employers sit in a U-shaped table arrangement; this provides a physical set up where they can more easily interact with each other. Print table tents and/or name tags so everyone knows who everyone is.
    - Employers meeting in person typically arrive about 15 minutes before the start time, so be ready early.
    - Have coffee and water available throughout the meeting.
    - If the meeting will be running more than three hours, provide a nice meal.
    - For reference, everyone in the room gets a printed copy of the KSA+T spreadsheet; those joining online get a copy emailed to them.
    - To help the Lead manage the meeting, prepare a reference list of employers expected to be on the phone and place it in a prominent location. This list helps the Lead to remember to proactively involve those attending virtually.
    - Prepare a sign-in sheet to track who attended.
    - Project the spreadsheet content to the meeting room's screen (and screenshare on the web meeting platform) so everyone's looking at the same results.

Figure 8: Two employers networking during a break at a Job Cluster SME meeting.

Figure 9: Employers sit in a U-shape during a Job Cluster SME meeting.

- Meeting Roles
    - As described in "Step 1: Identify Leadership and Personnel" –
        - Lead - Process expert responsible for efficiency and effectiveness of meeting.

- Skill Standards Coordinator – Manages meeting logistics and captures BILT/SME comments on the spreadsheet in real-time.
- Employer SMEs - Participate in ratings and discussion.
- Employability Skills Lead - Leads the discussion on employability skills.
- Educator SMEs - Attend as active listeners.
- Meeting Start
    - Launch the online meeting platform 15 minutes early.
- Typical "agenda and flow" of an Job Cluster SME Meeting.
    - Welcome from the specific program lead as well as their supervisor (or above as well).
    - Brief self-introductions of everyone in the room and on the web meeting.
    - Brief explanation of the BILT approach and how to vote.
    - Share the voting link (and QR code) and allow time to vote.
    - Discussion is the bulk of the meeting – be sure to ask Employer SMEs for items to be added to the KSA+T list (i.e., "what's missing?").
    - General Q&A.
    - Next steps.
    - Schedule the next meeting to provide feedback to SMEs to explain what has been done with their recommendations.
    - Adjournment (end on time, even if not finished).
- KSA+T Vote and Discussion – Both elements are equally important. Do not conduct a vote without the follow-up discussion.
    - VOTE
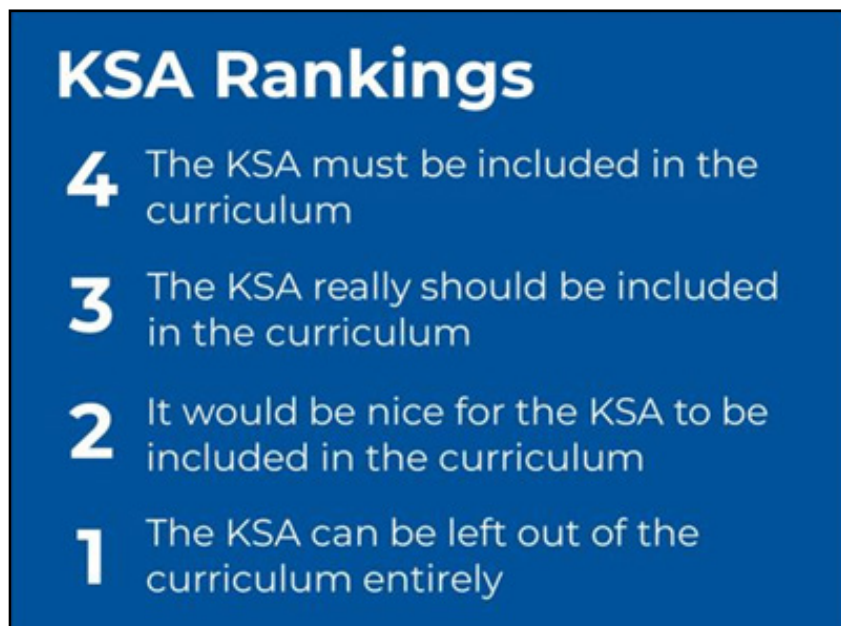   - Explain the 1-4 voting scale and how it works. See the graphic below.

Figure 10: Explanation of the 1-4 Tasks and KSA vote rankings.

- Consensus is not the goal of the vote.
- Allow about 20-25 minutes for voting during the meeting. This is especially important for Employer SMEs new to the process.
- BILT members/SMEs vote electronically on each item regarding importance for curriculum.

- Prioritized results are automatically tabulated and must be displayed for purposes of discussion in the room and for virtual attendees.
- DISCUSS
  - After the vote, go through the KSA+T spreadsheet one "screen" at a time. (See an example in **Appendix E**.) Synchronous discussion is **extremely important**.
  - Discussion is often spurred by…
    - Items with a vote average below 2.60. Items under the 2.6 average are typically cut. That cutoff amount can be adjusted – see **Appendix B**.
    - Items with votes that are split (i.e., several 1s and several 4s).
    - Items that interest the Employer SMEs.
  - The Skill Standards Coordinator amends the document in real time with changes requested and agreed upon by the employers. Employer SMEs may add, subtract, or modify items on the list through discussion.
  - Capture the meeting content by using a webinar recording platform and/or assigning someone the task of taking minutes. The discussion is also captured via those real-time edits to the KSA+T spreadsheet.
  - Consider assigning someone to monitor the chat window in the online platform. The facilitator (Lead) cannot effectively monitor and respond to the chat and also guide the discussion.
  - At the end of the KSA+T discussion, ask employers what is missing from the list. Those notes go at the bottom of the KSA+T spreadsheet. See below for an example of how additional notes are captured.

A-5	Ability to write technical documentation for technical and nontechnical audiences.	6	7	5	1	2.95
A-6	Ability to manage your own software development project activities and deliverables in a timely and efficient manner.	10	9	0	0	3.53
A-7	Ability to work on team projects and demonstrate critical thinking, teamwork, oral communications, inter-cultural appreciation, and technical and information literacy skills.	17	2	0	0	3.89
A-8	Ability to research and be able to find other sources to answer the problem.	15	3	1	0	3.74
A-9	Ability to engage with users and understand their user experience.	8	10	0	1	3.32
A-10	Ability to draw on prior knowledge and experience in a new situation.	14	5	0	0	3.74
	What is missing					
	knowledege about 3-4 architectures when to use them as why, you could cover patterns as we					
	Database, relational or no SQL or graph					
	data analysis, ETL (knowledge)					
	Should know SQL					
	Relational databases concepts					
	Big O knoweldge - algorithims					
	basic problem solving- scientific method					
	Solid prinicipals					
	Clean code					
	API					
	Response Codes					
	Web services: REST/SOAP- API/Integration Development					

Figure 11: Excerpt from sample Tasks and KSA spreadsheet during an SME meeting showing the "What's Missing" comments.

- Employability Skills – This follows the KSA+T vote and discussion. Employability skills are non-technical skills that employers see as necessary for an entry-level employee. At a high level, employability skills can include communication, troubleshooting, problem solving, and teamwork. These skills are broken down into levels of ability to perform and/or master.
    - This project used eleven specific employability skills spread across three "competency" categories. See the table below.
    - Employer SMEs use the voting form to vote on the level of proficiency that they expect of a person who have held an entry-level position for six months to one year.
    - Each level is described by a statement of what the employability skill would look like if performed at a Level 1 "Beginner," Level 2 "Intermediate," or Level 3 "Advanced."

Workplace Competencies	Academic Competencies	Personal Effectiveness Competencies
Cultural Competence	Written Communication	Initiative
Teamwork	Oral Communication	Self and Career Development
Organization and Planning	Problem Solving & Critical Thinking	Adapability & Flexibility
Accuracy		
Workplace Professionalism & Work Ethics		

Figure 12: Three competency categories of employability skills.

- See below for a sample list and level of Employability Skills.

Technical Project Management Employability Skills	
Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.

Figure 13: Excerpt from sample finalized Employability Skills table.

Wrapping Up the Job Cluster SME Meetings

- This step also serves as the preparation for the Step 5 "Verification SME" meeting.
- If hosting multiple Job Cluster SME Meetings, then combine the meeting content to find the average for all votes cast across all of the meetings. Otherwise, if there was only one meeting then that is the final KSA+T spreadsheet.
- Identify those noteworthy new KSA+T elements mentioned by the Employer SMEs after the regular vote. This will include reviewing the meeting minutes in addition to the KSA+T spreadsheet notes.
- Ideally, more than one person looks for these noteworthy elements have at least two pairs of eyes. This minimizes the possibility that something gets overlooked.
- Specifically, looking for...
    - Any items that were drastically reworded by the Employer SMEs.
    - Any "what's missing" items that two or more Employer SMEs mentioned (that includes one SME mentioning it and another agreeing).

STEP 5: VERIFICATION SME MEETING

This meeting is used to verify information that has been gathered in Step 4 "Job Cluster SME Meetings" and also collect feedback from Employer SMEs on Key Performance Indicators (if your program requires these; programs for a single college often do not need this step).

Preparing for the Verification Meeting

- Meeting prep.
    - The format and set-up is very similar to the KSA+T Job Cluster meeting described in Step 4 "Job Cluster SME Meetings."
    - Invite only those Employer SMEs who participated in the Job Cluster SME Meetings; do not invite any employers who did not attend.
    - Only one meeting is needed – which makes the invite process go easier. But it is imperative to have a representative sample of the SMEs who originally voted on the KSA+Ts.
- Create the KSA+T Verification voting form. Develop this form based solely on the noteworthy items identified at the end of the Step 4 "Job Cluster SME Meetings." Remember to only look at…
    - Any items that were drastically reworded by the Employer SMEs.
    - Any "what's missing" items that two or more Employer SMEs mentioned (that includes one SME mentioning it and another agreeing).
- The voting form logistics follow the same steps described in Step 4 "Job Cluster SME Meetings."
    - See below for an example of the Verification survey. Note that it's not seeking feedback for all KSA+T items, but rather a handful of specific items that were raised after the vote.
    - The goal is to allow the Employer SMEs to verify the changed items, "what's new" items and make any final changes as needed. Some skill standard projects won't need this step. This step is needed if there are multiple meetings and/or there were a lot of post-vote discussions that significantly added new or changed existing KSA+T elements.

Figure 14: Excerpt from Verification Meeting survey form.

- Create the Key Performance Indicators (KPIs) List. Note that KPIs are also called Key Performance Criteria when working with skill standards.
    - The KPI Lead converts the employer-approved tasks into "performance criteria statements" that address how to measure whether each task was correctly and thoroughly completed.
    - As mentioned, this step was required by the State of Texas and may not be necessary for all skill standard projects. In fact, it's typically not needed for a single college's purposes. Employer-approved tasks are often sufficient to develop curriculum. Note again that tasks do not correlate to SLOs; tasks are used to develop KPIs only. SLOs are developed from knowledge, skills, and abilities.

> **Key Performance Indicators** answer the question, "How do we know when a task is performed well?" Put another way, "how good is good enough?" and "how do we know when a task is performed well?" for a group of related tasks.

- Characteristics of KPIs.
    - KPIs should be concrete and measurable.
    - Avoid writing KPIs that are merely instructions for carrying out a key activity.
    - The total set of KPIs associated with a given set of tasks should be comprehensive.
- Convert the KSA+T "Tasks" into KPIs - The process described below is a practical means for determining KPIs, not a definitive explanation.
    - Examine those tasks that remain highly prioritized after the voting.
    - Group these tasks together by work functions, such as tasks related to project planning.
    - The KPI "performance statements" can be developed from scratch in collaboration with industry experts using their best efforts to capture how the tasks can be correctly and thoroughly completed. Reference third-party resources, like the National Institute of Standards and Technology, to develop them. The Texas Skill Standards Board website contains a document entitled "Developing Skill Standards, a User's Guide." This document can be found at https://tssb.org/publications-2
    - The example below is from the Technical Project Management Cluster. Note that there is often not a 1:1 alignment between Tasks and KPIs; in the example below, five KPIs address three Tasks.
    - The Tasks column on the left comes from the verified, finalized KSA+T list, while the column on the right is the new KPI material created for the Tasks.

GROUPED TASKS (verified by employers via the KSA+T vote and discussion)	KPI PERFORMANCE STATEMENTS (how do you know that task was completed?)
Develop project plans, including defining scope and time requirements	• Criteria for satisfying stakeholder needs are identified • The size and specifics of the project are documented accurately and completely.
Develop guidelines for system implementation	• Tasks requiring long lead times are identified to avoid project delays.
Identify IT project resource requirements	• Estimates of time, materials, and capabilities are accurately identified. • Detailed task list is developed

Figure 15: Excerpt from sample worksheet for KPIs.

- Things to think about when creating KPIs:
  - Do the performance indicators accurately depict how you would know if these functions and activities were performed well enough?
  - Is the language used in the performance indicators clear, appropriate, and understandable?
  - Are there any aspects of competent performance that are missing?
- Creating KPIs is an iterative process that involves identifying function groups and assigning tasks to them, moving tasks between function groups, and revising the function groups as tasks are added or removed. The process is repeated until all tasks have been included in a grouping.
- It may not be possible to group all of the tasks. Some may need to be left separate from the others.
- Using a simple Excel file is sufficient for this work, with grouped tasks in the left column and corresponding KPI performance statements in the right column.
- Review and edit the KPI list for coherence, including sharing it with others to get their input for final revisions.
- Create Key Performance Indicator voting form.
  - This form allows employers to verify and prioritize the draft KPI statements. Keep in mind that the employers will have the opportunity to edit and delete the KPI statements.
  - Creating this voting form follows the same steps described in Step 4 "Job Cluster SME Meetings."
  - Below is an example of a finalized KPI list.

Technical Project Management Key Performance Indicators	
For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with	
Task	Key Performance Indicators
Project Plan	
T-1 Follow project plans, including defining scope and time requirements.	Criteria for satisfying stakeholder needs are identified.
T-2 Identify information technology project resource requirements.	The size and the specifics of the project are documented accurately and completely.
T-3 Follow guidelines for system implementation.	Appropriate stakeholders and decision-makers are identified in a timely manner.
T-4 Identify interdependencies.	Tasks requiring long lead times are identified to avoid project delays. Escalation procedures are clearly identified and agreed upon.
T-5 Analyze data to identify trends or relationships among variables.	Detailed task list is developed (work breakdown structures). Time requirements are realistic and accommodate the time for the

Figure 16: Excerpt from sample finalized KPI table.

Hosting the Verification Meeting

As mentioned, the goal is to allow the Employer SMEs a final chance to make changes or adjustments. Some skill standard projects won't require this step, and work for a single college usually will not require KPIs. This step is needed if there are multiple meetings and/or there were a lot of post-vote discussions that significantly added new or changed existing KSA+T elements.

- Verification meeting agenda.
  - Welcome the SMEs and explain the plan for the meeting.
  - If needed, employer SMEs use the electronic form to vote on the KSA+T verification list on a 1-4 scale just as they did at the original Job Cluster SME meeting. If there are no major changes or new items, then there is nothing to vote on and this step can be skipped.
  - Employer SMEs then discuss the vote results – the goal is to ensure they agree their feedback was heard and accurately captured.

- If KPIs were developed, use the same process – the employers vote (on a scale from 1-4), then discuss the results, paying close attention to any KPI that doesn't rate high. Be sure to allow the employers time to discuss any other KPIs of interest. Employers can modify, delete, or add to the KPI list. See below for an example of the final KPI voting tally spreadsheet.

Tasks	Key Performance Indicators	# votes (4 = most important)				
		4	3	2	1	Avg
Business Problem (Question) Framing						
T-1 Assist in obtaining or receiving problem statement and usability requirements.	Problem statement and usability requirements are obtained in a timely manner and properly documented.	3	4	0	0	3.43
T-2 Assist in determining if the problem is amenable to an analytics solution.	Determination of the applicability of an analytics solution is accurate. Business and analytics problem statements are clear, and are continuously refined.	5	2	0	0	3.71
Analytics Problem Framing						
T-3 Assist in reformulating the problem statement as an analytics problem. T-4 Assist in developing a proposed set of drivers and relationships to outputs.	The alternatives to the analytics problem statement are documented and ranked according to best match with current problem and rationale for choices is clearly stated.	1	2	4	0	2.57
T-5 Assist in stating the set of assumptions related to the problem.	Assumptions related to the problem are stated clearly and concisely.	4	2	1	0	3.43
T-6 Assist with collecting metrics and trending data.	Criteria for success are clearly identified.	5	2	0	0	3.71
T-7 Assist in obtaining stakeholder agreement on analytical approach.	Accurate and relevant analysis is provided regarding analytical approach.	3	4	0	0	3.43
Data						
T-8 Assist with identifying and providing background for data sources.	Sources and methods for acquiring data are efficient and information is accurate and complete.	4	3	0	0	3.57
T-9 Assist with assessing the validity of source data and subsequent findings.	Data is secured from reliable and respected sources.	4	2	1	0	3.43
T-10 Assist in acquiring data. T-11 Assist in harmonizing, rescaling, cleaning, and sharing data.	Data is correctly harmonized, rescaled, and cleaned and relationships in the data are correctly identified.	4	2	1	0	3.43
T-12 Assist with identifying relationships in the data. T-13 Assist with documenting and reporting findings (e.g., insights, results, business performance).	Findings are documented in accordance with company procedures and communicated in a clear and timely manner.	2	3	1	1	2.86
T-14 Assist with refining the business and analytics problem statements.	Data definitions are fully developed and agreed upon in accordance with company procedures.	6	1	0	0	3.86

Figure 17: Excerpt from sample KPI voting spreadsheet during an SME Verification Meeting.

STEP 6: STUDENT LEARNING OUTCOMES

Student Learning Outcomes (SLOs) specify what students will know, be able to do, or be able to demonstrate when they have completed or participated in a course. SLOs are aligned with the knowledge, skills, and abilities areas of the KSA+T spreadsheet (not the tasks). Faculty SMEs perform this work for the Ks, Ss, and As.

> **Student Learning Outcomes (SLOs)** are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

- Grouping the KSAs.
    - The KSAs are usually already grouped together by major topics. For SLOs, those groupings will need to be refined further to look for common measurable outcomes.
- Creating the SLO list.
    - Use Bloom's taxonomy's six levels of thinking to evaluate each group. Refer to this list from Vanderbilt University Center for Teaching, which is available through a Creative Commons Attribution license. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/
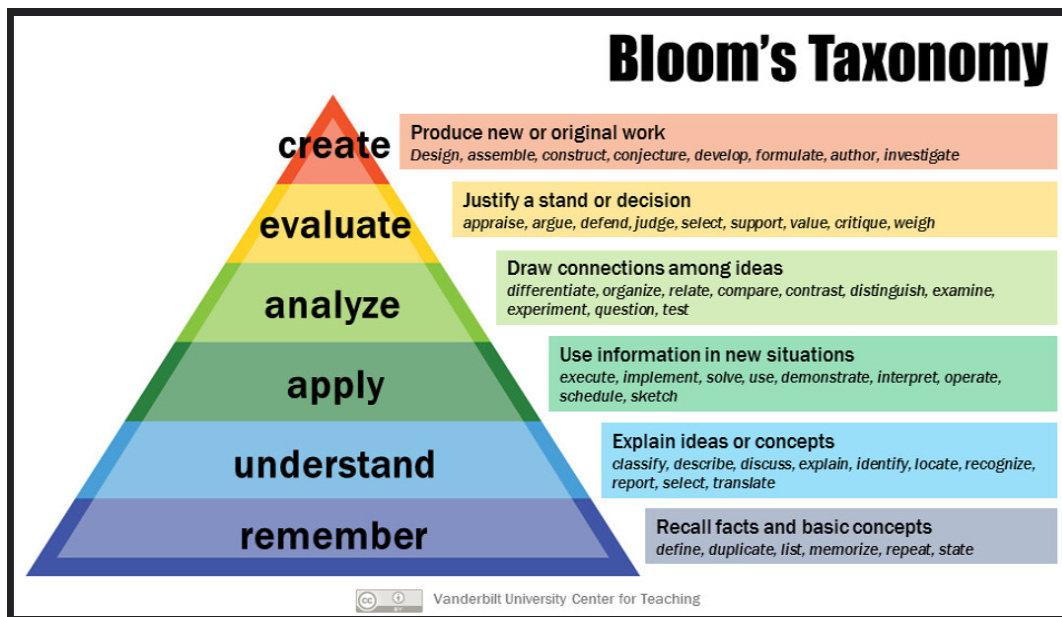
Figure 18: Bloom's Taxonomy Pyramid via Vanderbilt University Center for Teaching.

- Develop individual measurable SLOs using Bloom's taxonomy action verbs. SLO examples using action verbs:
    - Identify and describe common application security vulnerabilities.
    - Compare and contrast common open source frameworks and tools used for software development.
    - Develop a server page containing integrated object model components.
    - Demonstrate effective communication skills (both oral and written) when working with team members and stakeholders.

- Note that the Association for Computing Machinery created a list of action verbs for "computing disciplines," which can be viewed here: https://ccecc.acm.org/files/publications/Blooms-for-Computing-20230119.pdf
- Review and edit the SLO list for coherence. This includes sharing it with others to get their input for final revisions.
- Below is an example of a finalized SLO list. Note that there is a not a 1:1 match between SLOs and knowledge areas. Some SLOs cover multiple knowledge areas.

Technical Project Management Student Learning Outcomes		
	Knowledge	Student Learning Outcomes
K-15	Knowledge of standard operating procedures regarding project plan evaluation, resource allocation and availability, as well as project reviews and changes.	Define the systems view of project management, share how it applies to information technology (IT) projects, and discuss key elements of the project management framework, including project stakeholders, standard operating procedures, common tools and techniques, and project success.
K-6	Knowledge of resource management principles and techniques.	
K-9	Knowledge of the organization's enterprise information technology (IT) goals and objectives.	
K-23	Knowledge of project management terminology (specifically definitions and roles of Product Manager, team roles, stakeholders, Program Manager and Project Manager).	
K-24	Knowledge of project management frameworks and principles.	
K-7	Knowledge of business and management principles involved in strategic planning, resource allocation, coordination of human resources modeling, leadership technique, production methods, and coordination of people and resources.	Articulate and explain the management principles involved in strategic planning, resource allocation, and leadership techniques along with demonstrating a solid understanding of business operations in project management contexts.
K-8	Knowledge of system life cycle management principles, including software security and usability.	Demonstrate the use of waterfall and agile methodologies (Scrum framework) in designing a system life cycle project, including software security and usability.
K-19	Knowledge of agile methodologies (iterative/adoptive).	
K-20	Knowledge of waterfall methodology.	
K-21	Knowledge of the elements of a Scrum board and how they operate.	
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	Identify and mitigate technical risks through proactive risk management strategies and contingency planning.
K-5	Knowledge of Risk Management Framework (RMF).	
K-13	Knowledge of risk/threat assessment.	
K-3	Knowledge of benchmarking.	Discuss different project management software and planning tools, including tracking, milestones, and the importance of documentation.
K-12	Knowledge of project management software and planning tools, including tracking and milestones.	
K-22	Knowledge of documentation mechanisms and procedures.	

Figure 19: Excerpt from sample finalized SLOs table.

STEP 7: MAPPING TO CURRICULUM

Aside from creating SLOs, up to now, faculty involved in this process have participated mostly as "active listeners" in the Job Cluster and Verification meetings, allowing Employer SMEs to provide feedback without academic considerations (or pushback). Faculty can always provide clarity during these meetings if asked.

Mapping KSAs to curriculum will not apply to national efforts because there are no national curricula that all colleges use. To apply skill standards for a program at a single college, educators convene to determine where these skills need to be included into existing courses and determine if new modules or courses need to be developed.

This Faculty Cross-Reference meeting is sometimes also referred to as a "gap analysis" since the purpose is to identify possible gaps between what the Employer SMEs are seeking in new graduates and what a given program may be teaching.

Preparing for the Faculty Cross-Reference Meeting

- Invite as many faculty members as possible who are teaching in the program under consideration. All discipline faculty need to feel ownership of the process and outcome.
- Faculty determine together the "cutoff score" for items from the KSA list that are to be considered for coverage in courses based on the average and on the discussion in the Job Cluster meeting. That is, at what average vote will a KSA item be excluded from the curriculum? This is a subjective determination. For the ITSS grant, 2.6 was used as a baseline "cutoff." Items with an average of 2.6 or less turned pink on the spreadsheet to signal that the item likely wouldn't make it into curriculum. This 2.6 cutoff amount can be adjusted – see **Appendix B**.
- Prepare the "cross-reference spreadsheet." Using the prioritized KSAs from the BILT Job Cluster meeting, list the existing or planned courses in the credentials being considered across the top. This creates new cells faculty will use to categorize each KSA item by course. The far right "Es" column will help track which KSA items have only "exposure" coverage.
- Each KSA row that scored below the "cutoff" score is highlighted in pink.

Ks		Avg	Course A	Course B	Course C	Course D	Es
K-41	Knowledge of risks associated with storing various types of data in different physical locations.	2.64					
K-42	Knowledge of infrastructure data storage capabilities and storage clusters.	2.91					
K-43	Knowledge of IoT end devices and connectivity.	2.82					
K-44	Knowledge of Software Defined Networking concepts.	3.18					
K-45	Knowledge of database theory.	2.18					
K-46	Knowledge of Continuous Quality Improvement Principles (of particular value: Lean and Agile).	2.36					

Figure 20: Excerpt from sample Tasks and KSA voting spreadsheet with course columns added for faculty cross-reference.

Hosting the Cross-Reference Meeting

- Taking one course at a time, faculty determine if that course covers each of the highly prioritized KSAs at an Exposure (introductory) level or at a Thorough (full coverage) level, marking:
    - "E" for exposure coverage.
    - "T" for thorough coverage.
    - Blank for no coverage.

See below for an example.

Ks		Avg	Course A	Course B	Course C	Course D	Es
K-41	Knowledge of risks associated with storing various types of data in different physical locations.	2.64	E	E		E	
K-42	Knowledge of infrastructure data storage capabilities and storage clusters.	2.91				E	
K-43	Knowledge of IoT end devices and connectivity.	2.82	E	E		E	
K-44	Knowledge of Software Defined Networking concepts.	3.18			E		
K-45	Knowledge of database theory.	2.18					
K-46	Knowledge of Continuous Quality Improvement Principles (of particular value: Lean and Agile).	2.36				E	
K-47	Knowledge of how to balance organization goals with system architecture (i.e. know your business).	2.82	E	E			

Figure 21: Excerpt from sample Tasks and KSA voting spreadsheet with course columns filled in with Es and Ts.

- At the end of the mapping process, faculty will be able to see at a glance in which courses the KSAs are covered thoroughly (the green Ts), which are getting "exposure" only (red Es and yellow cells in the last column), and which have no coverage at all (empty cells all the way across).
- Faculty will next have to decide how to address those "gaps" – items that the Employer SMEs recommend but are not adequately covered in the current curriculum. This can mean supplementing existing curriculum (creating new labs, amending slides and lectures, etc.) or by creating a new course from scratch. Note that the number of new courses is expected to be large for a "new" program, though it is always a good idea to use existing courses as a starting point if possible.
- Create a "Program Summary Table" to track which courses cover which KSAs. In the example below, see how one school organized Welding courses (and their corresponding KSAs) into three certificates and one degree for presentation to their Employer SMEs in a feedback meeting.

KSAs	Plate Certificate	Plate & Pipe Certificate	Plate & Fab Certificate	Welding AAS
	K1, K2, K3, K4, K5, K6 S1, S2, S3, S4, S5, S6, S7, S8, S9, S12, S13, S19	K1, K2, K3, K4, K5, K6 S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S16, S18, S19, S20	K1, K2, K3, K4, K5, K6 S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20	K1, K2, K3, K4, K5, K6 S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20
Course Title				
Blueprint Reading	WELD 117	WELD 117	WELD 117	WELD 117
Plate Methods I	WELD 160	WELD 160	WELD 160	WELD 160
Plate Methods II	WELD 165	WELD 165	WELD 165	WELD 165
Pipe Methods I		WELD 270		WELD 270
Pipe Methods II		WELD 275		WELD 275

Figure 22: Excerpt from sample table mapping Tasks and KSAs to certificates and degrees.

Delivering Employer Feedback

It's essential to let Employer SMEs know what has been done with their recommendations. They need to feel heard and believe that you value their time and expertise. At the next Employer SME meeting:

- Share both of the charts – the cross-reference spreadsheet and the Program Summary Table.
- Show the Employer SMEs which Ks, Ss, and As are covered in each certificate and degree.
- Ask the Employer SMEs:
    - Is "Exposure" coverage enough for the items that show only "Exposure" coverage?
    - Do the items that have "NO" coverage truly belong in curriculum? (This is especially important if the item's average was close to the cutoff score).
    - For highly prioritized items that faculty could not cover, work with employer SMEs to determine a solution. Choices can range from seeking employer donations or loan of costly equipment to employers providing adjuncts for new courses to leaving the item out.
- Document feedback from the Employer SMEs during the meeting.
- Discuss and address as needed any of their concerns.

APPENDIX A
Examples of Raw Data Provided by Labor Market Analytic Companies

ITSS project staff downloaded reports like these to create job cluster slides as shown on page 13 for the Thought Leader meetings. These analytic companies offer countless ways of sorting their data (obtained by ITSS via a paid subscription with Lightcast - https://lightcast.io/). For ITSS, the data was sorted by education level and experience, by active job postings, by job salaries, by industry sector, by job skills, by skill clusters, and by state.
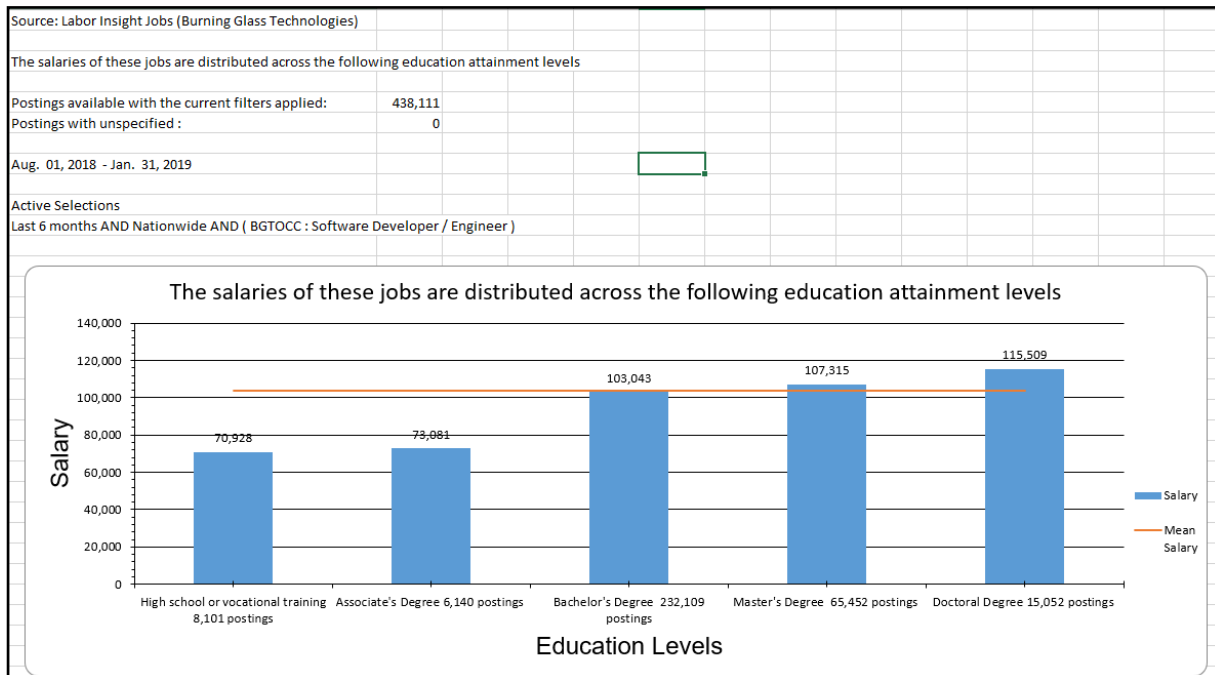
Figure 23: Labor market data sample - Job salaries and education levels.
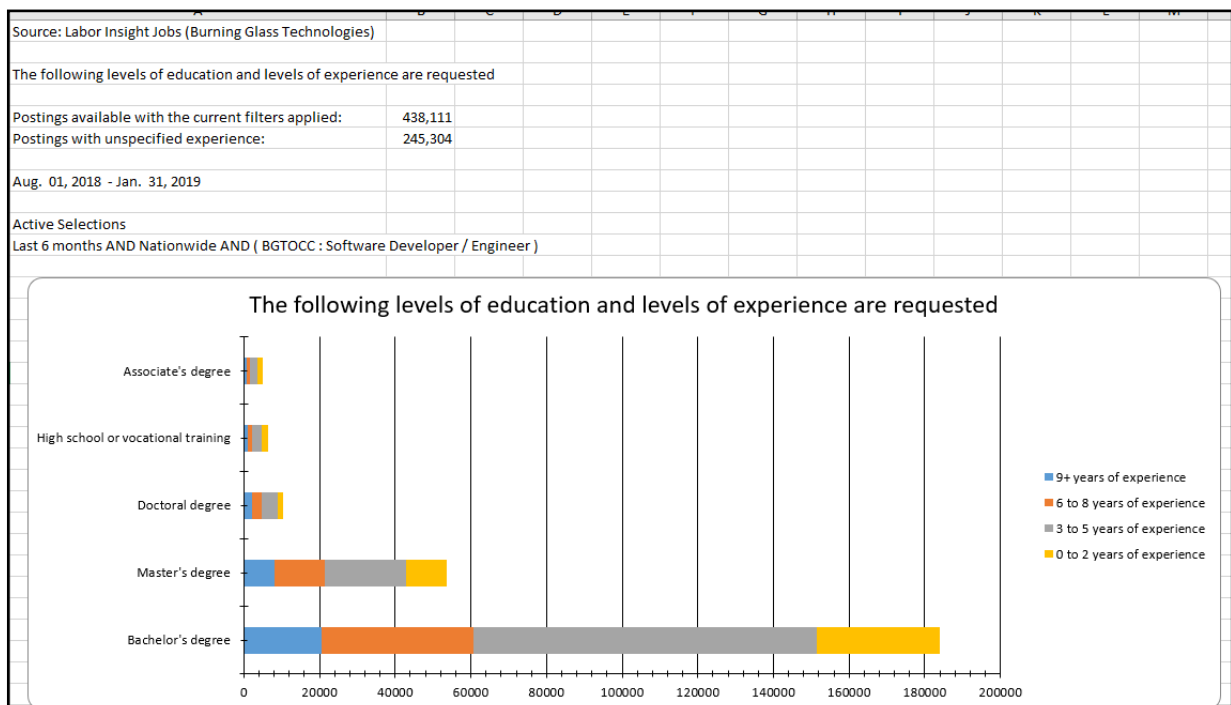
Figure 24: Labor market data sample - Education level and experience.

	Industry Sector code	Industry Sector	Job Postings
Source: Labor Insight Jobs (Burning Glass Technologies)			
The jobs are categorized into the following industries			
Postings available with the current filters applied:		438,111	
Postings with unspecified industry sector:		199,711	
Aug. 01, 2018 - Jan. 31, 2019			
Active Selections			
		Last 6 months AND Nationwide AND (BGTOCC : Software Developer / Engineer)	
	Industry Sector code	Industry Sector	Job Postings
	54	Professional, Scientific, and Technical Services	86,701
	56	Administrative and Support and Waste Management and Remediation Services	32,035
	52	Finance and Insurance	31,901
	31-33	Manufacturing	27,399
	51	Information	21,722
	44-45	Retail Trade	10,539
	62	Health Care and Social Assistance	5,669
	92	Public Administration	4,859
	61	Educational Services	4,229
	48-49	Transportation and Warehousing	3,124
	72	Accommodation and Food Services	2,396
	53	Real Estate and Rental and Leasing	1,930
	81	Other Services (except Public Administration)	1,222
	42	Wholesale Trade	1,162
	71	Arts, Entertainment, and Recreation	902
	23	Construction	747
	22	Utilities	633
	55	Management of Companies and Enterprises	522
	21	Mining, Quarrying, and Oil and Gas Extraction	505
	11	Agriculture, Forestry, Fishing and Hunting	203

Figure 25: Labor market data sample - Job postings by sector.

Skill Clusters	Job Postings
Source: Labor Insight Jobs (Burning Glass Technologies)	
The following skill clusters are most requested	
Postings available with the current filters applied:	438,111
Postings with unspecified skill clusters:	35,134
Aug. 01, 2018 - Jan. 31, 2019	
Active Selections	
	Last 6 months AND Nationwide AND (BGTOCC : Software Developer / Engineer)
Skill Clusters	Job Postings
Information Technology: Software Development Principles	259,568
Information Technology: Java	179,397
Information Technology: SQL Databases and Programming	164,614
Information Technology: JavaScript and jQuery	147,943
Information Technology: Web Development	115,465
Information Technology: Programming Principles	104,783
Information Technology: System Design and Implementation	104,321
Information Technology: Operating Systems	102,227
Information Technology: Scripting Languages	95,975
Information Technology: Microsoft Development Tools	94,213

Figure 26: Labor market data sample - Job postings by skill clusters.

The jobs are categorized into the following industries

Industry	Postings
Professional, Scientific, and Technical Services	86,701
Administrative and Support and Waste Management and Remediation Services	32,035
Finance and Insurance	31,901
Manufacturing	27,399
Information	21,722
Retail Trade	10,539
Health Care and Social Assistance	5,669
Public Administration	4,859
Educational Services	4,229
Transportation and Warehousing	3,124
Accommodation and Food Services	2,396
Real Estate and Rental and Leasing	1,930
Other Services (except Public Administration)	1,222
Wholesale Trade	1,162
Arts, Entertainment, and Recreation	902
Construction	747
Utilities	633
Management of Companies and Enterprises	522
Mining, Quarrying, and Oil and Gas Extraction	505
Agriculture, Forestry, Fishing and Hunting	203

Figure 27: Labor market data sample - Job postings by industry.

The following skill clusters are most requested

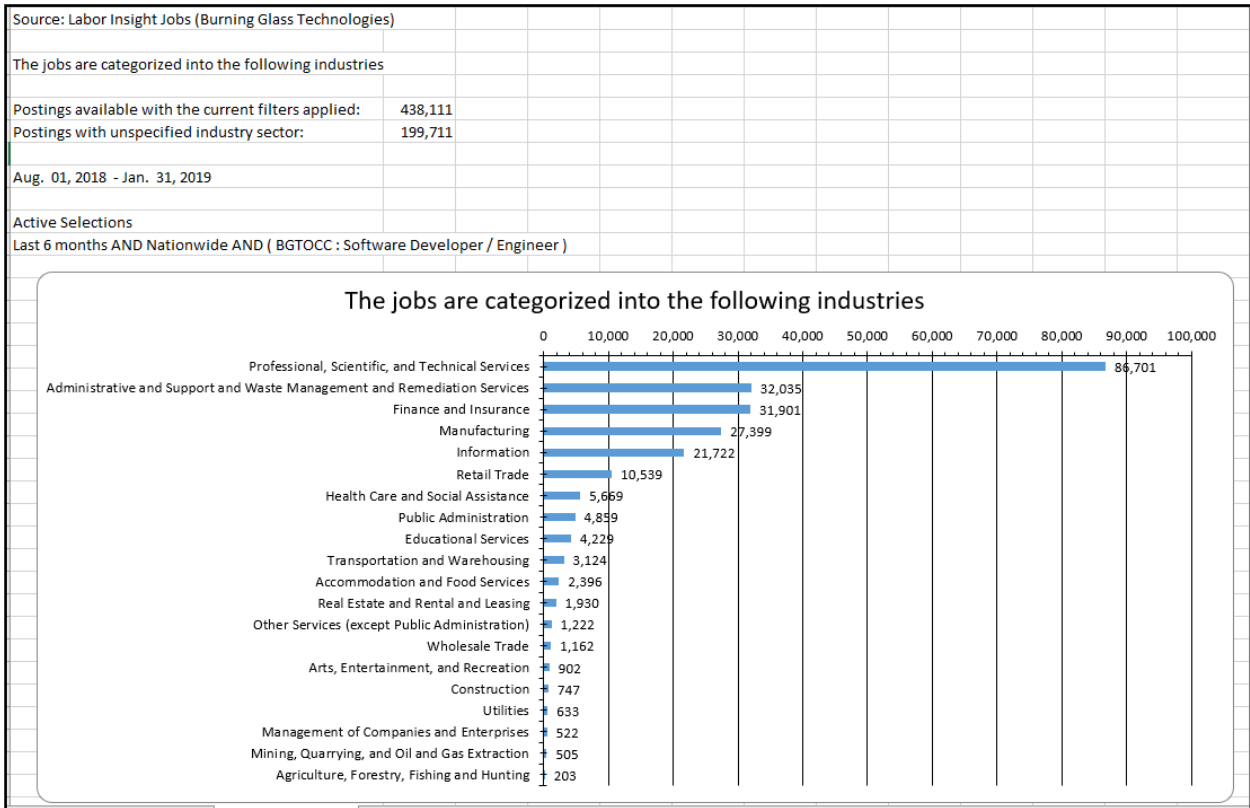| Skill cluster	Postings
Information Technology: Software Development Principles	259,568
Information Technology: Java	179,397
Information Technology: SQL Databases and Programming	164,614
Information Technology: JavaScript and jQuery	147,943
Information Technology: Web Development	115,465
Information Technology: Programming Principles	104,783
Information Technology: System Design and Implementation	104,321
Information Technology: Operating Systems	102,227
Information Technology: Scripting Languages	95,975
Information Technology: Microsoft Development Tools	94,213

Figure 28: Labor market data sample - Job postings by requested skill clusters.

		State	Job Postings
Source: Labor Insight Jobs (Burning Glass Technologies)		California	83,512
		Texas	38,380
The jobs are in the following locations		New York	27,674
		Virginia	22,924
Postings a 438,111		Florida	18,702
Postings v 624		Illinois	17,324
Aug. 01, 2018 - Jan. 31, 2019		Massachusetts	16,747
		North Carolina	16,564
Active Selections		Washington	16,098
Last 6 months AND Nationwide AND (BGTOCC : Software Developer / Engineer)		New Jersey	15,455
		Georgia	14,986
		Ohio	13,945
		Pennsylvania	13,184
		Colorado	12,340
		Michigan	11,352
		Maryland	10,938
		Arizona	9,924
		Minnesota	8,701
		Missouri	7,028
		District of Columbia	5,812
		Oregon	5,242
		Wisconsin	5,093
		Tennessee	4,734
		Connecticut	4,361
		Indiana	3,567
		Alabama	3,223
		Utah	3,171
		Iowa	3,141
		Nebraska	2,121
		Kentucky	2,015
		South Carolina	1,940
		Delaware	1,807

Figure 29: Labor market data sample - Job postings by state.

APPENDIX B
Creating the Electronic KSA+T Voting Form

This document will provide step-by-step directions to convert the KSA+T voting Excel spreadsheet into an online form that allows everyone in the room and online to vote virtually. This eliminates the need for time-consuming hand counts of the votes. This new online format still retains the familiar KSA+T voting format of 4, 3, 2, 1 (4 – Most Important, 1 – Least Important). Updated August 2023.

Companion video tutorial on YouTube (14 minutes): https://youtu.be/rVr65ycNlc8
Things you will need:

- A Google account.
- A list of KSA+Ts you gathered for your meeting.
- A "clear" web browser with no open tabs, as this process will open several new browser tabs. Do not close any of the tabs created by Google as you will need to access them during this process.
- Familiarity with basic Excel functions, formulas, and formatting.
- Time.

Categories covered:

I. Creating the Google Form that will collect the votes from your BILT members.
II. Linking the Google Form to the Google Sheet.
III. Formatting the Voting and Tabulation Functions.
IV. Testing the Form.

I. Creating the Google Form

Go back to Google Drive; to do so, go up to the tabs in your web browser. Reminder: do not close any of the tabs that Google has opened during this process.

In your web browser click on the "My Drive – Google Drive" tab:

Once there, you will click on the "+New" button on the Google Drive page. Select "Google Forms" if you do not see it listed select "More" and then select "Google Forms."
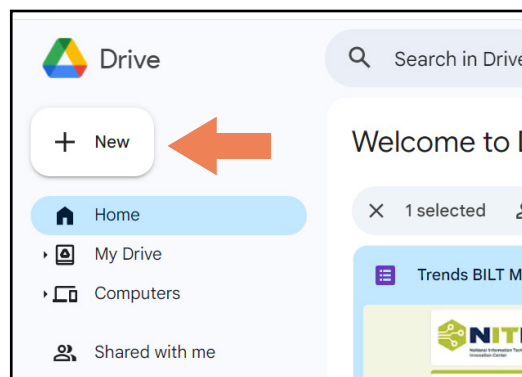

Figure 30: Selecting "New."
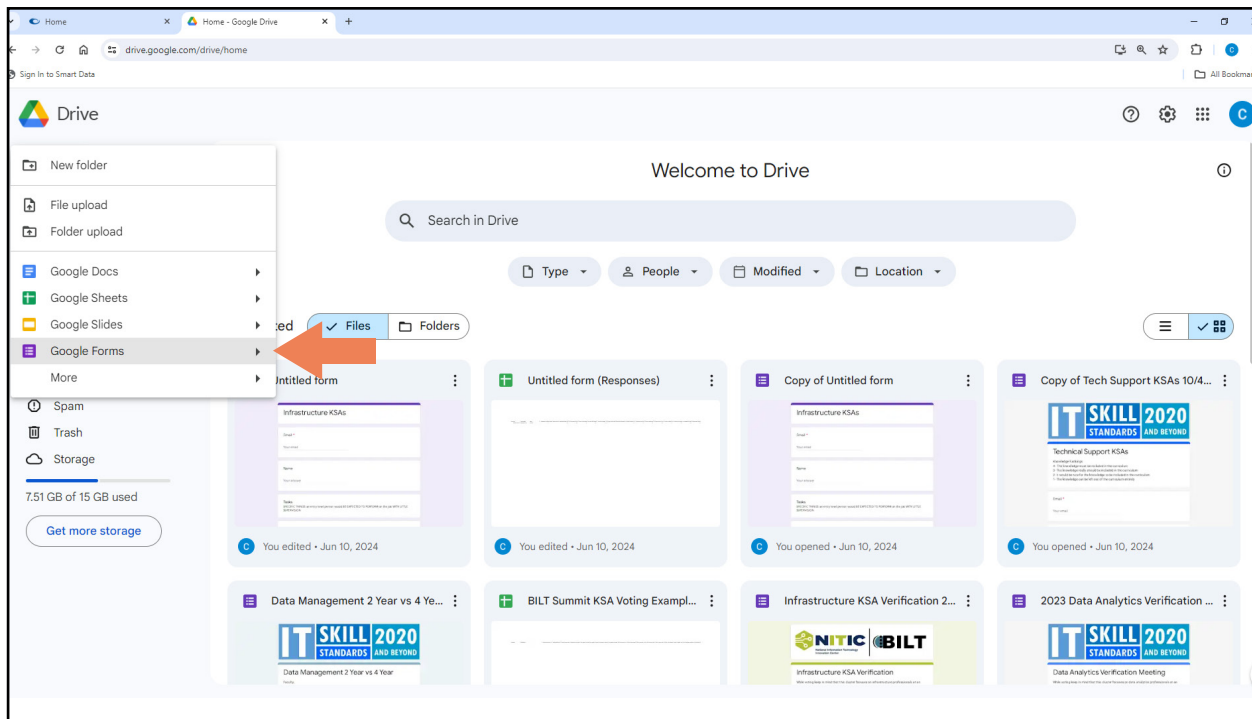
Figure 31: Selecting "Google Forms."

This is the "Untitled form" screen that will pop up:
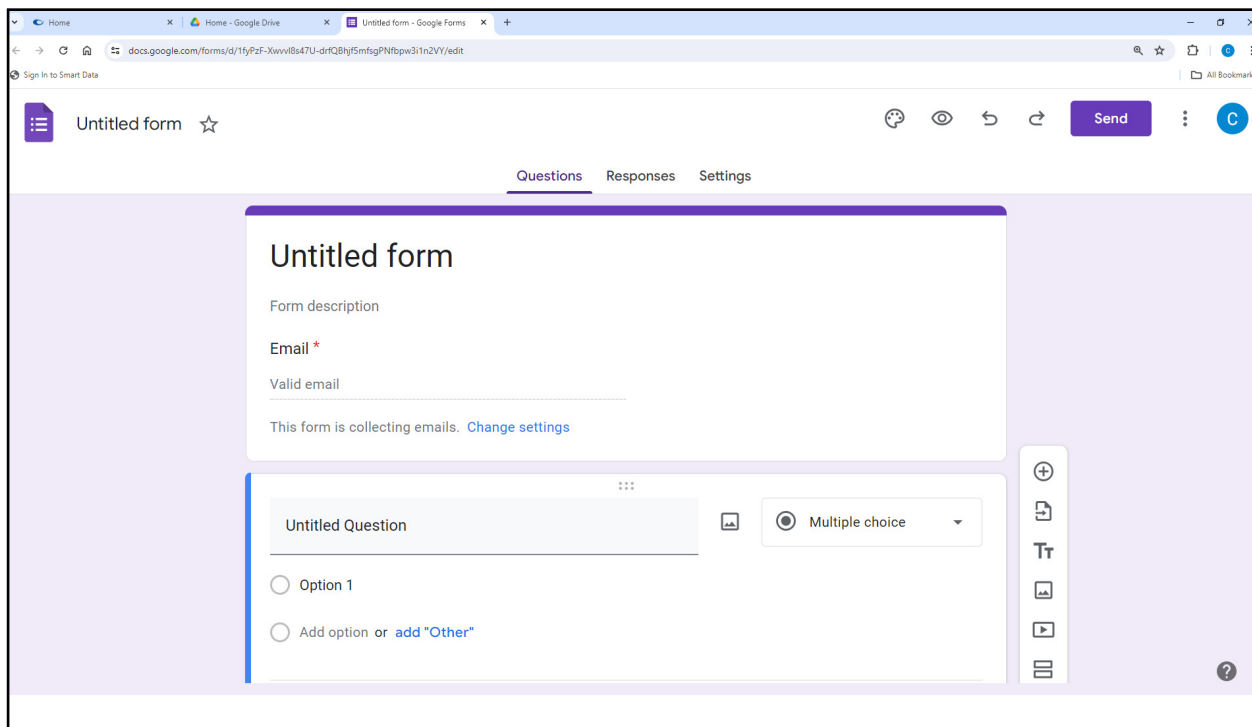
Figure 32: Google's untitled form.

Now you are ready to start building the form, question by question. Each KSA line item from your gathered list of KSA+Ts will become its own question on this Google Form.

There are three essential pieces that must be included in the Google form for the voting to work properly.

- Collect email address.
- Name (should be first question).
- KSA item numbering.

To direct Google to automatically send respondents a copy of their voting responses, follow these simple steps.

1. Go to the Google Form you will be using for voting.
2. Click on the "Settings" tab at the top of the screen.
3. The "Settings" menu will appear. Scroll down to the "Responses" section.
4. In that menu, under "Collect email addresses," select "Responder input" and under "Send responders a copy of their response," select "Always."

This setting change will **automatically e-mail your voters a copy of their voting responses**. Without this, BILT members may not remember their vote during the discussion.
Your changes to the "Settings" menu are saved automatically.
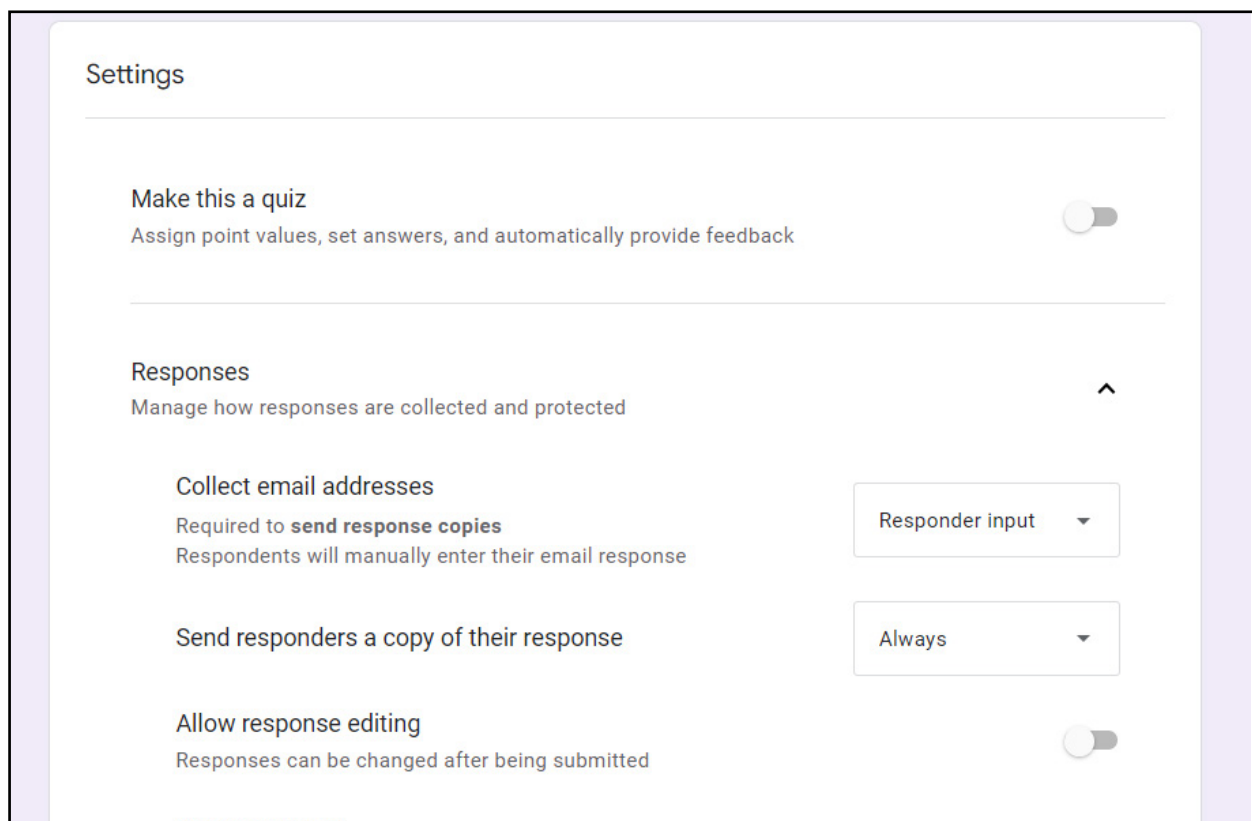
Figure 33: Google form settings.

Now that you have directed Google to collect email addresses, go back to the "Questions" tab and click on the words "Untitled Form" at the top of the form and rename the form by typing in the name of your survey (for example, "Infrastructure KSA+Ts"). Be sure you also change the overall document name to match – the document title is in the upper left corner next to the purple "Form" icon.

Now you are ready to start adding the second essential piece to your Google Form. There is a vertical toolbar with 6 icons on it. To add a question, you will click on the top icon in that list ⊕ . This will add a question below your survey title. In the question box that pops up, you will see a drop-down menu open up on the top right of the question box. To collect the respondents name you will want to click the down arrow and select "short answer" as the question type. Now on the right side of the question box in the line that says question type "Name".

In this form, the only required information is an email address (which you set up in the previous step using the "Setting" menu). You do not want to require answers as the BILT member may not want to provide a response for every item in the Google Form. Keep the "Required" toggle turned off.

Next, you will insert a section title. This is the third icon (double Ts) on the vertical toolbar next to your question (the blue arrow below shows which icon to click) in between your tasks, knowledge, skills and abilities sections. This will break up the form and help the respondent stay focused.

Along with the title you will also create a description to help define each of the four KSA sections.

- **Tasks** - Specific things an entry level person would be expected to perform on the job with little supervision.
- **Knowledge** - Focuses on the understanding of concepts. It is theoretical and not practical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it.
- **Skills** - The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course on investing in financial futures, and therefore has knowledge of it. But getting experience in trading these instruments adds skills.
- **Abilities** - Often confused with skills, yet there is a subtle but important difference. Abilities are the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade.

This is what your form should look like to this point. You have the survey title, the required email field, then an optional question for the respondent's name, and the first section heading with title and description.
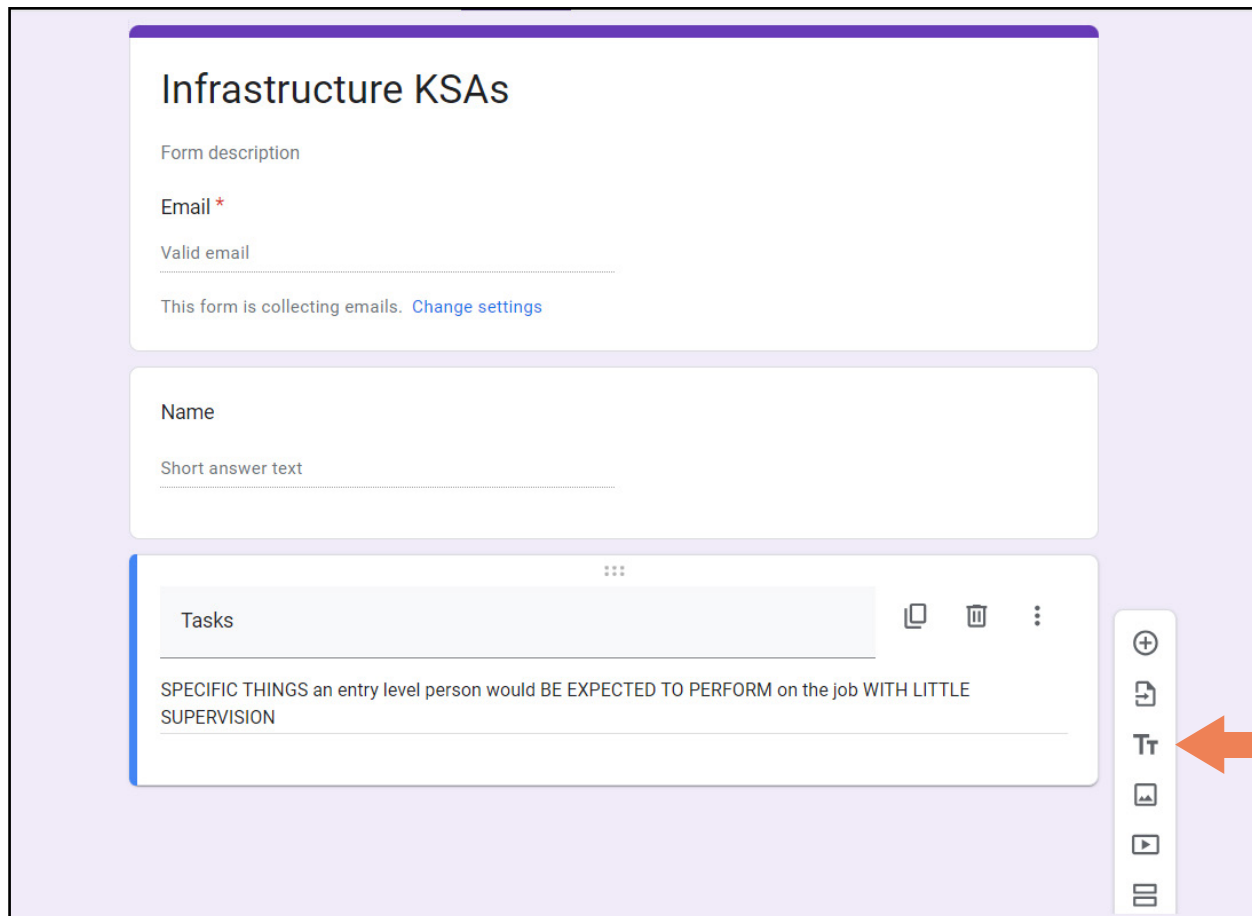
Figure 34: How your Google Form looks before adding questions.

Now we can move to the questions.

Each question for your KSA items will look like the question in the image below. Click the ⊕ icon again to add a question. Choose "Linear scale" for your question type. As mentioned, your scale will use the standard KSA voting format: 1 – 4 (1 – Least Important, 4 – Most Important). You may need to adjust the scale with the pull-down menus so the question offers only four choices. It is also important that you annotate your items with letter and numbers, T-task (example T-1); K-knowledge (example K-1); S-Skill (example S-1); A-ability (example A-1). <u>If you do not have this piece the voting formula will not work</u>. Keep the "Required" toggle turned off.

There is not a way to import the contents from your KSA list, unless you are pulling from a previously created survey. You will have to input each item on the list individually; you can either type them in or you can copy and paste it in from your collected list.

To add the next question simply click the plus-sign icon shown below by the red arrow to continue to build out your Google Form:
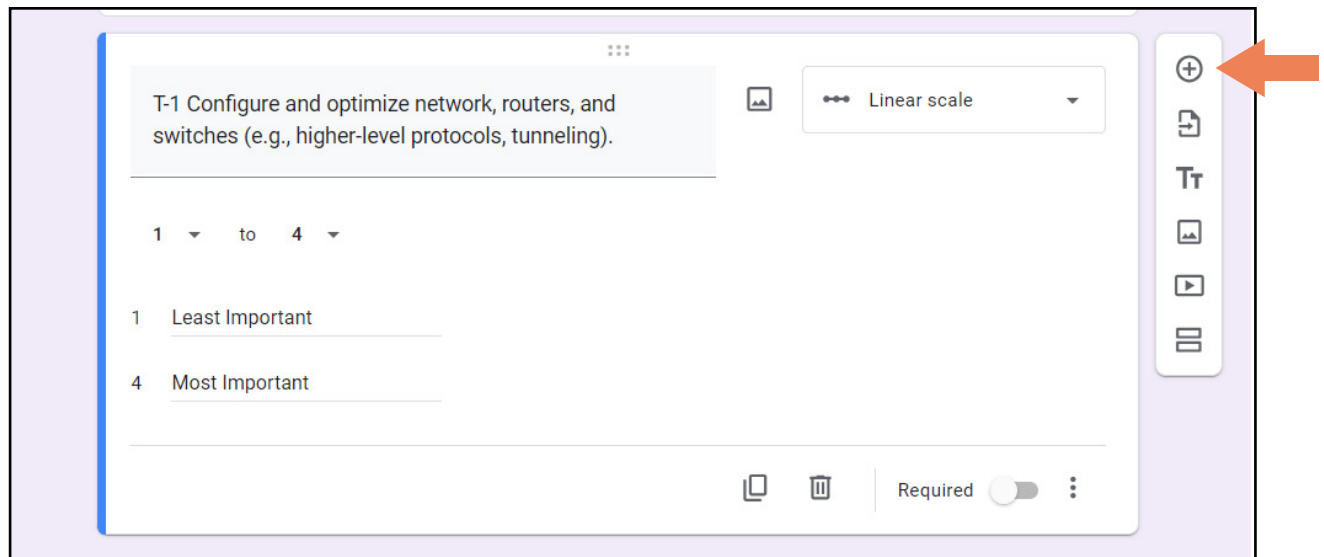
Figure 35: Creating the question answers via linear scale.

Note also that you can click on the 🗗 icon to duplicate at the bottom of the question window to duplicate the question, which can make this process go faster. All you'd have to do for the duplicate question is change the KSA description.

You can rename your form for easy finding in your Google Drive by clicking on "Untitled form" in top left corner of the tab. If you previously titled your survey, when you click on the "Untitled form" it will automatically update to the title you typed at the top of the form.

There are also ways to customize the form's style, including changing the colors and adding a logo. To make those adjustments, click on the painter's palette at the top right.

II. Linking the Google Form to the Google Sheet

Now it's time to connect the voting results of the Google Form to the Google Sheet.

Inside the Google Form page, click on the "Responses" tab in the Form menu header (it's to the right of the "Questions" tab you're working in now), then click on the three vertical dots. From there, click "Select response destination."
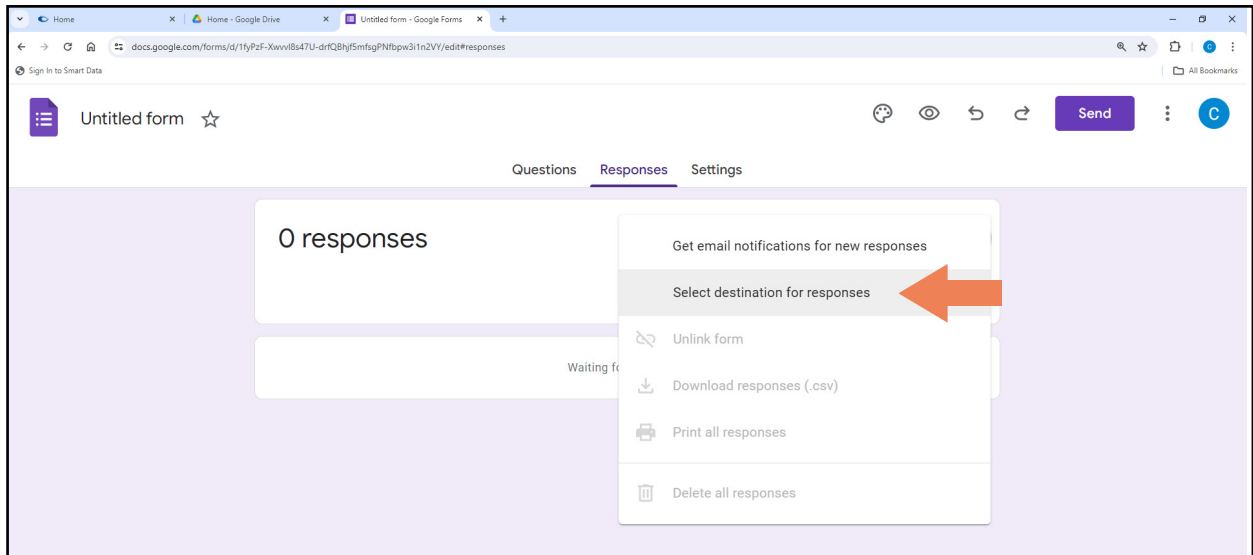
Figure 36: "Select response destination."

In the new "Select response destination" window click on "Create a new spreadsheet," then click "Create."
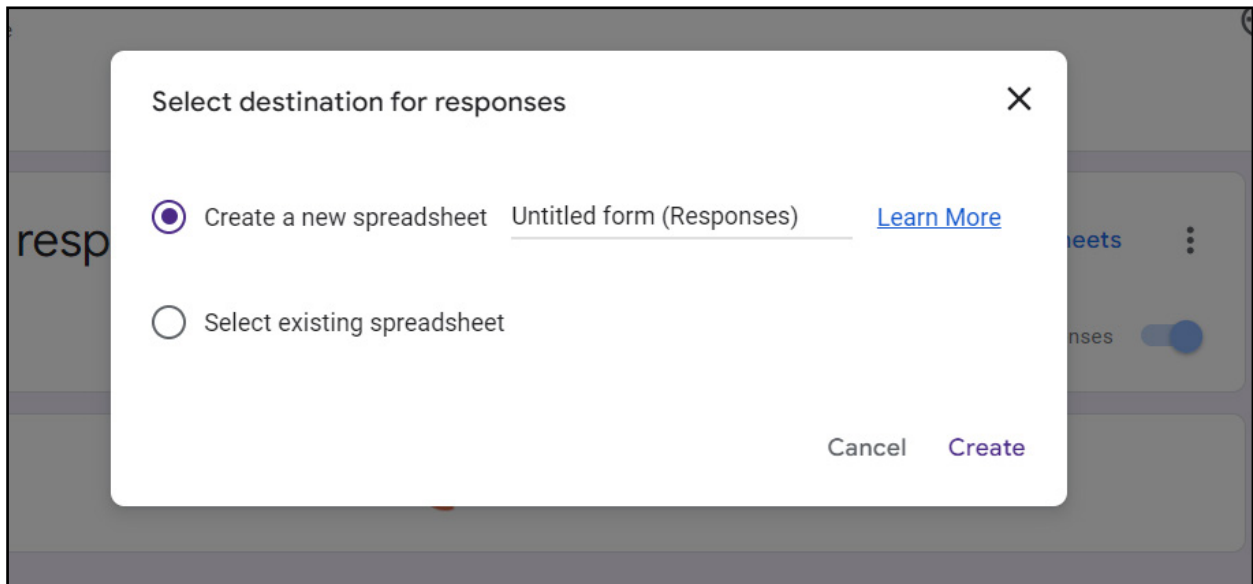
Figure 37: "Create a new spreadsheet."

Messages will pop up in the bottom left corner letting you know that the form and the spreadsheet are linking.

Next, go back to "My Drive," under files you will find a "Google Sheet" titled the same thing as your survey – with the word "(Responses)" added. Double click on it to open it.
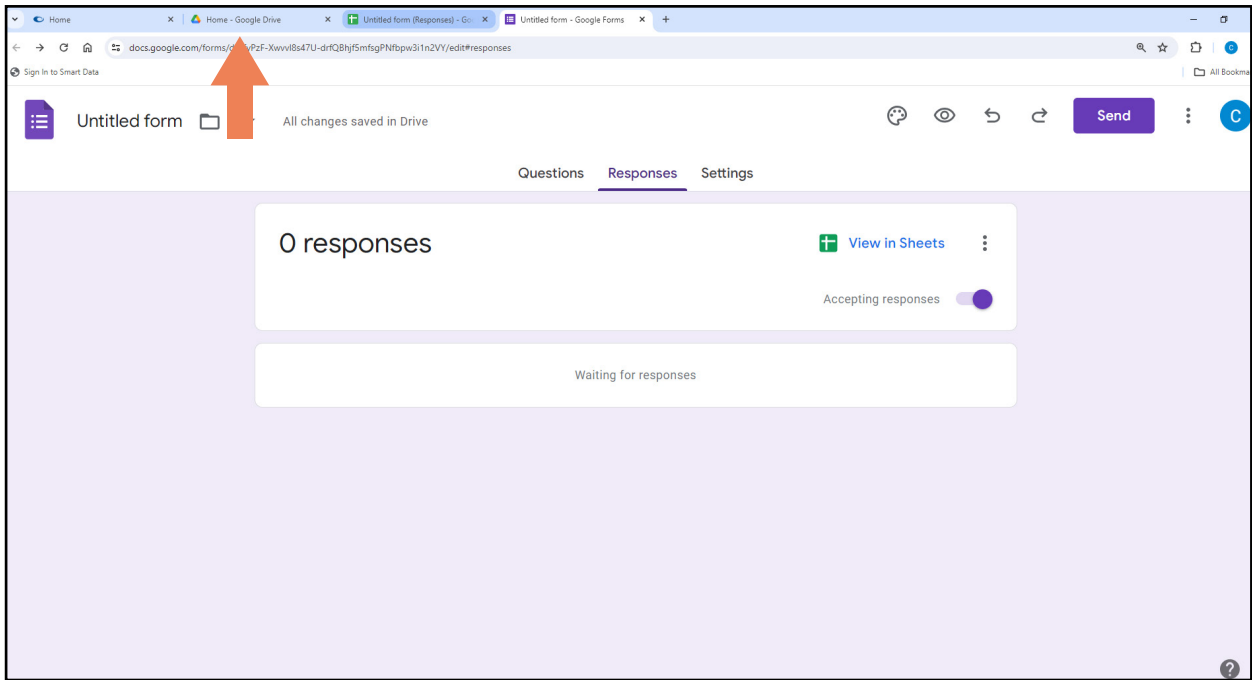
Figure 38: Opening the new Google sheet.

Now you will notice there is a tab on your Google Sheet titled "Form Responses 1."
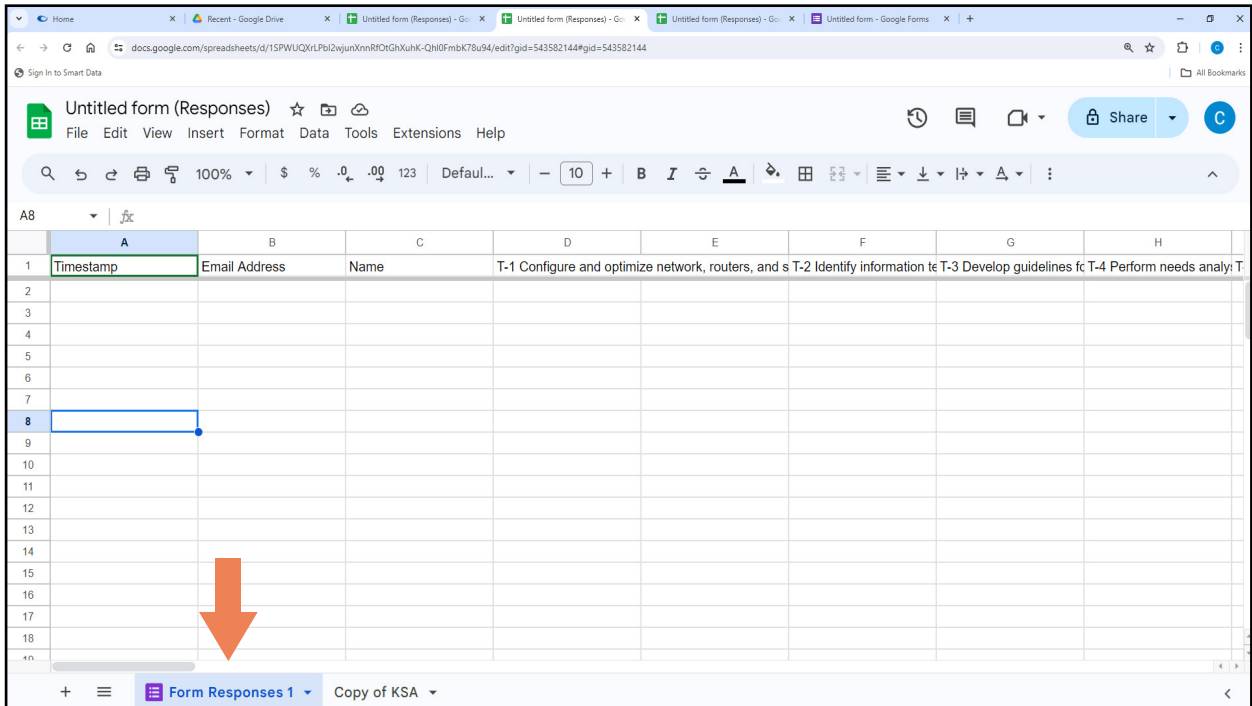
Figure 39: "Form Responses" tab.

Click on the "Form Responses 1" tab and you should see you questions from your Google Form across row 1.

III. Configuring the Vote Tabulation

To set up KSA sheet with the vote tally go to the Google Sheet "KSA Summary Template" at the link below. There are two tabs in that Google Sheet. "KSA" is the template you will copy. The other "Instructions for use" tab provides additional directions for how to use the template.

https://docs.google.com/spreadsheets/d/1v7CoXaG7HmfnWcl_6H5RjRhHKGoMu6mhcPnIewXgzYE/edit?usp=sharing

Here are the six steps to follow:

1. Using the link above, open this "KSA Summary Template" Google Sheet. This will open as a new tab in your browser. Make sure that you click on the tab labeled "KSA." Right-click the "KSA" sheet tab, select "Copy to" and "Existing spreadsheet," then select the Google Sheet file created in Section 1 and click select. Then click on the Google Sheet browser tab and note the added "Copy of KSA" tab next to your "Form Responses 1" tab.
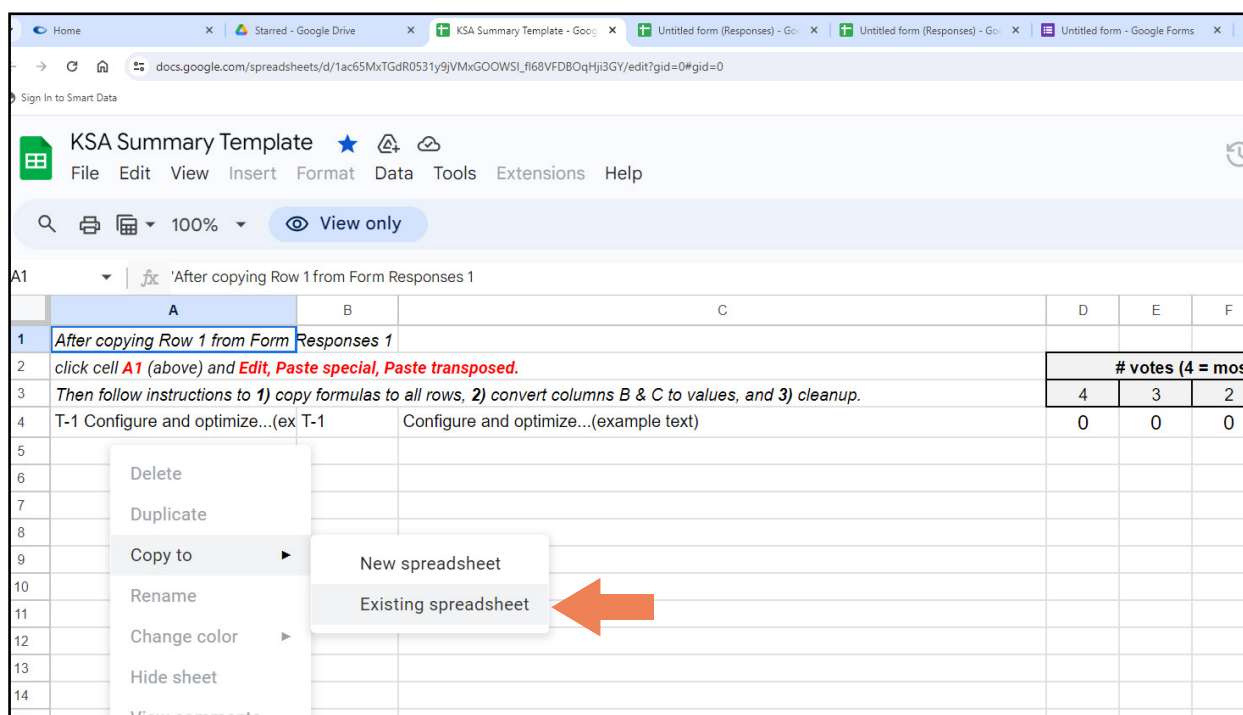
Figure 40: Using existing spreadsheet.

2. In the "Form Responses 1" tab of your Google Sheet (which in our example we're calling "Infrastructure KSA+Ts"), select all of row 1 by clicking on the number 1. The entire row should be highlighted. Right click on the highlighted row 1 and select Copy.
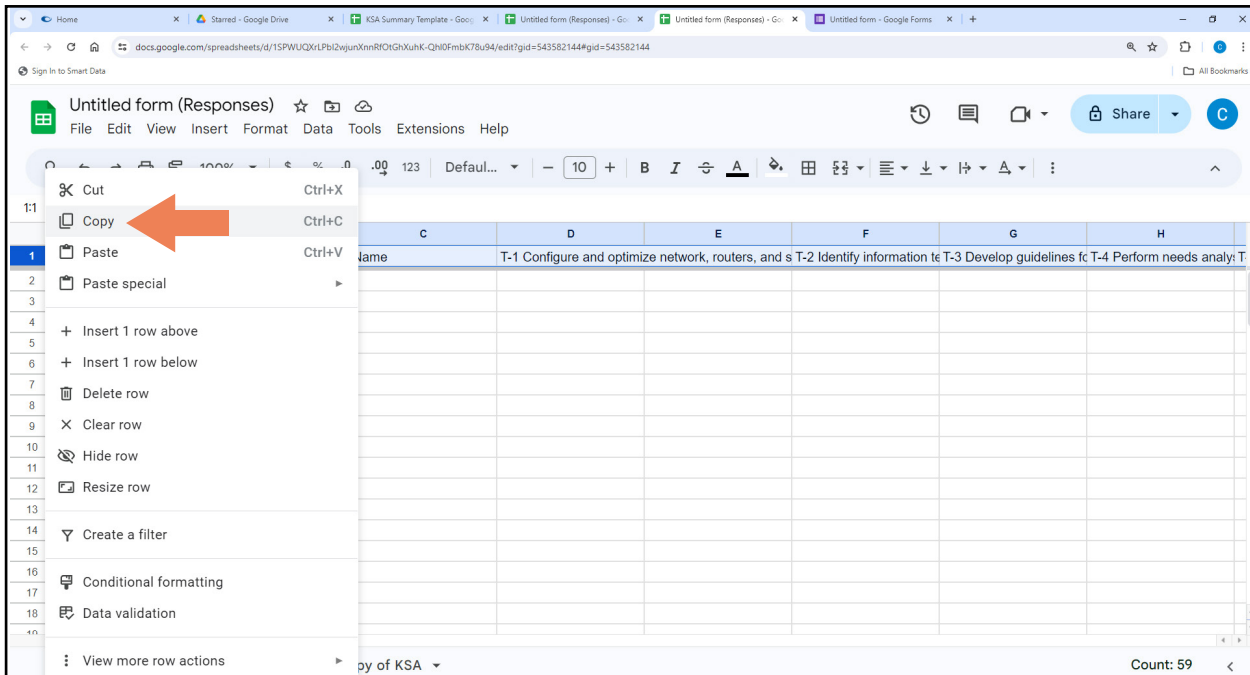
Figure 41: Copying the row.

3. In the "Copy of KSA" tab, select cell A1, right click to open up a menu. Select "Paste special" and then select "Paste transposed."
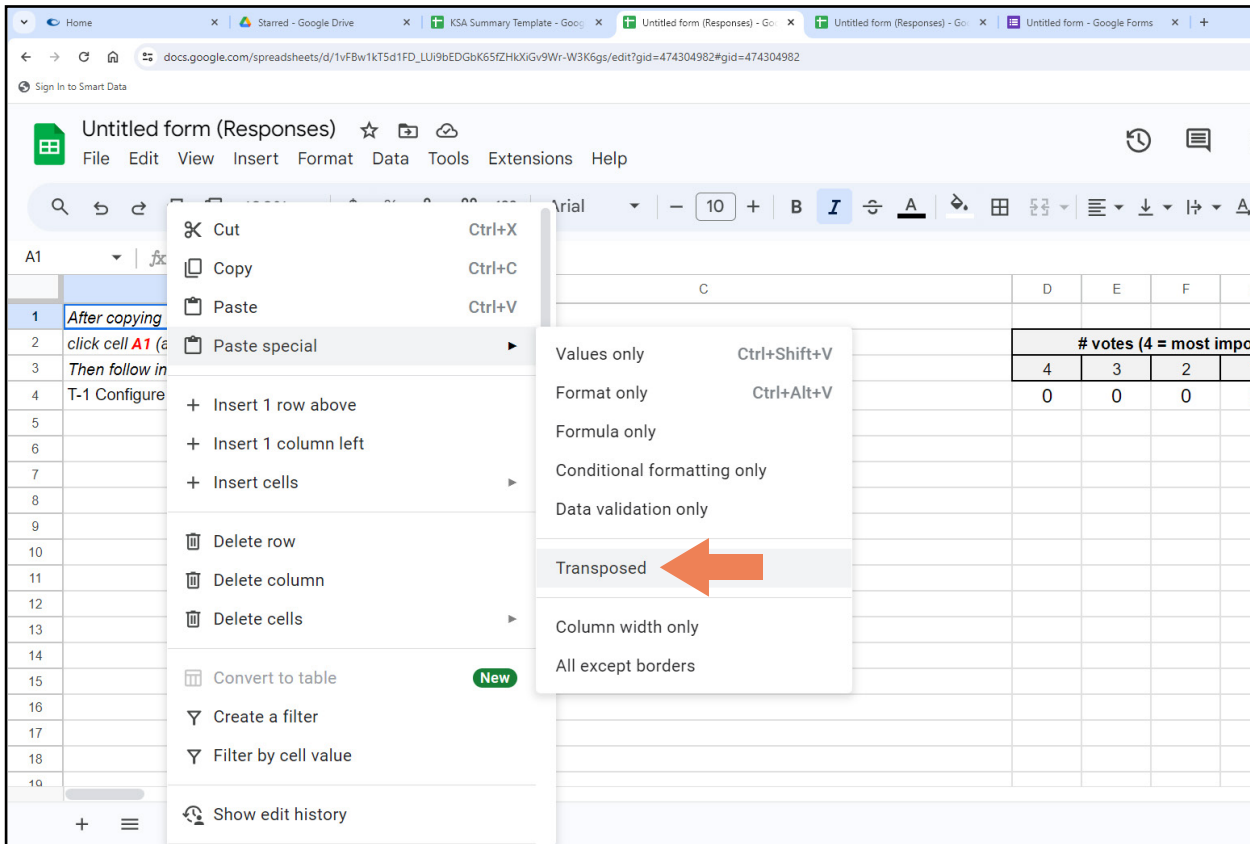
Figure 42: Pasting the row via "Paste transposed."

4. Select cells B4 thru I4, double click the tiny blue square in the lower right corner of the selected cells (this tiny square will automatically replicate the formula all the way down to the last row).
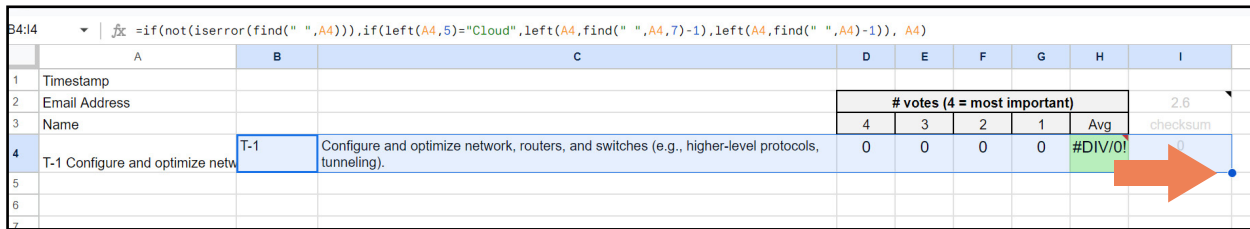
Figure 43: Clicking the tiny blue square.

5. Select columns B & C, right click on the selected columns and select "Copy." Then you will right click again in the highlighted selected columns, select "Paste special" then select "Paste values only."
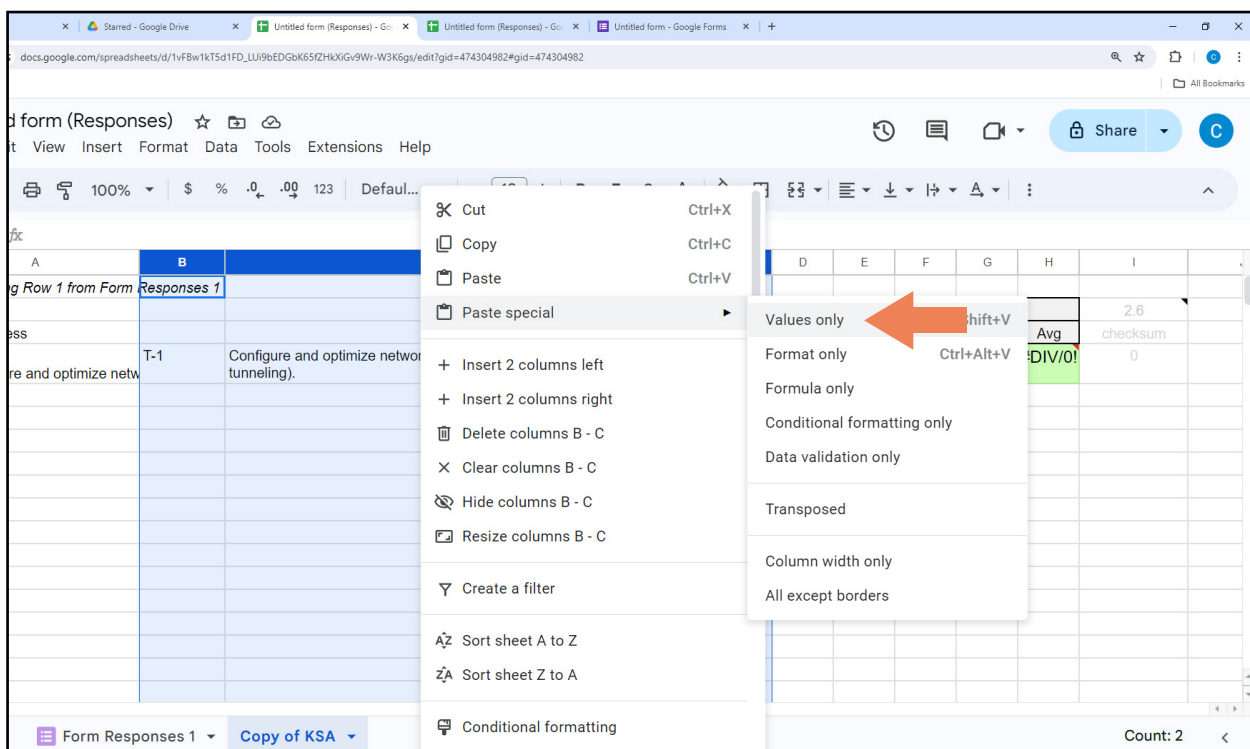
Figure 44: Paste values only.

6. Remove column A by selecting all of column A right click on the highlighted column, right click and select delete column.

When you are finished it should look like the screenshot below.

Figure 45: How your final Google sheet should look.

IV. Testing the Form

Now you are ready to have someone test the Google form. Thorough testing is strongly encouraged before you use the Google voting system with your BILT.

Go up to the tabs in your web browser and click on Google Form:

Figure 46: Testing the Google form.

Click on the purple send button at the top right of the screen:
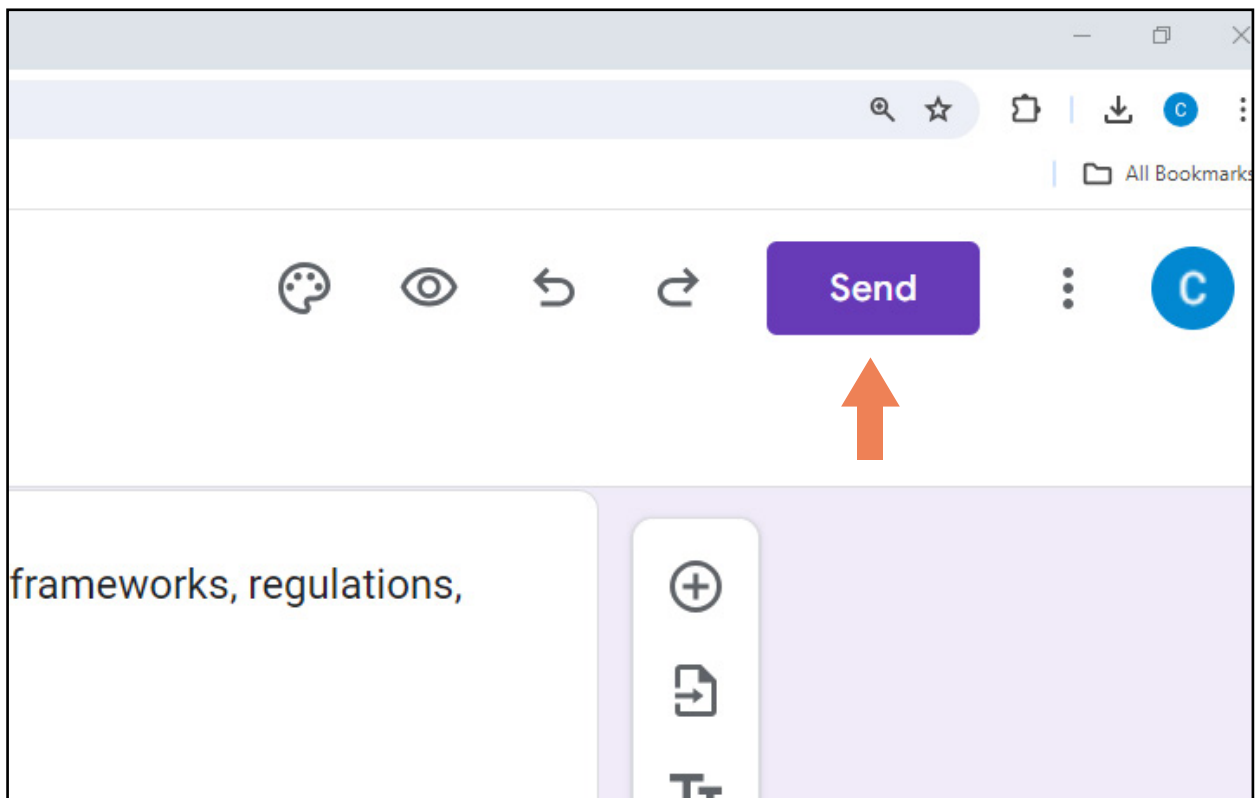
Figure 47: The "Send" button.

Click on the weblink icon (it looks like a chain). That will create a shareable link to this form (notice that under that link is a box you can click to shorten the URL).
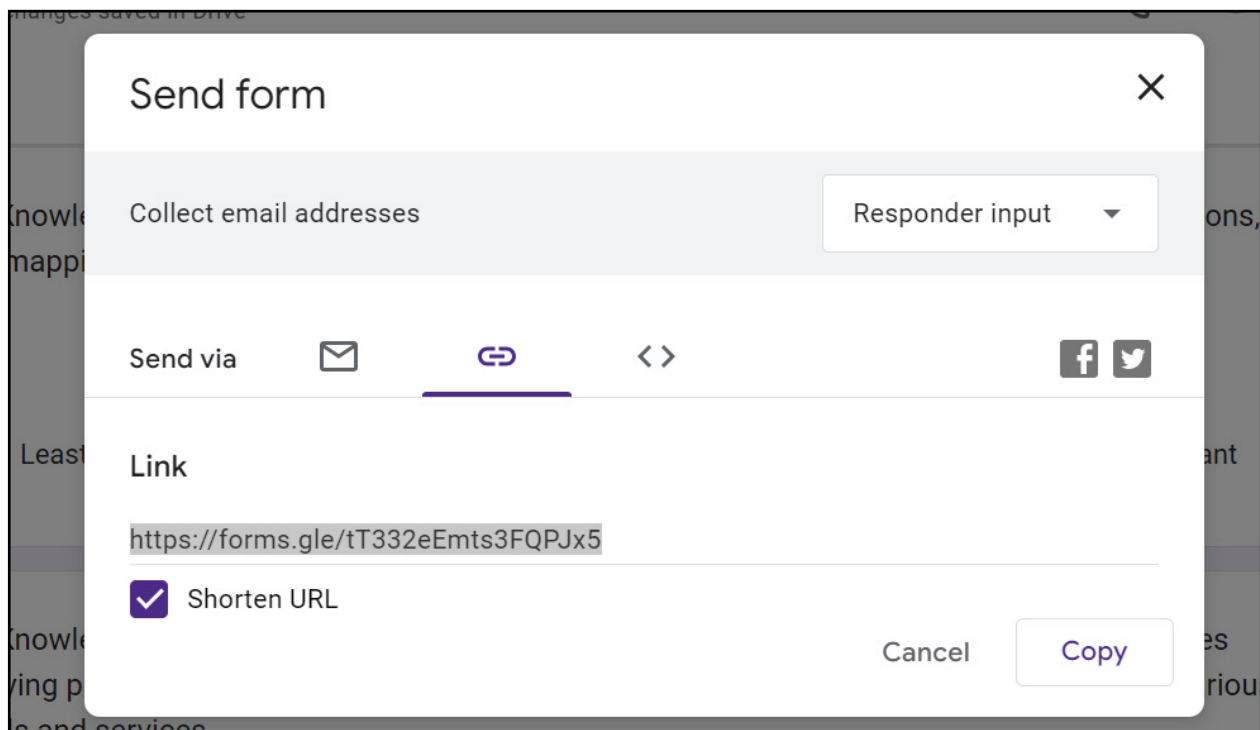
Figure 48: Copying a Google form link.

Send that form link URL to someone else and ask them to use it in a new browser and complete the Google Form:
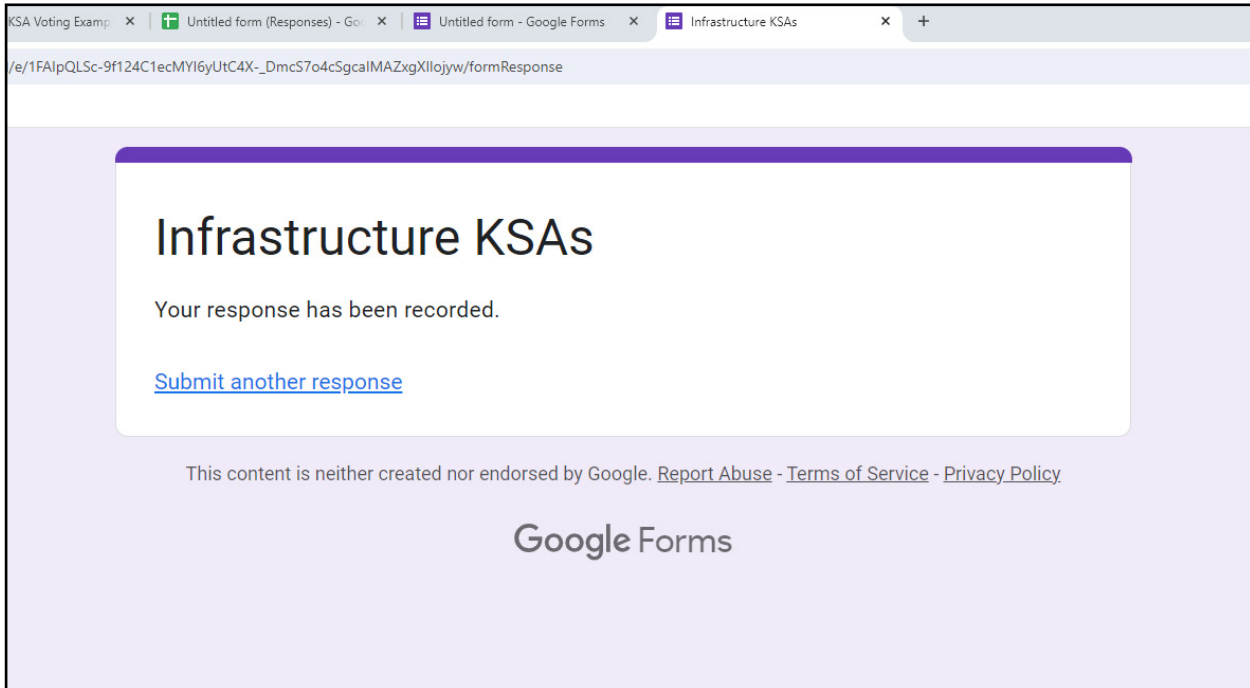
Figure 49: The final "your response has been submitted" form screen.

Now go back to "Infrastructure KSA+Ts" Google Sheet:
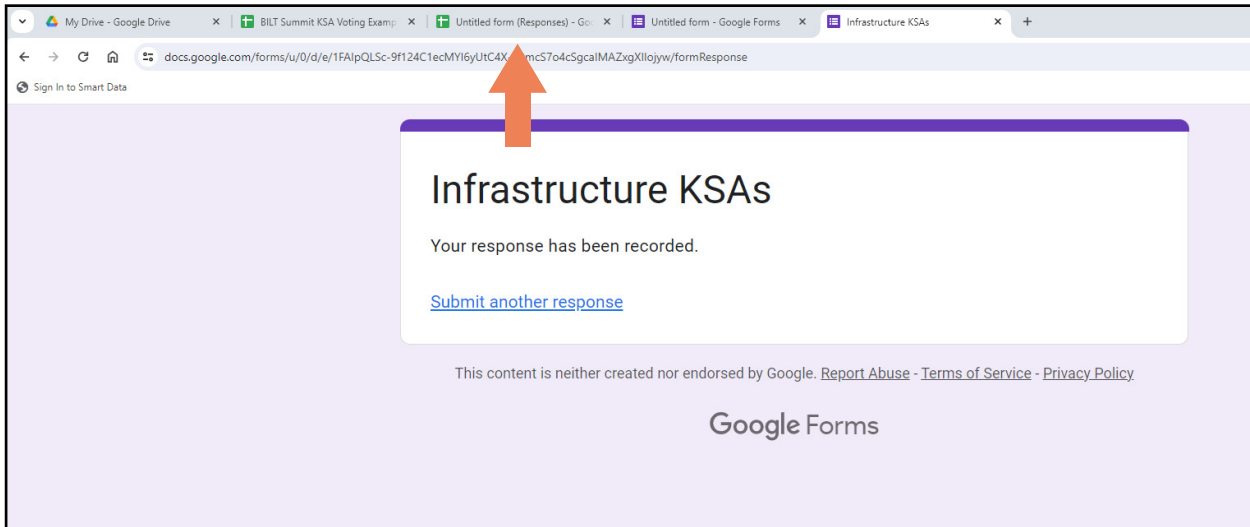
Figure 50: Look for the results in the Google sheet.

If done correctly you should see the test votes show up in your form:

Figure 51: Test votes appear on the Google sheet. Cell H2 contains the sheet's vote 2.6 cutoff average.

If that is reflecting correctly, then congratulations - you have finished! To change the vote cutoff average, enter your new number in cell H2. In the example above, the cutoff is 2.6. Any vote average 2.6 or lower turns the G column averages pink.

BUT... if the numbers don't look right, go back and ensure you followed the six steps in Section 3 for using the template.

VI. Additional elements

Re-voting

To enable re-voting follow these simple steps.

1. Go to the Google Form you will be using for voting.
2. Click on the "Settings" tab at the top of the screen scroll down to the "Responses" section.
3. Turn on the "Allow response editing" toggle. This will **allow your voters to change their vote**. The automatic email they receive with their votes will include a link which they can use to re-open the form and cast a new vote. They need only recast the vote(s) they want to change. Any "blank" choices will remain unchanged – that is, their first votes will remain as is. Respondents can re-vote as many times as they'd like.

Your changes to "Settings" will be saved automatically.

Figure 52: Allowing voters to receive an email "receipt."

Please note: Google Sheets does not keep a record the employer's original votes – new votes overwrite the original vote. In other words, while the Google Sheet will include a notation to let you know that a vote has been changed, you will not be able to see the original vote.

If you want to compare original votes to the changed votes, you'll need to save a copy of the results before re-votes.

** NOTE: If you do not make this "Edit after submit" settings change, <u>do not use the Google form for a re-vote</u>. Instead, conduct the re-vote in the room with hand-counting and make a manual adjustment of the KSA spreadsheet. Until that "Edit after submit" choice is selected, the Google Sheet will record every vote – that is, if a BILT member votes twice, both votes will be recorded and affect your average.

Amending an Existing Google Sheet and Google Form

The best way to amend a Google Sheet and Google Form is to copy the existing Google Form. If you copy the Google Sheet linked to the Google Form, it will copy both and link them but it is hard to make modifications. For this reason, it's better to copy the Google Form.

1. Right click on the Google Form you want to copy, then select "Make a copy" from the menu.
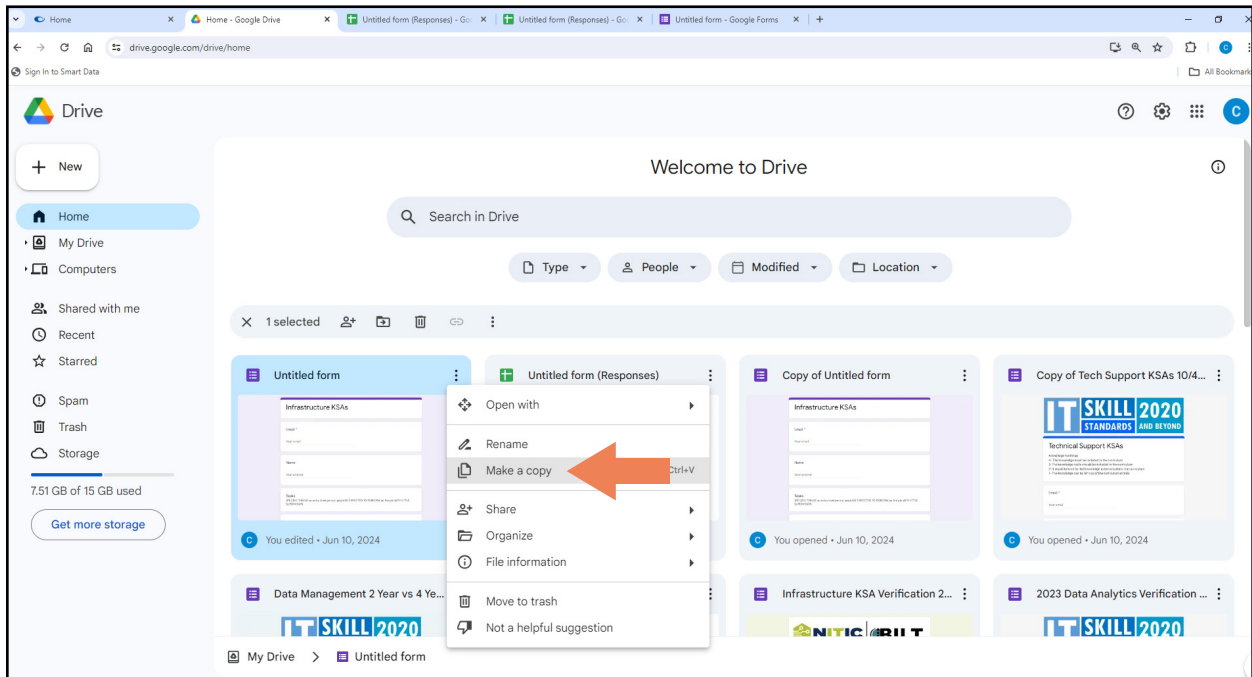
Figure 53: Making a Google form copy.

2. Open the new "Copy of the Google Form" via the new tab at the top of your browser. Rename the Google Form in the upper left field to avoid accidentally changing your original (see screenshot below).
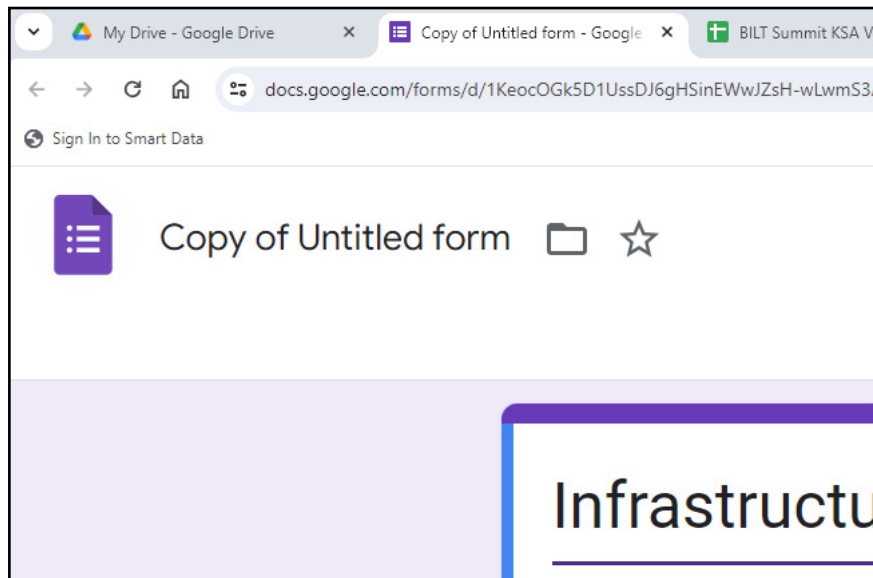
Figure 54: Updating the Google form title.

3. Modify the "Google Form" based on your needs. Once all modifications are completed link responses to a Google Sheet as described in Step 2 above.
4. Now follow the directions from Sections 3 and 4 above.

Employability Skills Survey Sample

3. Workplace Professionalism and Work Ethics

Demonstrate sound professionalism and judgment and integrity in the workplace; Abide by organization's formal and informal expectations, including punctuality and dependability.

○ Level 1: Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance.

○ Level 2: Employee exhibits sound professionalism, judgment and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed."

○ Level 3: Employee exhibits a mastery of professionalism and workplace norms and can provide peer guidance to co-workers and new hires.

4. Written Communication

Comprehend and execute written instructions; Effectively communicate concepts in writing.

○ Level 1: Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing.

○ Level 2: Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.

○ Level 3: Employee exhibits a mastery of communication internally and externally, demonstrating the ability to succinctly communicate complex concepts in clearly written form that meets the needs of the reader. Employee proactively seeks understanding and to be understood.

5. Oral Communication

Comprehend and execute oral instructions; Effectively communicate concepts orally and listen for meaning.

○ Level 1: Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills.

○ Level 2: Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.

○ Level 3: Employee exhibits a mastery of communication internally and externally, demonstrating the ability to present complex ideas and concepts. Employee proactively seeks understanding and to be understood.

Figure 55: Excerpt from sample Employability Skills survey.

APPENDIX D
Recruiting Samples

Verbal "elevator pitch" (aka "value proposition pitch") to an Employer SME Prospect –

We at (your college name) want to align a program in (program name) with employer demand in our area, and we are adopting the Business & Industry Leadership Team (BILT) Model for our advisory council. The BILT is a proven model that puts area employers in a co-leadership role for our programs.

We invite (business rep name or their company) to become part of our BILT team to guide our curriculum so that the knowledge and skills of our graduates better-align with your needs for job candidates.

Could you join us for a virtual orientation session in February or March (date TBD) to learn more about our BILT and how your participation may be beneficial? We will meet no longer than an hour.

Written invitation to an Employer SME Prospect –

At XYZ College, we're aware of the welding skills gap in our community and want your input on how we can increase your pool of qualified applicants. Our welding program is adopting the Business & Industry Leadership Team (BILT) model that puts employers in a co-leadership role. Our goal is to align curriculum with your talent needs so our graduates meet your requirements.

To accomplish this, we need a welding expert from your company to help identify the knowledge, skills, and abilities (KSA+Ts) you want in workers 12-36 months from now. The time commitment will be about 6-8 hours annually. We'll have four meetings: a KSA analysis and 3 trends discussions.

Who from your company can join us?
(Provide date / time for meeting to close the pitch.)
And, could you please forward this invitation to other colleagues who may be interested?

Verbal "elevator pitch" to an Internal Stakeholder –

Good to see you Vice President Smith. I'd like you to know about work we're doing to strengthen our Welding program and better align it with employer needs. We are implementing the Business & Industry Leadership Team (BILT) model that puts employers in a co-leadership role to guide our curriculum. This model has shown positive results at colleges across the country.

We are expanding our advisory council to include future-focused welding subject matter experts from local companies. They will participate in a structured KSA analysis process to identify the knowledge, skills, and abilities our graduates should possess 12-36 months from now. Faculty will align and update our curriculum to make sure it addresses these industry priorities. We're excited about deepening employer engagement to strengthen the program so we can increase enrollments and meet local workforce needs.

Ask for what you need from Vice President Smith [here].

SOFTWARE DEVELOPMENT

The definition for Software Development as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

Software development and engineering includes the research, design, secure creation, delivery and quality assurance/testing of computer software and applications including mobile. Additionally, web development can range from developing a simple single static page of plain text to complex web-based internet applications (web apps), and social network services. This definition was adapted from Wikipedia with input from national IT Thought Leaders.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 64).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster. More specific definitions can be found within the KSA list. The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 68).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 69).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 71).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 75).

A pool of 20 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Software Development KSAs

		AVG
Tasks		
Analysis and Design		
T-1	Identify, document, and effectively communicate security concerns and/or threat vulnerabilities.	2.8
T-2	Analyze information to determine, recommend, and plan development and installation of a new system or modification of an existing system.	2.7
Programming		
T-3	Develop code to read and write files.	3.7
T-4	Create webpages using data from a database.	3.3
T-5	Create applications such as Servlets that send HTML pages to Internet clients.	3.1
T-6	Write and debug effective code using various scripting languages.	3.5
T-7	Assist with development on multiple platforms (e.g., Linux, Windows, AppleOS, etc.).	3.0
T-8	Design, develop, and validate stable, robust, secure, and efficient code following industry best practices.	3.5
T-9	Develop secure code and error handling.	3.6
T-10	Develop cross platform applications targeted for an OS or platform other than the development environment.	2.5
T-11	Develop applications that run on multiple browsers.	3.5
T-12	Design, create, manage, and evaluate Apps.	3.2
T-13	Manipulate the objects contained in the Document Object Model (DOM).	2.8
T-14	Demonstrate familiarity with at least one current IDE and other developer productivity tools.	3.6
T-15	Identify, evaluate, and apply efficient algorithms and data structures (e.g., sorting, multithreading).	3.2
T-16	Apply SDLC (software development lifecycle) industry practices (e.g., Agile, waterfall, scrum, etc.).	3.2
T-17	Assist in designing countermeasures and mitigations against potential exploitations of programming language weaknesses and vulnerabilities in system and elements.	2.6
T-18	Apply secure code documentation in accordance with corporate policy to ensure safety of how code is implemented or processed for user access and security access to code that govern software driven apparatus.	3.4
T-19	Compile and write documentation of existing software program development and subsequent revisions, inserting comments in the coded instructions so others can understand the program.	3.5
T-20	Identify and leverage the enterprise-wide version control system while designing and developing secure applications.	3.4
T-21	Collaborate with a wide range of technical professionals, in person and virtually, using tools and strategies that support cooperative software development practices.	3.7
Testing		
T-22	Conduct trial runs of programs and software applications to ensure that the desired information is produced and instructions and security levels are correct.	3.3
T-23	Test and evaluate any software code/processes you developed (unit testing).	3.8
T-24	Utilize software testing tools to implement various test strategies.	3.3
T-25	Assist in developing software system testing and validation procedures, programming, and documentation.	3.2
T-26	Correct errors by making appropriate changes and rechecking the program to ensure that desired results are produced.	3.7
T-27	Apply coding and testing standards, security testing tools including "'fuzzing" static-analysis code scanning tools, and conduct code reviews.	3.3
Implementation		
T-28	Determine system performance against standards and follow appropriate action plan when issues arise.	2.8
T-29	Implement and properly document software patches and report any software security issues that would leave software vulnerable.	3.4
T-30	Modify existing software to correct errors, adapt it to new hardware, or upgrade interfaces and improve performance.	3.3
T-31	Contribute presentation materials and communicated effectively in a team meeting.	3.4

T-32	Communicate with customers or other departments on project status, proposals, or technical issues, such as software system design or maintenance, including both oral and written communication.	2.9
T-33	Contribute to team, follow directives from designers and engineers related to software design and implementation.	3.6

Knowledge Knowledge focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.		
K-1	Knowledge of software development models (e.g., Waterfall Model, Spiral Model).	3.3
K-2	Knowledge of system design tools, methods, and techniques, including automated systems analysis and design tools.	3.3
K-3	Knowledge of effective software debugging principles.	3.6
K-4	Knowledge of computer programming languages and principles in general.	3.7
K-5	Knowledge of web services (e.g., service-oriented architecture, REST, and web service description language).	3.3
K-6	Knowledge of visual representations of a program or system (e.g., UML, etc.).	2.5
K-7	Knowledge of how programs communicate across networks using asynchronous and synchronous techniques (when to use and why).	2.9
K-8	Knowledge of Software Integration Management Systems – how industry documents final product builds to show all of the elements that have changes and checks those that have not changed.	2.7
K-9	Knowledge of event handling in a GUI.	3.3
K-10	Knowledge of Regression Testing Development – how to test software using software.	3.3
K-11	Knowledge of the appropriate use of cookies.	3.2
K-12	Knowledge of how applets differ from applications in terms of program form, operating context, and how they are started.	3.1
K-13	Knowledge of two or more operating systems that are current industry standards (e.g., Linux, Windows Apple OS).	3.4
K-14	Knowledge of error handling constructs.	3.5
K-15	Knowledge of the differences between client-side scripting and server-side scripting.	3.5
K-16	Knowledge of common program architectures (e.g., standalone, three-tier, web-based, cloud-based, serverless, microservice).	3.3
K-17	Knowledge of the local development cycle (e.g., build, deploy, test, debug).	3.7
K-18	Knowledge of server software patterns, messaging patterns both async and synch.	3.3
K-19	Knowledge of database integration/management software.	3.1
K-20	Knowledge of AI and ML methods and algorithms.	2.7
K-21	Knowledge of software collaboration tools (e.g., version control, bug tracking, continuous integration).	3.6
K-22	Knowledge of the limits vs actual process of continuous integration and production deployment practices of devsecops/devnetsecops.	3.0
K-23	Knowledge of cybersecurity and privacy principles and methods that apply to software development.	3.3
K-24	Knowledge of system and application security threats and vulnerabilities (e.g., buffer overflow, mobile code, cross-site scripting, Procedural Language/Structured Query Language [PL/SQL] and injections, race conditions, covert channel, replay, return-oriented attacks, malicious code).	3.3
K-25	Knowledge of code security (e.g., hashing, encryption, cryptography, threat modeling).	3.1
K-26	Knowledge of Privacy Impact Assessments in terms of privacy and identity management.	2.7
K-27	Knowledge of cyber threats and vulnerabilities.	3.3
K-28	Knowledge of software related information technology (IT) security principles and methods (e.g., modularization, layering, abstraction, data hiding, simplicity/minimization).	3.2
K-29	Awareness of standards such as PCI, PHI, and GDPR.	2.8
K-30	Knowledge of basic security practices including threats and vulnerabilities that may arise from interactions with other systems, external and legacy code.	3.5
K-31	Knowledge of computer network fundamentals (e.g., TCP/IP, HTTPS, ports, firewall, LAN/WAN, etc.) and network security methodologies.	3.3

K-32	Knowledge of implementation and utilization of cloud services including deployment (e.g., AWS, Microsoft Azure).	3.1
K-33	Awareness of cloud computing concepts (e.g., IoT, edge computing).	2.5
K-34	Knowledge of software development and implementation for communicating and gathering data from IoT devices.	2.6
K-35	Knowledge of the difference between AI and ML.	2.9
K-36	Awareness of current and specialized AI and ML tools and their application to business problems.	2.7
K-37	Conceptual knowledge of PKI.	2.9
K-38	Knowledge of DevSecOps.	2.9
K-39	Knowledge of structured and unstructured data sources.	3.3
K-40	Knowledge of open source software and risks involved.	3.4
K-41	Knowledge of ethics and its application to software development.	3.4
K-42	Knowledge of best practices for Design/UI/UX/accessibility as applied to software development.	3.2
K-43	Knowledge of lifecycle development/steady state/end of life.	3.1
K-44	Knowledge of mobile application development.	2.8
K-45	Knowledge of how to protect data privacy through code.	3.1
K-46	Knowledge of process flow and how the upgrade/implementation of software is accomplished through definitive understanding of team collaboration in DevOps, End of Life Cycle, and including importance of foundational security.	2.7
K-47	Knowledge of performing integrated quality assurance testing for security functionality and resiliency attack.	2.6
K-48	Knowledge of how to identify security implications in the software acceptance phase including completion criteria, risk acceptance and documentation, common criteria, and methods of independent testing and report concerns to IT/software team.	2.6
K-49	Knowledge of applications with public keying by leveraging existing public key infrastructure (PKI) libraries and incorporating certificate management and encryption functionalities when appropriate.	2.5
K-50	Knowledge of how to identify and leverage the enterprise-wide security services while designing and developing secure applications (e.g., Enterprise PKI, Federated Identity server) when appropriate.	2.5
K-51	Knowledge of how to identify and analyze user needs and use needs to establish a plan in the selection, creation, evaluation, implementation and administration of information technology systems.	2.4
K-52	Knowledge of security requirements into application design elements including documenting the elements of the software attack surfaces, conducting threat modeling, and defining any specific security criteria.	2.4
K-53	Knowledge of architecture patterns and when to use them to build applications.	2.8
K-54	Knowledge of algorithms and data structures (e.g., big-O, linked lists, hash maps, sorting, etc.).	2.9
K-55	Knowledge of Binary search tree and how binary search works.	2.8
K-56	Knowledge of Hash maps.	2.8
Skills The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course on investing in financial futures, and therefore has knowledge of it. But getting experience in trading these instruments adds skills.		
S-1	Skill in using built-in functions as well as skill in creating custom functions, subroutines, and procedures within software using scripting languages.	3.3
S-2	Skill in integrating standard object model components with server pages in support of the User Experience.	2.9
S-3	Skill in conducting software debugging.	3.6
S-4	Skill in creating programs that validate and process multiple inputs including command line arguments, environmental variables, and input streams.	3.5
S-5	Skill in writing code in current programming languages and frameworks.	3.7

S-6	Skill in developing applications that can log and handle errors, exceptions, and application faults and logging.	3.3
S-7	Skill in applying root cause analysis (RCA) techniques to solving software/customer issues.	3.2
S-8	Skill in the live production environment (e.g., monitoring, logging, alerting, remote debugging).	3.2
S-9	Skill in using electronic mail software (e.g., Google Gmail; IBM Notes Hot technology; Microsoft Exchange Server Hot technology; Microsoft Outlook Hot technology).	3.4
S-10	Skill in using graphical user interface development software (e.g., Graphical user interface GUI builder software; Graphical user interface GUI design software; Salesforce Visualforce Hot technology).	3.1
S-11	Skill in using object or component-oriented development software (e.g., C++ Hot technology; Document Object Model DOM Scripting; Python Hot technology; Simple API for XML SAX).	3.2
S-12	Skill in creating classes that use inheritance aspects of the object-oriented paradigm.	3.2
S-13	Skill in using, incorporating and utilizing cookies.	2.8
S-14	Skill in implementing programs that use local or remote databases with standard protocols.	3.2
S-15	Skill in using a scripting language on the server side and the client side of a distributed program.	3.2
S-16	Skill in evaluating and reporting software needs, constraints, analysis for application-specific concerns.	2.9
S-17	Skill in implementing levels of security in distributed software applications and applets.	2.8
S-18	Skill in deploying secure software according to secure software deployment methodologies, tools, and practices (e.g., PCI,GDPR, HIPPA, CCPA).	3.1
S-19	Skill in mobile application development.	2.7
S-20	Skills such as time management, risk management.	3.3
S-21	Skill in incorporating user experience feedback into software.	3.1
S-22	Skill in integrating third party open source resources into software including minimizing risk.	3.1
S-23	Skill in learning new and/or industry standard tools involved in the development of software.	3.6
Abilities Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.		
A-1	Ability to both mentor and be mentored; provide critical feedback as well as accept critical feedback two-way.	3.5
A-2	Ability to comprehend and execute both written and oral instructions by asking clarifying questions.	3.8
A-3	Ability to effectively communicate technical concepts and constraints in written and oral form to technical team members, stakeholders.	3.6
A-4	Ability to work effectively in multi-disciplinary teams to apply information technology in support of organizational goals.	3.6
A-5	Ability to produce technical content for tech writers.	2.9
A-6	Ability to manage your own software development project activities and deliverables in a timely and efficient manner.	3.5
A-7	Ability to work on team projects and demonstrate critical thinking, teamwork, oral communications, inter-cultural appreciation, and technical and information literacy skills.	3.9
A-8	Ability to research and be able to find other sources to answer the problem.	3.7
A-9	Ability to engage with users and understand their user experience.	3.3
A-10	Ability to draw on prior knowledge and experience in a new situation.	3.7

Software Development Employability Skills

Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers. Level 2 - Employee demonstrates commitment, enthusiasm and supports team members. Employee follows up on assigned tasks and leads by example.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving. Level 2 - With minimal supervision, employee analyzes underlying causes, considers risks and implications, and uses logic to draw conclusions. Employee applies rules and principles to processes and recommends solutions.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight. Level 2 - Employee makes inquiries of co-workers regarding possible changes needed in ways of doing work and adapts accordingly. Observes co-workers increasing work productivity under pressure and follows their lead.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively.
Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor. Level 2 - Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor. Employee completes development plan without prompting from supervisor.

Software Development Key Performance Indicators

For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with verification after the employee has more experience. All tasks are done according to company guidelines.

	Tasks	Key Performance Indicators
Analysis & Design		
T-1	Identify, document, and effectively communicate security concerns and/or threat vulnerabilities.	Requirements are properly understood, interpreted, and evaluated, and conflicting requirements are identified and resolved. Time, technology, and resource constraints are defined, alternatives are presented, and risk analysis and contingency plans are implemented. Security requirements are consistent with company standards and all applicable laws and regulations. Analysis of new and existing software security concerns and/or threat vulnerabilities are provided to IT/software team to guide development/modification of a security application.
T-2	Analyze information to determine, recommend, and plan development and installation of a new system or modification of an existing system.	
Programming		
T-3	Develop code to read and write files.	Code is developed and documented using efficient software design processes. Links between web applications and associated databases are properly established. Appropriate debugging tools are used in an efficient manner. High-quality software of multiple types is produced that meets or exceeds customer expectations, follows industry best practices, and is completed within engineering time and cost estimates. Application, programming, or communication errors and security vulnerabilities are correctly anticipated, detected, and resolved. Authoring, modifying, compiling, deploying, and debugging of software are completed in a thorough and efficient manner. Programs are written in the most efficient way, and data is organized in such a way that it can be updated, deleted, retrieved efficiently, and securely protected. Software is deployed in accordance with secure software deployment methodologies, tools, documentation, and other practices. Implementing solutions known threats known to produce a reduction in threats and vulnerabilities. Documentation is clear and complete, including consistent use of enterprise-wide version control. The appropriate Integrated Development Environment is used in code creation. SDLC industry practices, as specified by the company, are consistently followed. Cooperative software development practices are utilized.
T-4	Create webpages using data from a database.	
T-5	Create applications such as Servlets that send HTML pages to Internet clients.	
T-6	Write and debug effective code using various scripting languages.	
T-7	Assist with development on multiple platforms (e.g., Linux, Windows, AppleOS, etc.).	
T-8	Design, develop and validate stable, robust, secure, and efficient code following industry best practices.	
T-9	Develop secure code and error handling.	
T-10	Develop cross platform applications targeted for an OS or platform other than the development environment.	
T-11	Develop applications that run on multiple browsers.	
T-12	Design, create, manage, and evaluate Apps.	
T-13	Manipulate the objects contained in the Document Object Model (DOM).	
T-14	Demonstrate familiarity with at least one current IDE and other developer productivity tools.	
T-15	Identify, evaluate, and apply efficient algorithms and data structures (e.g., sorting, multithreading).	
T-16	Apply SDLC (software development lifecycle) industry practices (e.g., Agile, waterfall, scrum, etc.).	
T-17	Assist in designing countermeasures and mitigations against potential exploitations of programming language weaknesses and vulnerabilities in system and elements.	
T-18	Apply secure code documentation in accordance with corporate policy to ensure safety of how code is implemented or processed for user access and security access to code that govern software driven apparatus.	
T-19	Compile and write documentation of existing software program development and subsequent revisions, inserting comments in the coded instructions so others can understand the program.	
T-20	Identify and leverage the enterprise-wide version control system while designing and developing secure applications.	
T-21	Collaborate with a wide range of technical professionals, in person and virtually, using tools and strategies that support cooperative software development practices.	

		Testing
T-22	Conduct trial runs of programs and software applications to ensure that the desired information is produced and instructions and security levels are correct.	Unit testing is accomplished using standard testing procedures, and testing on each unit is repeated until the unit is free of errors. Appropriate software testing tools are used. Testing identifies errors, gaps, or missing requirements and results in reliability, security, and high performance. Errors identified during testing are corrected and code is retested until no errors are identified. A systematic testing program is implemented that is relevant to application and test requirements and is in compliance with legal requirements, policies, procedures, and customer requirements. Code reviews are performed in a regular and timely manner.
T-23	Test and evaluate any software code/processes you developed (unit testing).	
T-24	Utilize software testing tools to implement various test strategies.	
T-25	Assist in developing software system testing and validation procedures, programming, and documentation.	
T-26	Correct errors by making appropriate changes and rechecking the program to ensure that desired results are produced.	
T-27	Apply coding and testing standards, security testing tools including "'fuzzing" static-analysis code scanning tools, and conduct code reviews.	
		Implementation
T-28	Determine system performance against standards and follow appropriate action plan when issues arise.	Software upgrades and patches are applied with minimal service disruptions to clients/users in a timely manner. Software performance meets design specs and client/user requirements. Software is modified on an ongoing basis to adapt to hardware and software changes. Recommendations based on customer input and analysis of system data are presented to appropriate personnel. Client/users are informed regarding requirements and technology. Effective presentations are used to communicate both internally and externally. Team members collaborate and follow the design and implementation guidelines provided.
T-29	Implement and properly document software patches and report any software security issues that would leave software vulnerable.	
T-30	Modify existing software to correct errors, adapt it to new hardware, or upgrade interfaces and improve performance.	
T-31	Contribute presentation materials and communicated effectively in a team meeting.	
T-32	Communicate with customers or other departments on project status, proposals, or technical issues, such as software system design or maintenance, including both oral and written communication.	
T-33	Contribute to team, follow directives from designers and engineers related to software design and implementation.	

Software Development Student Learning Outcomes

Knowledge		Student Learning Outcomes
K-22	Knowledge of the limits vs actual process of continuous integration and production deployment practices of devsecops/devnetsecops.	Explain the process of integration, production, and deployment of software development life cycle.
K-36	Awareness of current and specialized AI and ML tools and their application to business problems.	Stay informed regarding current and specialized AI and ML tools to solve business problems.
K-16	Knowledge of common program architectures (e.g., standalone, three-tier, web-based, cloud-based, serverless, microservice).	Describe common application architectures.
K-32	Knowledge of implementation and utilization of cloud services, including deployment (e.g., AWS, Microsoft Azure).	Identify the different cloud services and how they are different in their implementation process.
K-5	Knowledge of web services (e.g., service-oriented architecture, Simple Object Access Protocol, and web service description language).	Discuss common services, practices, and protocols used in the development of web services.
K-11	Knowledge of the appropriate use of cookies.	Explain the appropriate usage of cookies.
K-23	Knowledge of cybersecurity and privacy principles and methods that apply to software development.	Explain information security principles and fundamental methods that apply to software development.
K-27	Knowledge of cyber threats and vulnerabilities.	Discuss the potential threats and vulnerabilities that may arise from basic security practices when interacting with other systems, and external and legacy code.
K-30	Knowledge of basic security practices including threats and vulnerabilities that may arise from interactions with other systems,	
K-29	Awareness of standards such as PCI, PHI, and GDPR.	Be aware of laws, regulations, and standards related to cybersecurity and privacy globally.
K-25	Knowledge of code security (e.g., hashing, encryption, cryptography, threat modeling).	Describe secure coding algorithms such as hashing, encryption, cryptography in general, and PKI.
K-37	Conceptual knowledge of PKI.	
K-34	Knowledge of software development and implementation for communicating and gathering data from IoT devices.	Explain how to develop and implement software programs for the purpose of communicating and gathering data from IoT devices.
K-39	Knowledge of structured and unstructured data sources.	Describe how to access data from both structured and unstructured sources.
K-19	Knowledge of database integration/management software.	Discuss database integration tools and techniques for software management.
K-3	Knowledge of effective software debugging principles.	Demonstrate tools and techniques used to debug software applications.
K-18	Knowledge of server software patterns, messaging patterns both async and synch.	Explain async and synch in server software patterns and messaging patterns.
K-42	Knowledge of best practices for Design/UI/UX/accessibility as applied to software development.	Define UI, UX, and accessibility and demonstrate best practices for incorporating them in a software system design.
K-15	Knowledge of the differences between client-side scripting and server-side scripting.	Explain the differences between client-side and server-side scripting in software development.
K-46	Knowledge of process flow and how the upgrade/implementation of software is accomplished through definitive understanding of team collaboration in DevOps, End of Life Cycle, and including importance of foundational security.	Discuss DevSecOps as it relates to DevOps and the secure software development life cycle.
K-6	Knowledge of visual representations of a program or system (e.g., UML, etc.).	Explain the use of visual tools such as UML to represent software design.
K-8	Knowledge of Software Integration Management Systems – how industry documents final product builds to show all of the elements that have changes and checks those that have not changed.	Document software changes in the Software Integration Management Systems.
K-41	Knowledge of ethics and its application to software development.	Explain the importance of ethics and how it is applied to software development.
K-7	Knowledge of how programs communicate across the Internet using conventions such as Remote Method Invocation.	Explain how programs communicate across the Internet using conventions such as Remote Method Invocation.
K-14	Knowledge of error handling constructs.	Discuss how constructs are used to handle errors in software.
K-4	Knowledge of computer programming languages and principles in general.	List commonly used programming languages and general concepts that are common to these languages.

K-12	Knowledge of how applets differ from applications in terms of program form, operating context, and how they are started.	Explain the differences between applets and applications.
K-44	Knowledge of mobile application development.	Describe tools, techniques, and frameworks used for mobile application development.
K-31	Knowledge of computer network fundamentals (e.g., TCP/IP, HTTPS, ports, firewall, LAN/WAN etc.) and network security methodologies.	Explain computer network fundamentals and security methodologies such as TCP/IP, HTTPS, ports, firewall, and LAN/WAN.
K-13	Knowledge of two or more operating systems that are current industry standards (e.g., Linux, Windows Apple OS).	Discuss common operating systems used for software applications.
K-1	Knowledge of software development models (e.g., Waterfall Model, Spiral Model).	Explain the different types of software development models.
K-2	Knowledge of system design tools, methods, and techniques, including automated systems analysis and design tools.	Describe tools, methods, and techniques used for software analysis and design.
K-17	Knowledge of the local development cycle (e.g., build, deploy, test, debug).	List and discuss the phases of the software development lifecycle.
K-43	Knowledge of lifecycle development/steady state/end of life.	
K-10	Knowledge of Regression Testing Development – how to test software using software.	Explain how to test software with Regression Testing Development.
K-9	Knowledge of event handling in a GUI.	Describe how event-handling is implemented in a GUI (graphical user interface).
K-24	Knowledge of system and application security threats and vulnerabilities (e.g. buffer overflow, mobile code, cross-site scripting, Procedural Language/Structured Query Language [PL/SQL] and injections, race conditions, covert channel, replay, return-oriented attacks, malicious code).	Discuss software application and system security threats and vulnerabilities.
K-28	Knowledge of software related information technology (IT) security principles and methods (e.g., modularization, layering, abstraction, data hiding, simplicity/minimization).	Classify the application of secure coding principles and methods.
K-38	Knowledge of DevSecOps.	Describe DevSecOps principles and practices.
K-45	Knowledge of how to protect data privacy through code.	Explain how to protect data privacy by secure coding techniques.
K-26	Knowledge of Privacy Impact Assessments in terms of privacy and identity management.	Describe how Privacy Impact Assessment (PIA) tools are used to identify and mitigate privacy risks.
K-21	Knowledge of software collaboration tools (e.g., version control, bug tracking, continuous integration).	Describe how software tools are used to collaborate and manage the phases of the software development lifecycle.
K-40	Knowledge of open source software and risks involved.	Compare and contrast common open-source frameworks and tools used for software development, including describing the risks involved.
K-35	Knowledge of the difference between AI and ML.	Differentiate between Artificial Intelligence (AI) and Machine Learning (ML) methods and algorithms.
K-20	Knowledge of AI and ML methods and algorithms.	
K-33	Awareness of cloud computing concepts (e.g., IoT, edge computing).	Describe different cloud computing concepts such as IoT and edge computing.
K-47	Knowledge of performing integrated quality assurance testing for security functionality and resiliency attack.	Demonstrate how to perform an integrated quality assurance test for security functionality and resiliency attacks.
K-48	Knowledge of how to identify security implications in the software acceptance phase including completion criteria, risk acceptance and documentation, common criteria, and methods of independent testing and report concerns to IT/software team.	Explain how to identify security implications in the software acceptance phase.
K-49	Knowledge of applications with public keying by leveraging existing public key infrastructure (PKI) libraries and incorporating certificate management and encryption functionalities when appropriate.	Demonstrate how to use public keying by leveraging existing public key infrastructure (PKI) libraries while incorporating certificate management and encryption functionalities.
K-50	Knowledge of how to identify and leverage the enterprise-wide security services while designing and developing secure applications (e.g., Enterprise PKI, Federated Identity server) when appropriate.	Explain how to identify and leverage enterprise-wide security services while designing and developing secure applications.

K-51	Knowledge of how to identify and analyze user needs and use needs to establish a plan in the selection, creation, evaluation, implementation and administration of information technology systems.	Discuss how to identify and analyze user needs when creating information technology systems.
K-52	Knowledge of security requirements into application design elements including documenting the elements of the software attack surfaces, conducting threat modeling, and defining any specific security criteria.	Discuss the security factors to consider when designing software application, including attack surface analysis, threat modeling, and specific security criteria.
K-53	Knowledge of architecture patterns and when to use them to build applications.	Explain contemporary software architecture patterns and how to use them in creating applications.
K-54	Knowledge of algorithms and data structures (e.g., big-O, linked lists, hash maps, sorting, etc.).	Discuss the differences between algorithms and data structures such as big-O, linked lists, hash maps, trees, sorting, and searching.
K-55	Knowledge of Binary search tree and how binary search works.	
K-56	Knowledge of Hash maps.	
Skills		**Student Learning Outcomes**
S-1	Skill in using built-in functions as well as skill in creating custom functions, subroutines, and procedures within software using scripting languages.	Design and create a modularized, distributed application using a scripting language.
S-15	Skill in using a scripting language on the server side and the client side of a distributed program.	
S-2	Skill in integrating standard object model components with server pages in support of the User Experience.	Develop a server page containing integrated object model components.
S-3	Skill in conducting software debugging.	Evaluate a software program's effectiveness by using debugging tools and techniques.
S-4	Skill in creating programs that validate and process multiple inputs including command line arguments, environmental variables, and input streams.	Design and implement applications which acquire and validate input from various sources, including command line arguments, files, environment variables, and input streams.
S-5	Skill in writing code in current programming languages and frameworks.	Develop applications which use a standard current programming language.
S-6	Skill in developing applications that can log and handle errors, exceptions, and application faults and logging.	Create applications that can log and handle errors, and exceptions, and identify application faults.
S-7	Skill in applying root cause analysis (RCA) techniques to solving software/customer issues.	Apply root cause analysis techniques to identify and diagnose software defects.
S-8	Skill in the live production environment (e.g., monitoring, logging, alerting, remote debugging).	Create a live production environment that will support monitoring, logging, alert processing, and debugging remotely.
S-9	Skill in using electronic mail software (e.g., Google Gmail; IBM Notes Hot technology; Microsoft Exchange Server Hot technology; Microsoft Outlook Hot technology).	Demonstrate the use of electronic mail systems.
S-10	Skill in using graphical user interface development software (e.g., Graphical user interface GUI builder software; Graphical user interface GUI design software; Salesforce Visualforce Hot technology).	Create software using a graphical user interface.
S-11	Skill in using object or component oriented development software (e.g., C++ Hot technology; Document Object Model DOM Scripting; Python Hot technology; Simple API for XML SAX).	Use a component-driven development software tool to build software components.
S-12	Skill in creating classes that use inheritance aspects of the object-oriented paradigm.	Create objects that inherit properties and methods from a class.
S-13	Skill in using, incorporating and utilizing cookies.	Create web applications that use common services, practices, protocols, and cookies.
S-14	Skill in implementing programs that use local or remote databases with standard protocols.	Design and develop programs that use databases with standard protocols.
S-16	Skill in evaluating and reporting software needs, constraints, analysis for application-specific concerns.	Evaluate domain-specific needs, identify requirements, and define scope for applications.
S-17	Skill in implementing levels of security in distributed software applications and applets.	Deploy secure software according to secure software deployment methodologies, tools, and practices.
S-18	Skill in deploying secure software according to secure software deployment methodologies, tools, and practices (e.g., PCI,GDPR, HIPPA, CCPA).	
S-19	Skill in mobile application development.	Design and develop mobile applications.
S-20	Skills such as time management, risk management.	Apply time management and risk management skills.

S-21	Skill in incorporating user experience feedback into software.	Incorporate user experience feedback into software applications.
S-22	Skill in integrating third party open source resources into software.	Integrate third-party open source components into applications.
S-23	Skill in learning new and/or industry standard tools involved in the development of software.	Evaluate and learn new and standard software tools as they become available.
Abilities		**Student Learning Outcomes**
A-1	Ability to both mentor and be mentored; provide critical feedback as well as accept critical feedback two-way.	Distinguish the responsibilities of being a mentor and a mentee and perform in both roles.
A-2	Ability to comprehend and execute both written and oral instructions by asking clarifying questions.	Effectively execute written and oral instructions after asking clarifying questions.
A-3	Ability to effectively communicate technical concepts and constraints in written and oral form to technical team members, stakeholders.	
A-4	Ability to work effectively in multi-disciplinary teams to apply information technology in support of organizational goals.	Demonstrate the ability to work effectively in multi-disciplinary teams to meet and support organizational goals.
A-9	Ability to engage with users and understand their user experience.	
A-5	Ability to produce technical content for tech writers.	Organize technical content for technical writers to finalize.
A-6	Ability to manage your own software development project activities and deliverables in a timely and efficient manner.	Organize and schedule software projects to meet one's own deliverables timeline.
A-7	Ability to work on team projects and demonstrate critical thinking, teamwork, oral communications, inter-cultural appreciation, and technical and information literacy skills.	Demonstrate effective team collaboration and communications skills for technical and information proficiency.
A-8	Ability to research and be able to find other sources to answer the problem.	Perform research to solve a problem.
A-10	Ability to draw on prior knowledge and experience in a new situation.	Apply prior knowledge and experience in new situations.

Software Development Degree Expectations

A pool of 20 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
			% Best Estimate		
T-1	Identify, document and effectively communicate security concerns and/or threat vulnerabilities.	11%	73%	16%	19
T-2	Analyze information to determine, recommend, and plan development and installation of a new system or modification of an existing system.	25%	45%	30%	20
T-3	Develop code to read and write files.	15%	70%	15%	20
T-4	Create webpages using data from a database.	15%	70%	15%	20
T-5	Create applications such as Servlets that send HTML pages to Internet clients.	25%	35%	40%	20
T-6	Write and debug effective code using various scripting languages.	15%	65%	20%	20
T-7	Assist with development on multiple platforms (e.g. Linux, Windows, AppleOS, etc.).	15%	50%	35%	20
T-8	Design, develop and validate stable, robust, secure, and efficient code following industry best practices.	10%	70%	20%	20
T-9	Develop secure code and error handling.	15%	65%	20%	20
T-10	Develop cross platform applications targeted for an OS or platform other than the development environment.	5%	32%	63%	19
T-11	Develop applications that run on multiple browsers.	11%	72%	17%	18
T-12	Design, create, manage, and evaluate Apps.	6%	67%	28%	18
T-13	Manipulate the objects contained in the Document Object Model (DOM).	17%	50%	33%	18
T-14	Demonstrate familiarity with at least one current IDE and other developer productivity tools.	25%	65%	10%	20
T-15	Identify, evaluate, and apply efficient algorithms and data structures (e.g. sorting, multithreading).	11%	37%	53%	19
T-16	Apply SDLC (software development lifecycle) industry practices (e.g. Agile, waterfall, scrum, etc.).	5%	55%	40%	20
T-17	Assist in designing countermeasures and mitigations against potential exploitations of programming language weaknesses and vulnerabilities in system and elements.	5%	21%	74%	19
T-18	Apply secure code documentation in accordance with corporate policy to ensure safety of how code is implemented or processed for user access and security access to code that govern software driven apparatus.	16%	37%	47%	19
T-19	Compile and write documentation of existing software program development and subsequent revisions, inserting comments in the coded instructions so others can understand the program.	6%	72%	22%	18
T-20	Identify and leverage the enterprise-wide version control system while designing and developing secure applications.	11%	42%	47%	19
T-21	Collaborate with a wide range of technical professionals, in person and virtually, using tools and strategies that support cooperative software development practices.	16%	47%	37%	19
T-22	Conduct trial runs of programs and software applications to ensure that the desired information is produced and instructions and security levels are correct.	11%	68%	21%	19
T-23	Test and evaluate any software code/processes you developed - unit testing.	16%	61%	21%	19
T-24	Utilize software testing tools to implement various test strategies.	17%	56%	28%	18

T-25	Assist in developing software system testing and validation procedures, programming, and documentation.	26%	68%	5%	19
T-26	Correct errors by making appropriate changes and rechecking the program to ensure that desired results are produced.	21%	74%	5%	19
T-27	Apply coding and testing standards, security testing tools including "'fuzzing" static-analysis code scanning tools, and conduct code reviews.	0%	35%	65%	20
T-28	Determine system performance against standards and follow appropriate action plan when issues arise.	10%	40%	50%	20
T-29	Implement and properly document software patches and report any software security issues that would leave software vulnerable.	11%	42%	47%	19
T-30	Modify existing software to correct errors, adapt it to new hardware, or upgrade interfaces and improve performance.	11%	42%	47%	19
T-31	Contribute presentation materials and communicated effectively in a team meeting.	5%	80%	15%	20
T-32	Communicate with customers or other departments on project status, proposals, or technical issues, such as software system design or maintenance, including both oral and written communication.	11%	68%	21%	19
T-33	Contribute to team, follow directives from designers and engineers related to software design and implementation.	20%	55%	25%	20
Knowledge					
K-1	Knowledge of software development models (e.g. Waterfall Model, Spiral Model).	11%	42%	47%	20
K-2	Knowledge of system design tools, methods, and techniques, including automated systems analysis and design tools.	11%	63%	26%	19
K-3	Knowledge of effective software debugging principles.	15%	70%	15%	20
K-4	Knowledge of computer programming languages and principles in general.	25%	60%	15%	20
K-5	Knowledge of web services (e.g. service-oriented architecture, REST, and web service description language).	16%	63%	21%	19
K-6	Knowledge of visual representations of a program or system. (e.g. UML, etc.)	10%	60%	30%	20
K-7	Knowledge of how programs communicate across networks using asynchronous and synchronous techniques. (when to use and why)	0%	47%	47%	20
K-8	Knowledge of Software Integration Management Systems – how industry documents final product builds to show all of the elements that have changes and checks those that have not changed.	16%	32%	53%	20
K-9	Knowledge of event handling in a GUI.	12%	71%	18%	17
K-10	Knowledge of Regression Testing Development – how to test software using software.	10%	35%	55%	20
K-11	Knowledge of the appropriate use of cookies.	10%	65%	25%	20
K-12	Knowledge of how applets differ from applications in terms of program form, operating context, and how they are started.	20%	55%	25%	20
K-13	Knowledge of two or more operating systems that are current industry standards (e.g. Linux, Windows Apple OS).	5%	68%	26%	19
K-14	Knowledge of error handling constructs.	10%	75%	15%	20
K-15	Knowledge of the differences between client-side scripting and server-side scripting.	10%	65%	25%	20
K-16	Knowledge of common program architectures (e.g. standalone, three-tier, web-based, cloud-based, serverless, microservice).	5%	53%	42%	19
K-17	Knowledge of the local development cycle (e.g. build, deploy, test, debug).	15%	75%	10%	20
K-18	Knowledge of server software patterns, messaging patterns both async and synch.	11%	39%	50%	18
K-19	Knowledge of database integration/management software.	5%	58%	37%	19
K-20	Knowledge of AI and ML methods and algorithms.	0%	39%	61%	18
K-21	Knowledge of software collaboration tools (e.g. version control, bug tracking, continuous integration).	17%	56%	28%	18

K-22	Knowledge of the limits vs actual process of continuous integration and production deployment practices of devsecops/devnetsecops.	0%	42%	58%	19
K-23	Knowledge of cybersecurity and privacy principles and methods that apply to software development.	5%	80%	15%	20
K-24	Knowledge of system and application security threats and vulnerabilities (e.g. buffer overflow, mobile code, cross-site scripting, Procedural Language/Structured Query Language [PL/SQL] and injections, race conditions, covert channel, replay, return-oriented attacks, malicious code).	0%	56%	44%	18
K-25	Knowledge of code security (e.g. hashing, encryption, cryptography, threat modeling).	5%	47%	47%	19
K-26	Knowledge of Privacy Impact Assessments in terms of privacy and identity management.	7%	47%	47%	15
K-27	Knowledge of cyber threats and vulnerabilities.	5%	90%	5%	19
K-28	Knowledge of software related information technology (IT) security principles and methods (e.g. modularization, layering, abstraction, data hiding, simplicity/minimization).	0%	63%	37%	19
K-29	Awareness of standards such as PCI, PHI, and GDPR.	0%	47%	53%	17
K-30	Knowledge of basic security practices including threats and vulnerabilities that may arise from interactions with other systems, external and legacy code.	11%	58%	32%	19
K-31	Knowledge of computer network fundamentals (e.g., TCP/IP, HTTPS, ports, firewall, LAN/WAN, etc.)and network security methodologies.	16%	58%	26%	19
K-32	Knowledge of implementation and utilization of cloud services including deployment (e.g. AWS, Microsoft Azure).	16%	53%	32%	19
K-33	Awareness of cloud computing concepts (e.g. IoT, edge computing).	16%	42%	42%	19
K-34	Knowledge of software development and implementation for communicating and gathering data from IoT devices.	18%	35%	47%	17
K-35	Knowledge of the difference between AI and ML.	0%	56%	44%	18
K-36	Awareness of current and specialized AI and ML tools and their application to business problems.	0%	44%	56%	18
K-37	Conceptual knowledge of PKI.	6%	44%	50%	16
K-38	Knowledge of DevSecOps.	0%	53%	47%	17
K-39	Knowledge of structured and unstructured data sources.	0%	58%	42%	19
K-40	Knowledge of open source software and risks involved.	5%	89%	5%	19
K-41	Knowledge of ethics and its application to software development.	5%	84%	11%	19
K-42	Knowledge of best practices for Design/UI/UX/accessibility as applied to software development.	0%	74%	26%	19
K-43	Knowledge of lifecycle development/steady state/end of life.	11%	63%	26%	19
K-44	Knowledge of mobile application development.	28%	50%	22%	18
K-45	Knowledge of how to protect data privacy through code.	5%	47%	47%	19
K-46	Knowledge of process flow and how the upgrade/implementation of software is accomplished through definitive understanding of team collaboration in DevOps, End of Life Cycle, and including importance of foundational security.	6%	33%	61%	18
K-47	Knowledge of performing integrated quality assurance testing for security functionality and resiliency attack.	0%	31%	68%	19
K-48	Knowledge of how to identify security implications in the software acceptance phase, including completion criteria, risk acceptance and documentation, common criteria, and methods of independent testing and report concerns to IT/software team.	0%	42%	58%	19
K-49	Knowledge of applications with public keying by leveraging existing public key infrastructure (PKI) libraries and incorporating certificate management and encryption functionalities when appropriate.	11%	22%	67%	18
K-50	Knowledge of how to identify and leverage the enterprise-wide security services while designing and developing secure applications (e.g., Enterprise PKI, Federated Identity server) when appropriate.	6%	6%	88%	17

K-51	Knowledge of how to identify and analyze user needs and use needs to establish a plan in the selection, creation, evaluation, implementation and administration of information technology systems.	6%	50%	44%	18
K-52	Knowledge of security requirements into application design elements including documenting the elements of the software attack surfaces, conducting threat modeling, and defining any specific security criteria.	6%	28%	67%	18
K-53	Knowledge of architecture patterns and when to use them to build applications.	11%	47%	42%	19
K-54	Knowledge of algorithms and data structures (e.g. big-O, linked lists, hash maps, sorting, etc.).	0%	42%	58%	19
K-55	Knowledge of Binary search tree and how binary search works.	0%	42%	58%	19
K-56	Knowledge of Hash maps.	5%	37%	58%	19
Skills					
S-1	Skill in using built-in functions as well as skill in creating custom functions, subroutines, and procedures within software using scripting languages.	15%	70%	15%	20
S-2	Skill in integrating standard object model components with server pages in support of the User Expierence.	10%	55%	35%	20
S-3	Skill in conducting software debugging.	15%	75%	10%	20
S-4	Skill in creating programs that validate and process multiple inputs including command line arguments, environmental variables, and input streams.	11%	74%	16%	19
S-5	Skill in writing code in current programming languages and frameworks.	16%	79%	5%	19
S-6	Skill in developing applications that can log and handle errors, exceptions, and application faults and logging.	17%	50%	33%	18
S-7	Skill in applying root cause analysis (RCA) techniques to solving software/customer issues.	6%	28%	67%	18
S-8	Skill in the live production environment (e.g. monitoring, logging, alerting, remote debugging).	11%	28%	61%	18
S-9	Skill in using electronic mail software (e.g. Google Gmail; IBM Notes Hot technology; Microsoft Exchange Server Hot technology; Microsoft Outlook Hot technology).	22%	56%	22%	18
S-10	Skill in using graphical user interface development software (e.g. Graphical user interface GUI builder software; Graphical user interface GUI design software; Salesforce Visualforce Hot technology).	11%	53%	37%	19
S-11	Skill in using object or component oriented development software (e.g. C++ Hot technology; Document Object Model DOM Scripting; Python Hot technology; Simple API for XML SAX).	6%	50%	44%	18
S-12	Skill in creating classes that use inheritance aspects of the object-oriented paradigm.	11%	63%	26%	19
S-13	Skill in using, incorporating and utilizing cookies.	11%	58%	32%	19
S-14	Skill in implementing programs that use local or remote databases with standard protocols.	5%	53%	42%	19
S-15	Skill in using a scripting language on the server side and the client side of a distributed program .	11%	61%	28%	18
S-16	Skill in evaluating and reporting software needs, constraints, analysis for application-specific concerns.	16%	58%	26%	19
S-17	Skill in implementing levels of security in distributed software applications and applets.	11%	50%	39%	18
S-18	Skill in deploying secure software according to secure software deployment methodologies, tools, and practices (e.g. PCI,GDPR, HIPPA, CCPA).	5%	21%	74%	19
S-19	Skill in mobile application development.	11%	58%	32%	19
S-20	Skills such as time management, risk management.	5%	79%	16%	19
S-21	Skill in incorporating user experience feedback into software.	11%	63%	21%	18
S-22	Skill in integrating third-party open-source resources into software, including minimizing risk.	21%	37%	42%	19

S-23	Skill in learning new and/or industry standard tools involved in the development of software.	26%	63%	11%	19
Abilities					
A-1	Ability to both mentor and be mentored; provide critical feedback as well as accept critical feedback two-way.	5%	55%	40%	20
A-2	Ability to comprehend and execute both written and oral instructions by asking clarifying questions.	11%	68%	21%	19
A-3	Ability to effectively communicate technical concepts and constraints in written and oral form to technical team members, stakeholders.	11%	79%	11%	19
A-4	Ability to work effectively in multi-disciplinary teams to apply information technology in support of organizational goals.	5%	75%	20%	20
A-5	Ability to produce technical content for tech writers.	5%	60%	35%	20
A-6	Ability to manage your own software development project activities and deliverables in a timely and efficient manner.	0%	72%	28%	18
A-7	Ability to work on team projects and demonstrate critical thinking, teamwork, oral communications, intercultural appreciation, and technical and information literacy skills.	5%	80%	15%	20
A-8	Ability to research and be able to find other sources to answer the problem.	5%	74%	21%	19
A-9	Ability to engage with users and understand their user experience.	10%	70%	20%	20
A-10	Ability to draw on prior knowledge and experience in a new situation.	5%	80%	15%	20

TECHNICAL PROJECT MANAGEMENT

The definition for Technical Project Management as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

Technical Project Management comprises the planning and management of a technical initiative from concept through to a concrete deliverable. This includes overall responsibility for outcomes and requires specific knowledge of technologies, applied methodologies and development models to ensure success in planning, managing budget, estimation and execution of the project. Additionally, this area is responsible for change management. The Technical Project Management serves as the liaison between the business and technical experts. This definition was adapted from Iasa Global with input from national IT Thought Leaders.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 82).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

More specific definitions can be found within the KSA list.

The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 85).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 86).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources

included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 87).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 89).

A pool of 28 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Technical Project Management Tasks and KSAs

	Project Plan	Avg
T-1	Follow project plans, including defining scope and time requirements.	2.9
T-2	Identify information technology project resource requirements.	3.2
T-3	Follow guidelines for system implementation.	2.2
T-4	Perform needs analysis to determine opportunities for new and improved business process solutions, and participate in determining opportunities for new and improved business process solutions.	2.5
T-5	Identify interdependencies.	3.2
T-6	Analyze data to identify trends or relationships among variables.	2.7
T-7	Contribute contingency plans regarding project risks.	3.1
T-8	Provide input on project costs, design concepts, or design changes.	2.8
	Tracking, Reporting, and Problem Solving	
T-9	Ensure that appropriate Service-Level Agreements (SLAs) and underpinning contracts have been defined that clearly set out for the customer a description of the service and the measures for monitoring the service.	2.8
T-10	Follow methods to monitor and measure risk, compliance, and assurance efforts.	3.1
T-11	Identify and track critical milestones.	3.4
T-12	Report project status.	3.6
T-13	Track duties, work schedules, or resources.	3.7
T-14	Prepare analytical reports.	3.0
T-15	Provide ongoing improvement and problem-solving support.	2.9
T-16	Collaborate with others to resolve information technology issues.	3.3
T-17	Provide recommendations for possible improvements and upgrades.	2.8
T-18	Review service performance reports identifying any significant issues and variances; initiating, where necessary, corrective actions; and ensuring that all outstanding issues are followed up.	2.9
T-19	Participate in project phase review.	3.6
	Customers/Stakeholders	
T-20	Manage the change control process.	2.9
T-21	Coordinate and manage the overall expectations provided to a customer/project stakeholder, end-to-end, as it relates to the project.	3.1
T-22	Gather feedback on customer satisfaction and internal service performance to foster continual improvement.	3.4
T-23	Manage the internal relationship with information technology (IT) process owners supporting the service, assisting with the definition and agreement of Operating Level Agreements (OLAs).	2.9
T-24	Follow established communication procedures.	2.8
T-25	Collaborate with other service managers and product owners to balance and prioritize services to meet overall customer requirements, constraints, and objectives.	3.0

K-1	Knowledge of emerging technologies.	2.4
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	3.6
K-3	Knowledge of benchmarking.	2.9
K-4	Knowledge of information technology (IT) architectural concepts and frameworks, regulations, and mapping.	2.9
K-5	Knowledge of Risk Management Framework (RMF).	3.1
K-6	Knowledge of resource management principles and techniques.	3.3

K-7	Knowledge of business and management principles involved in strategic planning, resource allocation, coordination of human resources modeling, leadership technique, production methods, and coordination of people and resources.	2.8
K-8	Knowledge of system life cycle management principles, including software security and usability.	3.0
K-9	Knowledge of the organization's enterprise information technology (IT) goals and objectives.	3.1
K-10	Knowledge of the resources and methods to identify and stay current with the organization's enterprise information technology (IT) goals and objectives.	3.7
K-11	Knowledge of the organization's core business/mission processes.	3.4
K-12	Knowledge of project management software and planning tools, including tracking and milestones.	3.4
K-13	Knowledge of risk/threat assessment.	3.3
K-14	Knowledge of principles and processes for providing customer and professional services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	2.9
K-15	Knowledge of standard operating procedures regarding project plan evaluation, resource allocation and availability, as well as project reviews and changes.	4.0
K-16	Knowledge of capabilities and requirements analysis.	3.2
K-17	Knowledge of industry-standard and organizationally-accepted analysis principles and methods.	3.1
K-18	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	3.6
K-19	Knowledge of agile methodologies (iterative/adoptive).	3.1
K-20	Knowledge of waterfall methodology.	2.9
K-21	Knowledge of the elements of a Scrum board and how they operate.	3.0
K-22	Knowledge of documentation mechanisms and procedures.	3.4
K-23	Knowledge of project management terminology (specifically definitions and roles of Product Manager, team roles, stakeholders, Program Manager and Project Manager).	3.5
K-24	Knowledge of project management frameworks and principles.	3.7
K-25	Knowledge of RACI charts and how to use them.	3.8

Skills The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course to gain knowledge of concepts without developing the skills to apply those concepts. Development of skills requires hands-on application of the concepts.		
S-1	Skill in identifying measures or indicators of project performance and the actions needed to improve or correct performance relative to the goals of the project.	3.0
S-2	Skill to translate, track, and prioritize information needs and intelligence collection requirements.	2.7
S-3	Skill in thinking critically, evaluating pros and cons of different ways to solve a problem.	3.6
S-4	Skill in writing materials for co-workers or customers.	3.6
S-5	Skill in reading work-related information.	3.8
S-6	Skill in coordinating and changing what is done based on other people's actions.	3.3
S-7	Skill in managing your time and the time of other people.	3.7
S-8	Skill in listening to others, not interrupting, and asking good questions.	3.6
S-9	Skill in actively learning: Figuring out how to use new ideas or things.	3.4
S-10	Skill in communicating with others virtually and in person.	3.7
S-11	Skill in sharing and presenting information to others.	3.6
S-12	Skill in monitoring: Keeping track of how well people and/or groups are doing in order to make improvements.	3.3
S-13	Skill in social perceptiveness: Understanding people's reactions.	3.1
S-14	Skill in problem solving: Noticing a problem and figuring out the best way to solve it.	3.4
S-15	Skill in negotiating: Bringing people together to solve differences.	3.2
S-16	Skill in using productivity software, spreadsheets, word processing, email, collaboration tools, and file-sharing.	3.4
S-17	Skill in working with agile teams.	3.2

S-18	Skill in conflict resolution.	2.9
S-19	Skill in facilitation.	3.1
S-20	Skill in effectively influencing others.	2.7
S-21	Skill in documenting key decisions.	3.6
S-22	Skill in effectively managing change and the communication and enforcement thereof.	3.1
S-23	Skill in adaptive project management.	3.1
S-24	Skill in recognizing and controlling scope creep.	3.7

Abilities

Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.

A-1	Ability to use rules to solve problems.	3.4
A-2	Ability to make general rules or come up with answers from detailed information.	2.9
A-3	Ability to sequence and arrange activities.	3.6
A-4	Ability to brainstorm ideas.	3.3
A-5	Ability to adjust plans and milestones to changing priorities or customer requirements.	3.6
A-6	Ability to critique project plans.	3.1
A-7	Ability to develop alternative plans and workarounds.	3.1
A-8	Ability to diagram or document interdependencies.	3.2
A-9	Ability to orchestrate and communicate project resource and budgetary needs.	3.5
A-10	Ability to orchestrate and communicate impact of changes on project plan.	3.5
A-11	Ability to develop and deliver presentations.	3.1
A-12	Ability to drive to a decision and manage conflict.	3.8

Technical Project Management Employability Skills

Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers. Level 2 - Employee demonstrates commitment, enthusiasm and supports team members. Employee follows up on assigned tasks and leads by example.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight. Level 2 - Employee makes inquiries of co-workers regarding possible changes needed in ways of doing work and adapts accordingly. Observes co-workers increasing work productivity under pressure and follows their lead.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively.
Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor. Level 2 - Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor. Employee completes development plan without prompting from supervisor.

Technical Project Management Key Performance Indicators

For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with

	Task	Key Performance Indicators
Project Plan		
T-1	Follow project plans, including defining scope and time requirements.	Criteria for satisfying stakeholder needs are identified. The size and the specifics of the project are documented accurately and completely. Appropriate stakeholders and decision-makers are identified in a timely manner. Tasks requiring long lead times are identified to avoid project delays. Escalation procedures are clearly identified and agreed upon. Detailed task list is developed (work breakdown structures). Time requirements are realistic and accommodate the time for the management approved process. Estimates of time, materials, and capabilities needed are accurately identified. Activities dependent upon other activities are sequenced appropriately. Approval points, milestones, and go/no go decision points are defined to allow for project review, evaluation, postponement, and cancellation. Task priorities are assigned. The constraints and potential conflicts are accurately identified.
T-2	Identify information technology project resource requirements.	
T-3	Follow guidelines for system implementation.	
T-4	Identify interdependencies.	
T-5	Analyze data to identify trends or relationships among variables.	
T-6	Contribute contingency plans regarding project risks.	
T-7	Provide input on project costs, design concepts, or design changes.	
T-8	Verify that appropriate Service-Level Agreements (SLAs) and underpinning contracts have been defined that clearly set out for the customer a description of the service and the measures for monitoring the service.	
Tracking, Reporting, and Problem Solving		
T-9	Follow methods to monitor and measure risk, compliance, and assurance efforts.	Project outcomes are in scope, on time, on budget, and customer satisfaction is evaluated against project goals. Complete project phase results are documented, reviewed, and clearly communicated. Lessons learned are clearly documented and communicated. Performance metrics associated with the process are captured and documented. Significant problems are immediately reported. Milestones and schedules are clearly understood and communicated.
T-10	Identify and track critical milestones.	
T-11	Report project status.	
T-12	Track duties, work schedules, or resources.	
T-13	Prepare analytical reports.	
T-14	Provide ongoing improvement and problem-solving support.	
T-15	Collaborate with others to resolve information technology issues.	
T-16	Contribute to recommendations for possible improvements and upgrades.	
T-17	Review service performance reports identifying any significant issues and variances; initiating, where necessary, corrective actions; and ensuring that all outstanding issues are followed up.	
T-18	Participate in project phase review.	
T-19	Manage the change control process.	
Customers/Stakeholders		
T-20	customer/project stakeholder, end-to-end, as it relates to the project.	Relationships are managed so that customers are satisfied with their service. Customers are contacted on a regular basis to provide input on important issues. Feedback from customers is analyzed for important and underlying concerns. Recommendations for continual improvement based on customer feedback are gathered and/or developed. Customer feedback and requests are communicated effectively to appropriate personnel in a timely manner.
T-21	Gather feedback on customer satisfaction and internal service performance to foster continual improvement.	
T-22	Manage the internal relationship with information technology (IT) process owners supporting the service, assisting with the definition and agreement of Operating Level Agreements (OLAs).	
T-23	Follow established communication procedures.	
T-24	Collaborate with other service managers and product owners to balance and prioritize services to meet overall customer requirements, constraints, and objectives.	
T-25	Collaborate with other service managers and product owners to balance and prioritize services to meet overall customer requirements, constraints, and objectives.	

Technical Project Management Student Learning Outcomes

	Knowledge	Student Learning Outcomes
K-15	Knowledge of standard operating procedures regarding project plan evaluation, resource allocation and availability, as well as project reviews and changes.	Define the systems view of project management, share how it applies to information technology (IT) projects, and discuss key elements of the project management framework, including project stakeholders, standard operating procedures, common tools and techniques, and project success.
K-6	Knowledge of resource management principles and techniques.	
K-9	Knowledge of the organization's enterprise information technology (IT) goals and objectives.	
K-23	Knowledge of project management terminology (specifically definitions and roles of Product Manager, team roles, stakeholders, Program Manager and Project Manager).	
K-24	Knowledge of project management frameworks and principles.	
K-7	Knowledge of business and management principles involved in strategic planning, resource allocation, coordination of human resources modeling, leadership technique, production methods, and coordination of people and resources.	Articulate and explain the management principles involved in strategic planning, resource allocation, and leadership techniques along with demonstrating a solid understanding of business operations in project management contexts.
K-8	Knowledge of system life cycle management principles, including software security and usability.	Demonstrate the use of waterfall and agile methodologies (Scrum framework) in designing a system life cycle project, including software security and usability.
K-19	Knowledge of agile methodologies (iterative/adoptive).	
K-20	Knowledge of waterfall methodology.	
K-21	Knowledge of the elements of a Scrum board and how they operate.	
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	Identify and mitigate technical risks through proactive risk management strategies and contingency planning.
K-5	Knowledge of Risk Management Framework (RMF).	
K-13	Knowledge of risk/threat assessment.	
K-3	Knowledge of benchmarking.	Discuss different project management software and planning tools, including tracking, milestones, and the importance of documentation.
K-12	Knowledge of project management software and planning tools, including tracking and milestones.	
K-22	Knowledge of documentation mechanisms and procedures.	
K-4	Knowledge of information technology (IT) architectural concepts and frameworks, regulations, and mapping.	Identify various information technology (IT) architectural concepts and frameworks, including mapping and regulation requirements.
K-11	Knowledge of the organization's core business/mission processes.	Explain how organizations develop information technology (IT) project management methodologies to meet industry-standard requirements.
K-14	Knowledge of principles and processes for providing customer and professional services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	
K-16	Knowledge of capabilities and requirements analysis.	
K-17	Knowledge of industry-standard and organizationally-accepted analysis principles and methods.	
K-25	Knowledge of RACI charts and how to use them.	Proficient in designing, creating, and utilizing RACI (Responsible, Accountable, Consulted, Informed) charts.
K-18	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	Demonstrate the use of proper structure and content of the English language, including the correct use of composition and grammar.
K-10	Knowledge of the resources and methods to identify and stay current with the organization's enterprise information technology (IT) goals and objectives.	Classify emerging technologies that will enhance organization's goals to be competitive.
K-1	Knowledge of emerging technologies.	

	Skills	Student Learning Outcomes
S-1	Skill in identifying measures or indicators of project performance and the actions needed to improve or correct performance relative to the goals of the project.	Collaborate and select appropriate technology solutions and methodologies to address technical challenges within projects, solve problems, and achieve project goals. Monitor performance by key project resources to make improvements to keep the project on schedule.
S-3	Skill in thinking critically, evaluating pros and cons of different ways to solve a problem.	
S-9	Skill in actively learning: Figuring out how to use new ideas or things.	
S-12	Skill in monitoring: Keeping track of how well people and/or groups are doing in order to make improvements.	
S-14	Skill in problem solving: Noticing a problem and figuring out the best way to solve it.	
S-6	Skill in coordinating and changing what is done based on other people's actions.	Develop methods for tracking and coordinating resources and managing time effectively by utilizing productivity software tools (spreadsheets, word processing, email, collaboration tools, and file-sharing platforms).
S-7	Skill in managing your time and the time of other people.	
S-16	Skill in using productivity software, spreadsheets, word processing, email, collaboration tools, and file-sharing.	
S-2	Skill to translate, track, and prioritize information needs and intelligence collection requirements across the extended enterprise.	Design and develop a technical project model that demonstrates the ability to translate, track, and prioritize resource allocation. Consume and compose technical materials for internal and external customers.
S-4	Skill in writing materials for co-workers or customers.	
S-5	Skill in reading work-related information.	
S-10	Skill in communicating with others virtually and in person.	Assemble a cross-functional agile team with focus on collaborating and influencing others, facilitation, and conflict resolution within the team.
S-11	Skill in sharing and presenting information to others.	
S-15	Skill in negotiating: Bringing people together to solve differences.	
S-17	Skill in working with agile teams.	
S-18	Skill in conflict resolution.	
S-19	Skill in facilitation.	
S-20	Skill in effectively influencing others.	
S-21	Skill in documenting key decisions.	Create project plans outlining scope, documenting key decisions, and system implementation strategies with enforcement protocols to handle change.
S-22	Skill in effectively managing change and the communication and enforcement thereof.	
S-8	Skill in listening to others, not interrupting, and asking good questions.	Build enhanced team productivity by utilizing strong collaboration and communication abilities. Maintain records of progress against the project plan to recognize and manage scope creep.
S-13	Skill in social perceptiveness: Understanding people's reactions.	
S-23	Skill in adaptive project management.	
S-24	Skill in recognizing and controlling scope creep.	Demonstrate proficiency in identifying and mitigating scope creep within project environments.
	Abilities	Student Learning Outcomes
A-1	Ability to use rules to solve problems.	Design, develop, and/or critique a project plan to solve an organization's problem using brainstorming techniques and following organizational rules.
A-2	Ability to make general rules or come up with answers from detailed information.	
A-4	Ability to brainstorm ideas.	
A-6	Ability to critique project plans.	
A-3	Ability to sequence and arrange activities.	Validate the project progress using key performance indicators and metrics, making adjustments and developing alternative plans as necessary to ensure project success.
A-5	Ability to adjust plans and milestones to changing priorities or customer requirements.	
A-7	Ability to develop alternative plans and workarounds.	
A-9	Ability to orchestrate and communicate project resource and budgetary needs.	Monitor and communicate project resources to demonstrate proficiency in managing project budgets, timelines, and resources effectively.
A-8	Ability to diagram or document interdependencies.	Configure visual documents illustrating interdependencies to assess the effects of alterations on a project plan. Create and deliver presentations detailing project plan modifications to a customer.
A-10	Ability to orchestrate and communicate impact of changes on project plan.	
A-11	Ability to develop and deliver presentations.	
A-12	Ability to drive to a decision and manage conflict.	Carry out leadership directives while showcasing decision-making skills and managing disputes.

Technical Project Management Degree Expectations

A pool of 28 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
			% Best Estimate		
T-1	Follow project plans, including defining scope and time requirements.	18%	75%	7%	28
T-2	Identify information technology project resource requirements.	19%	52%	30%	27
T-3	Follow guidelines for system implementation.	22%	74%	4%	28
T-4	Perform needs analysis to determine opportunities for new and improved business process solutions, and participate in determining opportunities for new and improved business process solutions.	7%	32%	61%	28
T-5	Identify interdependencies.	11%	57%	32%	28
T-6	Analyze data to identify trends or relationships among variables.	4%	61%	36%	28
T-7	Contribute contingency plans regarding project risks.	4%	50%	46%	28
T-8	Provide input on project costs, design concepts, or design changes.	4%	75%	21%	28
T-9	Ensure that appropriate Service-Level Agreements (SLAs) and underpinning contracts have been defined that clearly set out for the customer a description of the service and the measures for monitoring the service.	4%	48%	48%	27
T-10	Follow methods to monitor and measure risk, compliance, and assurance efforts.	11%	57%	32%	28
T-11	Identify and track critical milestones.	7%	75%	18%	28
T-12	Report project status.	18%	71%	11%	28
T-13	Track duties, work schedules, or resources.	18%	57%	25%	28
T-14	Prepare analytical reports.	4%	46%	50%	28
T-15	Provide ongoing improvement and problem-solving support.	4%	79%	18%	28
T-16	Collaborate with others to resolve information technology issues.	7%	86%	7%	28
T-17	Provide recommendations for possible improvements and upgrades.	7%	75%	18%	28
T-18	Review service performance reports identifying any significant issues and variances; initiating, where necessary, corrective actions; and ensuring that all outstanding issues are followed up.	7%	29%	64%	28
T-19	Participate in project phase review.	4%	71%	25%	28
T-20	Manage the change control process.	0%	61%	39%	28
T-21	Coordinate and manage the overall expectations provided to a customer/project stakeholder, end-to-end, as it relates to the project.	4%	30%	67%	28
T-22	Gather feedback on customer satisfaction and internal service performance to foster continual improvement.	11%	64%	25%	28
T-23	Manage the internal relationship with information technology (IT) process owners supporting the service, assisting with the definition and agreement of Operating Level Agreements (OLAs).	0%	33%	67%	28
T-24	Follow established communication procedures.	18%	82%	0%	28
T-25	Collaborate with other service managers and product owners to balance and prioritize services to meet overall customer requirements, constraints, and objectives.	4%	57%	39%	28
Knowledge					
K-1	Knowledge of emerging technologies.	11%	86%	4%	28
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	7%	75%	18%	28
K-3	Knowledge of benchmarking.	11%	71%	18%	28

K-4	Knowledge of information technology (IT) architectural concepts and frameworks, regulations, and mapping.	7%	64%	29%	28
K-5	Knowledge of Risk Management Framework (RMF).	4%	54%	43%	28
K-6	Knowledge of resource management principles and techniques.	11%	50%	39%	28
K-7	Knowledge of business and management principles involved in strategic planning, resource allocation, coordination of human resources modeling, leadership technique, production methods, and coordination of people and resources.	4%	32%	64%	28
K-8	Knowledge of system life cycle management principles, including software security and usability.	11%	75%	14%	28
K-9	Knowledge of the organization's enterprise information technology (IT) goals and objectives.	7%	71%	21%	28
K-10	Knowledge of the resources and methods to identify and stay current with the organization's enterprise information technology (IT) goals and objectives.	4%	75%	21%	28
K-11	Knowledge of the organization's core business/mission processes.	4%	75%	21%	28
K-12	Knowledge of project management software and planning tools, including tracking and milestones.	14%	61%	25%	28
K-13	Knowledge of risk/threat assessment.	11%	68%	21%	28
K-14	Knowledge of principles and processes for providing customer and professional services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	14%	57%	29%	28
K-15	Knowledge of standard operating procedures regarding project plan evaluation, resource allocation and availability, as well as project reviews and changes.	14%	68%	18%	28
K-16	Knowledge of capabilities and requirements analysis.	11%	68%	21%	28
K-17	Knowledge of industry-standard and organizationally-accepted analysis principles and methods.	7%	71%	21%	28
K-18	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	14%	82%	4%	28
K-19	Knowledge of agile methodologies (iterative/adoptive).	7%	67%	26%	27
K-20	Knowledge of waterfall methodology.	7%	68%	25%	28
K-21	Knowledge of the elements of a Scrum board and how they operate.	7%	54%	39%	28
K-22	Knowledge of documentation mechanisms and procedures.	7%	89%	4%	28
K-23	Knowledge of project management terminology (specifically definitions and roles of Product Manager, team roles, stakeholders, Program Manager and Project Manager).	7%	79%	14%	28
K-24	Knowledge of project management frameworks and principles.	7%	79%	14%	28
K-25	Knowledge of RACI charts and how to use them.	13%	38%	50%	24
Skills					
S-1	Skill in identifying measures or indicators of project performance and the actions needed to improve or correct performance relative to the goals of the project.	7%	64%	29%	28
S-2	Skill to translate, track, and prioritize information needs and intelligence collection requirements.	11%	54%	36%	28
S-3	Skill in thinking critically, evaluating pros and cons of different ways to solve a problem.	4%	86%	11%	28
S-4	Skill in writing materials for co-workers or customers.	7%	89%	4%	28
S-5	Skill in reading work-related information.	21%	79%	0%	28
S-6	Skill in coordinating and changing what is done based on other people's actions.	14%	64%	21%	28
S-7	Skill in managing your time and the time of other people.	18%	64%	18%	28
S-8	Skill in listening to others, not interrupting, and asking good questions.	18%	82%	0%	28
S-9	Skill in actively learning - Figuring out how to use new ideas or things.	7%	89%	4%	28
S-10	Skill in communicating with others virtually and in person.	7%	93%	0%	28
S-11	Skill in sharing and presenting information to others.	11%	89%	0%	28

S-12	Skill in monitoring: Keeping track of how well people and/or groups are doing in order to make improvements.	7%	68%	25%	28
S-13	Skill in social perceptiveness - Understanding people's reactions.	0%	81%	19%	27
S-14	Skill in problem solving: Noticing a problem and figuring out the best way to solve it.	0%	89%	11%	28
S-15	Skill in negotiating: Bringing people together to solve differences.	0%	61%	39%	28
S-16	Skill in using productivity software, spreadsheets, word processing, email, collaboration tools, and file-sharing.	21%	79%	0%	28
S-17	Skill in working with agile teams.	7%	81%	11%	27
S-18	Skill in conflict resolution.	7%	82%	11%	28
S-19	Skill in facilitation.	0%	61%	39%	28
S-20	Skill in effectively influencing others.	0%	64%	36%	28
S-21	Skill in documenting key decisions.	7%	75%	18%	28
S-22	Skill in effectively managing change and the communication and enforcement thereof.	0%	50%	50%	28
S-23	Skill in adaptive project management.	7%	33%	59%	28
S-24	Skill in recognizing and controlling scope creep.	4%	54%	43%	28
Abilities					
A-1	Ability to use rules to solve problems.	11%	79%	11%	28
A-2	Ability to make general rules or come up with answers from detailed information.	4%	64%	32%	28
A-3	Ability to sequence and arrange activities.	18%	82%	0%	28
A-4	Ability to brainstorm ideas.	7%	82%	11%	28
A-5	Ability to adjust plans and milestones to changing priorities or customer requirements.	4%	73%	23%	28
A-6	Ability to critique project plans.	4%	71%	25%	28
A-7	Ability to develop alternative plans and workarounds.	0%	68%	32%	28
A-8	Ability to diagram or document interdependencies.	4%	64%	32%	28
A-9	Ability to orchestrate and communicate project resource and budgetary needs.	4%	52%	44%	28
A-10	Ability to orchestrate and communicate impact of changes on project plan.	4%	46%	50%	28
A-11	Ability to develop and deliver presentations.	4%	96%	0%	28
A-12	Ability to drive to a decision and manage conflict.	0%	54%	46%	28

TECHNICAL SUPPORT

The definition for Technical Support as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

Technical Support refers to services that entities provide to users of technology products or services. In general, technical support provides help regarding specific problems with a software, hardware or network product or service. In some organizations it may include training. This definition was adapted from Wikipedia with input from national IT Thought Leaders.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 94).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

More specific definitions can be found within the KSA list.

The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 97).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 99).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the

ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 100).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 103).

A pool of 36 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Technical Support Tasks and KSAs

		Avg
Tasks SPECIFIC THINGS an entry level person would BE EXPECTED TO PERFORM on the job WITH LITTLE SUPERVISION.		
Install, Configure, Update, Maintain		
T-1	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware).	3.3
T-2	Install and configure hardware, software, and peripheral equipment for system users in accordance with organizational standards.	3.3
T-3	Manage changes/updates for both internal and external customers when policies and procedures change.	3.0
T-4	Maintain computer hardware.	2.8
T-5	Provide technical support for software maintenance or use.	3.6
T-6	Troubleshoot system hardware and software.	3.4
T-7	Diagnose and resolve customer-reported system incidents, problems, and events.	3.3
T-8	Identify, test, and implement solutions to computer hardware and software problems or escalate if required.	3.5
T-9	Test software performance in relation to troubleshooting.	2.8
T-10	Test computer hardware performance in relation to troubleshooting.	2.6
T-11	Collaborate with others to resolve information technology issues.	3.3
T-12	Identify and escalate issues to improve computer or information systems.	3.2
T-13	Escalate computer hardware and software problems according to organization policies.	3.3
T-14	Monitor and report client-level computer system performance.	3.3
T-15	Monitor computer system performance to ensure proper operation.	3.1
T-16	Assess or monitor system for cyberattacks.	3.3
T-17	Responds to crises/security incidents following SOPs.	3.3
T-18	Learn continuously about emerging industry or technology trends (e.g., machine learning and AI).	3.2
T-19	Administer accounts, network rights, and access to systems and equipment.	3.5
T-20	Perform asset management/inventory of information technology (IT) resources.	2.8
T-21	Maintain incident tracking and solution database.	2.8
T-22	Effectively document operational activities and enter results into the knowledge base and/or ticketing systems.	3.3
Knowledge Knowledge focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.		
K-1	Knowledge of the basic operation of computers.	3.9
K-2	Knowledge of computer networking concepts and protocols and network security methodologies.	3.6
K-3	Knowledge of operating environments, organizational software and applications.	3.3
K-4	Knowledge of practices of internal, external, and global customers (as applicable).	2.8
K-5	Knowledge of internal organizational communication processes.	3.1
K-6	Knowledge of customer support processes and practices.	3.7
K-7	Knowledge of technical support operations, issues, and constraints.	3.4
K-8	Knowledge of business issues regarding software licensing.	3.0
K-9	Knowledge of interrelation between different organizational groups.	2.5
K-10	Knowledge of organization chart and roles/responsibilities of company personnel/departments.	2.7
K-11	Knowledge of preventative maintenance procedures and processes.	3.3
K-12	Knowledge of applicable backup and restoration procedures.	3.5
K-13	Knowledge of system monitoring and diagnostic tools and processes.	3.5
K-14	Awareness of the components of the risk management process (e.g., methods for assessing and mitigating risk).	3.0
K-15	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	3.0
K-16	Knowledge of cybersecurity and privacy principles.	3.8

K-17	Knowledge of cyber threats and vulnerabilities.	3.3
K-18	Knowledge of specific operational impacts of cybersecurity lapses.	3.2
K-19	Knowledge of measures or indicators of system performance and availability.	3.0
K-20	Knowledge of systems administration concepts.	3.1
K-21	Knowledge of physical computer components and architectures, including the functions of various components and peripherals.	3.3
K-22	Knowledge of electronic devices (e.g., computer systems/components, access control devices, digital cameras, digital scanners, electronic organizers, hard drives, memory cards, modems, network components, networked appliances, networked home control devices, printers, removable storage devices, telephones, copiers, facsimile machines, etc.).	3.1
K-23	Knowledge of file extensions (e.g., .dll, .bat, .zip, .pcap, .gzip).	3.1
K-24	Knowledge of Cloud-based technologies and concepts (e.g., IAAS, SAAS, PAAS, file/sync/share).	3.6
K-25	Knowledge of system administration concepts for operating systems such as but not limited to Unix/Linux, IOS, Android, and Windows operating systems.	3.4
K-26	Knowledge of industry best practices for service desk (e.g., machine learning and AI).	3.1
K-27	Knowledge of organizational security policies.	3.4
K-28	Knowledge of remote access processes, tools, and capabilities related to customer support.	3.6
K-29	Knowledge of Personally Identifiable Information (PII) data security standards.	3.3
K-30	Knowledge of Payment Card Industry (PCI) data security standards at an awareness level.	2.9
K-31	Knowledge of Personal Health Information (PHI) data security standards.	3.1
K-32	Knowledge of an organization's information classification program and procedures for information compromise.	2.8
K-33	Knowledge of the operations and processes for incident, problem, and event management including escalation as needed.	3.3
K-34	Knowledge of IT system operation, maintenance, and security needed to keep equipment functioning properly.	3.3
K-35	Knowledge of procedures used for documenting and querying reported incidents, problems, and events.	3.0
K-36	Knowledge of successful capabilities to identify the solutions to less common and more complex system problems.	3.1
K-37	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, knowledge assessment, meeting quality standards for services, and evaluation of customer satisfaction.	2.8
K-38	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	3.3
K-39	Knowledge of troubleshooting methods.	3.6
K-40	Knowledge of change control procedures.	3.3
K-41	Knowledge of documentation processes and procedures.	3.1
K-42	Knowledge of technical presentation tools.	2.6
K-43	Knowledge of continuous quality improvement.	2.8
K-44	Knowledge of VOIP telecommunication systems, both cloud-based and on premise, as well as the OSI model and common networking protocols.	2.8
K-45	Knowledge of what is cloud-based and what is on premises as well as the different support models for each.	3.4
K-46	Knowledge of when to escalate to vendor or providers and how to monitor progress through solution.	3.2
K-47	Knowledge of cybersecurity trends and effect of changes due to cybersecurity event.	3.0
K-48	Knowledge of change management approaches and communication.	2.9
K-49	Knowledge of security threats.	3.6
K-50	Knowledge of professional services automation and management (e.g. security patches that are automatically deployed).	3.0
K-51	Knowledge of case management tools, processes, and procedures.	3.1
K-52	Knowledge of crisis management processes and procedures.	2.9

	Skills The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course to gain knowledge of concepts without developing the skills to apply those concepts. Development of skills requires hands-on application of the concepts.	
S-1	Skill in identifying possible causes of degradation of system performance or availability as well as skill in initiating actions needed to mitigate this degradation.	3.3
S-2	Skill in using the appropriate tools for repairing software, hardware, and peripheral equipment of a system.	3.3
S-3	Skill in conducting research for troubleshooting novel client-level problems.	3.1
S-4	Skill in configuring and validating network workstations and peripherals in accordance with approved standards and/or specifications.	3.3
S-5	Skill in incident response for on premises or cloud service models.	3.3
S-6	Skill in communicating with others.	3.7
S-7	Skill in listening to others, not interrupting, and asking good questions.	3.7
S-8	Skill in recognizing a problem and figuring out the best way to solve it.	3.5
S-9	Skill in thinking about the pros and cons of different ways to solve a problem.	3.4
S-10	Skill in writing for communicating with co-workers or customers.	3.2
S-11	Skill in reading work-related technical information.	3.5
S-12	Skill in monitoring workload, managing time, and prioritizing requests.	3.4
S-13	Skill in adapting to and implementing change as a result of cybersecurity incident or AI directive.	3.3
S-14	Skill in applying techniques for handling unhappy customers professionally.	3.7
S-15	Skill in communicating with a customer at a level they can comprehend.	3.7
	Abilities Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.	
A-1	Ability to analyze and interpret customer input for expressed and implied issues.	3.4
A-2	Ability to accurately define incidents, problems, and events in the trouble ticketing system.	3.4
A-3	Ability to follow, develop, update, and/or maintain standard operating procedures (SOPs).	2.9
A-4	Ability to find solutions to less common and more complex system problems including escalating problems when needed.	3.0
A-5	Ability to translate technical language into lay terminology when needed.	3.2
A-6	Ability to communicate verbally, appropriately for different audiences and organizational levels.	3.2
A-7	Ability to communicate complex technical issues and business implications.	2.9
A-8	Ability to read and interpret technical documents, diagrams, and decision trees.	3.4
A-9	Ability to record data in knowledge bases using proper keywords.	3.5
A-10	Ability to listen and understand what people say.	3.8
A-11	Ability to recognize and understand details.	3.7
A-12	Ability to speak clearly.	3.7
A-13	Ability to make order out of ambiguity.	3.5
A-14	Ability to use rules to solve problems.	3.3
A-15	Ability to communicate by writing.	3.6
A-16	Ability to create appropriate presentation visuals for technical material.	2.5
A-17	Ability to adjust to changing technology.	3.5

Technical Support Employability Skills

Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers. Level 2 - Employee demonstrates commitment, enthusiasm and supports team members. Employee follows up on assigned tasks and leads by example.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving. Level 2 - With minimal supervision, employee analyzes underlying causes, considers risks and implications and uses logic to draw conclusions. Employee applies rules and principles to processes and recommends solutions.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight. Level 2 - Employee makes inquiries of co-workers regarding possible changes needed in ways of doing work and adapts accordingly. Observes co-workers increasing work productivity under pressure and follows their lead.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively. Level 3: Easily works with diverse teams to achieve collective goals. Demonstrates empathy and respect for all colleagues leading to positive working relationships throughout the organization.

Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor. Level 2 - Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor. Employee completes development plan without prompting from supervisor.

Technical Support Key Performance Indicators

For the entry-level employee, all tasks are typically done under supervision for as much as the first year and then with some independence with verification after the employee has more experience. All tasks are done according to company guidelines.

	Task	Key Performance Indicators
Install, Configure, Update, Maintain		
T-1	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware).	Current hardware, software and system documentation are obtained and evaluated.
T-2	Install and configure hardware, software, and peripheral equipment for system users in accordance with organizational standards.	System hardware and peripherals are installed, configured and maintained according to specifications. System and peripherals are tested for functionality and performance.
T-3	Manage changes/updates for both internal and external customers when policies and procedures change.	Operating and application software are installed, configured and upgraded according to specifications. Maintenance includes appropriate follow-up action according to company policy.
T-4	Maintain computer hardware.	Changes are documented and distributed in accordance with company policy.
T-5	Provide technical support for software maintenance or use.	
Troubleshoot and Support		
T-6	Troubleshoot system hardware and software.	Users/customers are serviced in timely manner. Customer input is gathered and analyzed. Relationships are managed so that users/customers are satisfied with the level of service. Problems are correctly identified and causes are isolated. Solutions are thoroughly researched, using existing knowledge base. Solutions are tested in a complete and realistic manner. Test scenarios are representative of actual use and environment. Resolutions are documented to the appropriate level of detail in accordance with company policy.
T-7	Diagnose and resolve customer-reported system incidents, problems, and events.	
T-8	Identify, test and implement solutions to computer hardware and software problems or escalate if required.	
T-9	Test software performance in relation to troubleshooting.	
T-10	Test computer hardware performance in relation to troubleshooting.	
T-11	Collaborate with others to resolve information technology issues.	
T-12	Identify and escalate issues to improve computer or information systems.	
T-13	Escalate computer hardware and software problems according to organization policies.	
Monitor		
T-14	Monitor and report client-level computer system performance.	System performance is monitored and reported according to procedures. Disruptions, outages, security violations and attacks of network services are monitored, recognized and reported in a timely manner, in accordance with company policies and procedures.
T-15	Monitor computer system performance to ensure proper operation.	
T-16	Assess or monitor system for cyberattacks.	
T-17	Responds to crises/security incidents following SOPs.	
Research and Evaluation		
T-18	Learn continuously about emerging industry or technology trends (e.g., machine learning and AI).	Initiative is demonstrated regarding pursuit of research and/or training opportunities on emerging industry or technology trends.
Administration		
T-19	Administer accounts, network rights, and access to systems and equipment.	Accounts are set up following standard operating procedures. Incidents are documented via the company incident tracking system and procedures. Documentation is clear and accurate and follows organization format and procedures. Assets are tracked and documented in accordance with company policy.
T-20	Perform asset management/inventory of information technology (IT) resources.	
T-21	Maintain incident tracking and solution database.	
T-22	Effectively document operational activities and enter results into the knowledge base and/or ticketing systems.	

Technical Support Student Learning Outcomes

	Knowledge	Student Learning Outcomes
K-9	Knowledge of interrelation between different organizational groups.	Describe a company's organizational structural, group roles and responsibilities, and internal and external communication processes.
K-10	Knowledge of organizational chart and roles/responsibilities of company personnel/departments.	
K-32	Knowledge of an organization's information classification program and procedures for information compromise.	
K-5	Knowledge of internal organizational communication processes.	
K-35	Knowledge of procedures used for documenting and querying reported incidents, problems, and events.	Explain a company's business process for systems documentation. Discuss business processes and issues for IT professionals including privacy laws, software licensing, ethical and professional behavior.
K-41	Knowledge of documentation processes and procedures.	
K-8	Knowledge of business issues regarding software licensing.	
K-2	Knowledge of computer networking concepts and protocols, and network security methodologies.	Explain the OSI model as it applies to various network environments. Identify and summarize techniques to secure network communication. Demonstrate the use of operating system commands to manipulate files and directories and perform systems software troubleshooting. Explain various terminologies and technologies related to cloud-based systems. Differentiate between public, private, and hybrid cloud-based environments. Describe the Voice over Internet Protocol (VoIP) telecommunications systems within the networking protocols.
K-20	Knowledge of systems administration concepts.	
K-28	Knowledge of remote access processes, tools, and capabilities related to customer support.	
K-19	Knowledge of measures or indicators of system performance and availability.	
K-24	Knowledge of cloud-based technologies and concepts (e.g., IAAS, SAAS, PAAS, file/sync/share).	
K-44	Knowledge of VOIP telecommunication systems, both cloud-based and on premise, as well as the OSI model and common networking protocols.	
K-45	Knowledge of what is cloud-based and what is on premises as well as the different support models for each.	
K-21	Knowledge of physical computer components and architectures, including the functions of various components and peripherals .	Identify and resolve common hardware faults and failures. Describe how to install, configure, diagnose, and perform preventive maintenance on different hardware devices. Identify the components of integrating the TCP/IP protocol into the networking environment. Discuss how to identify issues with software installation, configuration, permissions, and licensing restrictions. Describe how to assemble commonly required components in standard desktop/laptop computers.
K-22	Knowledge of electronic devices (e.g., computer systems/components, access control devices, digital cameras, digital scanners, electronic organizers, hard drives, memory cards, modems, network components, networked appliances, networked home control devices, printers, removable storage devices, telephones, copiers, facsimile machines, etc.).	
K-34	Knowledge of IT system operation, maintenance, and security needed to keep equipment functioning properly.	
K-1	Knowledge of the basic operation of computers.	
K-11	Knowledge of preventative maintenance procedures and processes.	
K-12	Knowledge of applicable backup and restoration procedures.	Discuss the organization's backup and restoration process.
K-13	Knowledge of system monitoring and diagnostic tools and processes.	Explain the use of system monitoring and diagnostic tools.
K-14	Awareness of the components of the risk management process (e.g., methods for assessing and mitigating risk).	Interpret the importance of Controlled Access to mitigate risk and vulnerabilities in all network environments.
K-52	Knowledge of crisis management processes and procedures.	Explain crisis management processes and procedures.

K-33	Knowledge of the operations and processes for incident, problem, and event management including escalation as needed.	Enumerate the best technologies to support and solve actual technical support problems. Identify the common troubleshooting methods to solve a customer problem. Describe how to troubleshoot and repair a non-functioning device of a customer.
K-36	Knowledge of successful capabilities to identify the solutions to less common and more complex system problems.	
K-46	Knowledge of when to escalate to vendor or providers and how to monitor progress through solution.	
K-26	Knowledge of industry best practices for service desk (e.g., machine learning and AI).	
K-7	Knowledge of technical support operations, issues, and constraints.	
K-37	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, knowledge assessment, meeting quality standards for services, and evaluation of customer satisfaction.	
K-39	Knowledge of troubleshooting methods.	
K-40	Knowledge of change control procedures.	
K-51	Knowledge of case management tools, processes, and procedures.	
K-4	Knowledge of practices of internal, external, and global customers (as applicable).	
K-6	Knowledge of customer support processes and practices.	
K-3	Knowledge of operating environments, organizational software and ap	Describe different types of file extensions. Explain command line interface operating system commands. Discuss system administration concepts for various operating systems.
K-23	Knowledge of file extensions (e.g., .dll, .bat, .zip, .pcap, .gzip).	
K-25	Knowledge of system administration concepts for operating systems such as but not limited to Unix/Linux, IOS, Android, and Windows operating systems.	
K-16	Knowledge of cybersecurity and privacy principles.	Explain data privacy laws with respect to federal and state laws in the USA. Describe laws, regulations, and ethical behavior for cybersecurity
K-15	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	
K-18	Knowledge of specific operational impacts of cybersecurity lapses.	Discuss the consequences of cybersecurity lapses to an organization in light of organizational security policies, including automated functions.
K-27	Knowledge of organizational security policies.	
K-47	Knowledge of cybersecurity trends and effect of changes due to cybersecurity event.	
K-50	Knowledge of professional services automation and management (e.g., security patches that are automatically deployed).	
K-29	Knowledge of Personally Identifiable Information (PII) data security standards.	Discuss data security standards in depth as they pertain to different business and industry environments. Describe how to assess network vulnerabilities and attacks. Identify hardware and software defenses needed to protect the infrastructure in both wired and wireless installations.
K-30	Knowledge of Payment Card Industry (PCI) data security standards at an awareness level.	
K-31	Knowledge of Personal Health Information (PHI) data security standards.	
K-17	Knowledge of cyber threats and vulnerabilities.	
K-49	Knowledge of security threats.	
K-42	Knowledge of technical presentation tools.	Demonstrate effective oral, written, and presentation communication skills in the delivery of customer service, project planning and task completion in the technology support environment. Identify key organizational methods for continuous quality improvement and change management.
K-38	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	
K-43	Knowledge of continuous quality improvement.	
K-48	Knowledge of change management approaches and communication.	

	Skills	Student Learning Outcomes
S-12	Skill in monitoring workload, managing time, and prioritizing requests.	Create a basic schedule for handling technical job requests based on deadlines and urgency. Configure network software and hardware equipment based on industry standards and specifications. Demonstrate practical skills in the selection and utilization of hardware and software tools to diagnose, repair, and optimize computer systems. Conduct research to troubleshoot client-level problems. Apply troubleshooting skills to solve a technical support problem. Use appropriate network performance monitoring tools to identify and solve system issues.
S-4	Skill in configuring and validating network workstations and peripherals in accordance with approved standards and/or specifications.	
S-2	Skill in using the appropriate tools for repairing software, hardware, and peripheral equipment of a system.	
S-3	Skill in conducting research for troubleshooting novel client-level problems.	
S-8	Skill in recognizing a problem and figuring out the best way to solve it.	
S-9	Skill in thinking about the pros and cons of different ways to solve a pro	
S-1	Skill in identifying possible causes of degradation of system performance or availability as well as skill in initiating actions needed to mitigate this degradation.	
S-13	Skill in adapting to and implementing change as a result of cybersecurity incident or AI directive.	Analyze the impact of cybersecurity incidents or directives and implement appropriate adaptive changes in security policies, procedures, or technologies. Demonstrate ability to effectively respond to on-premises or cloud-
S-5	Skill in incident response for on premises or cloud service models.	
S-6	Skill in communicating with others.	Demonstrate collaboration and communication skills to improve team productivity and customer support. Identify and interpret relevant technical information from multiple sources.
S-7	Skill in listening to others, not interrupting, and asking good questions.	
S-10	Skill in writing for communicating with co-workers or customers.	
S-11	Skill in reading work-related technical information.	
S-14	Skill in applying techniques for handling unhappy customers professionally.	Adapt communication and problem-solving approaches based on the specific nature of the complaint, demonstrating composure in challenging situations.
S-15	Skill in communicating with a customer at a level they can comprehend.	
	Abilities	Student Learning Outcomes
A-2	Ability to accurately define incidents, problems, and events in the trouble ticketing system.	Diagnose and document responses to maintenance and trouble tickets by following SOP. Evaluate issues not addressed by the SOP, and update necessary steps and knowledge databases as needed. Demonstrate consistent adherence to organizational SOPs, ensuring tasks are executed accurately and efficiently within established guidelines.
A-3	Ability to follow, develop, update, and/or maintain standard operating procedures (SOPs).	
A-9	Ability to record data in knowledge bases using proper keywords.	
A-14	Ability to use rules to solve problems.	
A-5	Ability to translate technical language into lay terminology when needed.	Communicate technical jargon in simple terms to clients. Explain complex problems and refer to appropriate higher technical support levels.
A-7	Ability to communicate complex technical issues and business implications.	
A-4	Ability to find solutions to less common and more complex system problems including escalating problems when needed.	
A-13	Ability to make order out of ambiguity.	Detect and identify the customer issue, considering all details and addressing ambiguities. Manage the details of the customer troubleshooting issue.
A-1	Ability to analyze and interpret customer input for expressed and implied issues.	
A-11	Ability to recognize and understand details.	
A-6	Ability to communicate verbally, appropriately for different audiences and organizational levels.	Demonstrate competence in effective collaboration, communication (both oral and written), and listening skills to define and solve technical problems for a diverse audience. Identify, evaluate, and suggest solutions to technical problems encountered.
A-10	Ability to listen and understand what people say.	
A-12	Ability to speak clearly.	
A-15	Ability to communicate by writing.	
A-16	Ability to create appropriate presentation visuals for technical material.	Communicate and present technical information. Analyze and interpret technical documents and diagrams. Analyze the impact of emerging technologies and adapt accordingly.
A-8	Ability to read and interpret technical documents, diagrams, and decision trees.	
A-17	Ability to adjust to changing technology.	

Technical Support Degree Expectations

A pool of 36 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
			% Best Estimate		
T-1	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware).	37%	51%	11%	35
T-2	Install and configure hardware, software, and peripheral equipment for system users in accordance with organizational standards.	50%	44%	6%	36
T-3	Manage changes/updates for both internal and external customers when policies and procedures change.	25%	61%	14%	36
T-4	Maintain computer hardware.	56%	44%	0%	36
T-5	Provide technical support for software maintenance or use.	42%	53%	6%	36
T-6	Troubleshoot system hardware and software.	39%	58%	3%	36
T-7	Diagnose and resolve customer reported system incidents, problems, and events.	25%	67%	8%	36
T-8	Identify, test and implement solutions to computer hardware and software problems or escalate if required.	36%	58%	6%	36
T-9	Test software performance in relation to troubleshooting.	19%	61%	19%	36
T-10	Test computer hardware performance in relation to troubleshooting.	28%	64%	8%	36
T-11	Collaborate with others to resolve information technology issues.	17%	81%	3%	36
T-12	Identify and escalate issues to improve computer or information systems.	33%	61%	6%	36
T-13	Escalate computer hardware and software problems according to organization policies.	33%	56%	11%	36
T-14	Monitor and report client-level computer system performance.	33%	47%	19%	36
T-15	Monitor computer system performance to ensure proper operation.	28%	58%	14%	36
T-16	Assess or monitor system for cyberattacks.	11%	58%	31%	36
T-17	Responds to crises/security incidents following SOPs.	11%	58%	31%	36
T-18	Learn continuously about emerging industry or technology trends (e.g., machine learning and AI).	6%	67%	28%	36
T-19	Administer accounts, network rights, and access to systems and equipment.	25%	58%	17%	36
T-20	Perform asset management/inventory of information technology (IT) resources.	22%	61%	17%	36
T-21	Maintain incident tracking and solution database.	19%	61%	19%	36
T-22	Effectively document operational activities and enter results into the knowledge base and/or ticketing systems.	23%	66%	11%	36
	Knowledge				
K-1	Knowledge of the basic operation of computers.	31%	69%	0%	36
K-2	Knowledge of computer networking concepts and protocols, and network security methodologies.	28%	72%	0%	36
K-3	Knowledge of operating environments, organizational software and applications.	25%	67%	8%	36
K-4	Knowledge of practices of internal, external, and global customers (as applicable).	17%	56%	28%	36
K-5	Knowledge of internal organizational communication processes.	17%	77%	6%	35
K-6	Knowledge of customer support processes and practices.	31%	67%	3%	36
K-7	Knowledge of technical support operations, issues, and constraints.	25%	72%	3%	36

K-8	Knowledge of business issues regarding software licensing .	11%	56%	33%	36
K-9	Knowledge of interrelation between different organizational groups.	12%	49%	39%	33
K-10	Knowledge of organization chart and roles/responsibilities of company personnel/departments.	11%	63%	26%	35
K-11	Knowledge of preventative maintenance procedures and processes.	22%	72%	6%	36
K-12	Knowledge of applicable backup and restoration procedures.	17%	72%	11%	36
K-13	Knowledge of system monitoring and diagnostic tools and processes.	22%	72%	6%	36
K-14	Awareness of the components of the risk management process(e.g., methods for assessing and mitigating risk).	11%	43%	46%	36
K-15	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	3%	64%	33%	36
K-16	Knowledge of cybersecurity and privacy principles.	6%	83%	11%	36
K-17	Knowledge of cyber threats and vulnerabilities.	6%	86%	8%	36
K-18	Knowledge of specific operational impacts of cybersecurity lapses.	3%	69%	28%	36
K-19	Knowledge of measures or indicators of system performance and availability.	6%	66%	29%	35
K-20	Knowledge of systems administration concepts.	11%	71%	17%	36
K-21	Knowledge of physical computer components and architectures, including the functions of various components and peripherals.	33%	64%	3%	36
K-22	Knowledge of electronic devices (e.g., computer systems/components, access control devices, digital cameras, digital scanners, electronic organizers, hard drives, memory cards, modems, network components, networked appliances, networked home control devices, printers, removable storage devices, telephones, copiers, facsimile machines, etc.).	33%	67%	0%	36
K-23	Knowledge of file extensions (e.g., .dll, .bat, .zip, .pcap, .gzip).	28%	72%	0%	36
K-24	Knowledge of Cloud-based technologies and concepts (e.g. IAAS, SAAS, PAAS, file/sync/share).	8%	72%	19%	36
K-25	Knowledge of system administration concepts for operating systems such as but not limited to Unix/Linux, IOS, Android, and Windows operating systems.	17%	81%	3%	36
K-26	Knowledge of industry best practices for service desk (e.g. Machine learning and AI).	17%	53%	31%	36
K-27	Knowledge of organizational security policies.	14%	86%	0%	36
K-28	Knowledge of remote access processes, tools, and capabilities related to customer support.	31%	61%	8%	36
K-29	Knowledge of Personally Identifiable Information (PII) data security standards.	12%	74%	15%	34
K-30	Knowledge of Payment Card Industry (PCI) data security standards at an awareness level.	12%	61%	27%	33
K-31	Knowledge of Personal Health Information (PHI) data security standards.	9%	64%	27%	33
K-32	Knowledge of an organization's information classification program and procedures for information compromise.	9%	56%	35%	34
K-33	Knowledge of the operations and processes for incident, problem, and event management including escalation as needed.	23%	66%	11%	36
K-34	Knowledge of IT system operation, maintenance, and security needed to keep equipment functioning properly.	25%	67%	8%	36
K-35	Knowledge of procedures used for documenting and querying reported incidents, problems, and events.	19%	67%	14%	36
K-36	Knowledge of successful capabilities to identify the solutions to less common and more complex system problems.	6%	40%	54%	35
K-37	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, knowledge assessment, meeting quality standards for services, and evaluation of customer satisfaction.	11%	54%	34%	36

K-38	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	11%	86%	3%	36
K-39	Knowledge of troubleshooting methods.	19%	78%	3%	36
K-40	Knowledge of change control procedures.	11%	69%	19%	36
K-41	Knowledge of documentation processes and procedures.	8%	86%	6%	36
K-42	Knowledge of technical presentation tools.	11%	81%	8%	36
K-43	Knowledge of continuous quality improvement.	8%	61%	31%	36
K-44	Knowledge of VOIP telecommunication systems, both cloud based and on premise, as well as the OSI model and common networking protocols.	18%	77%	6%	34
K-45	Knowledge of what is cloud based and what is on premises as well as the different support models for each.	17%	67%	17%	36
K-46	Knowledge of when to escalate to vendor or providers and how to monitor progress through solution.	27%	53%	21%	34
K-47	Knowledge of cybersecurity trends & effect of changes due to Cybersecurity event.	6%	72%	22%	36
K-48	Knowledge of change management approaches and communication.	11%	56%	33%	36
K-49	Knowledge of security threats.	6%	92%	3%	36
K-50	Knowledge of professional services automation and management (e.g. security patches that are automatically deployed).	8%	67%	25%	36
K-51	Knowledge of case management tools, processes and procedures.	8%	58%	33%	36
K-52	Knowledge of crisis management processes and procedures.	8%	61%	31%	36
Skills					
S-1	Skill in identifying possible causes of degradation of system performance or availability as well as skill in initiating actions needed to mitigate this degradation.	20%	49%	31%	35
S-2	Skill in using the appropriate tools for repairing software, hardware, and peripheral equipment of a system.	42%	50%	8%	36
S-3	Skill in conducting research for troubleshooting novel client-level problems.	25%	61%	14%	36
S-4	Skill in configuring and validating network workstations and peripherals in accordance with approved standards and/or specifications.	25%	67%	8%	36
S-5	Skill in incident response for on premises or cloud service models.	18%	68%	15%	34
S-6	Skill in communicating with others.	6%	94%	0%	36
S-7	Skill in listening to others, not interrupting, and asking good questions.	6%	92%	3%	36
S-8	Skill in recognizing a problem and figuring out the best way to solve it.	6%	94%	0%	36
S-9	Skill in thinking about the pros and cons of different ways to solve a problem.	6%	91%	3%	36
S-10	Skill in writing for communicating with co-workers or customers.	9%	89%	3%	36
S-11	Skill in reading work-related technical information.	6%	92%	3%	36
S-12	Skill in monitoring workload, managing time, and prioritizing requests.	6%	83%	11%	36
S-13	Skill in adapting to and implementing change as a result of cybersecurity incident or AI directive.	6%	47%	47%	34
S-14	Skill in applying techniques for handling unhappy customers professionally.	3%	89%	9%	35
S-15	Skill in communicating with a customer at a level they can comprehend.	3%	94%	3%	36
Abilities					
A-1	Ability to analyze and interpret customer input for expressed and implied issues.	17%	80%	3%	35

A-2	Ability to accurately define incidents, problems, and events in the trouble ticketing system.	25%	72%	3%	36
A-3	Ability to follow, develop, update, and/or maintain standard operating procedures (SOPs).	6%	77%	17%	35
A-4	Ability to find solutions to less common and more complex system problems including escalating problems when needed.	11%	78%	11%	36
A-5	Ability to translate technical language into lay terminology when needed.	11%	86%	3%	35
A-6	Ability to communicate verbally, appropriately for different audiences and organizational levels.	11%	77%	11%	35
A-7	Ability to communicate complex technical issues and business implications.	9%	49%	43%	35
A-8	Ability to read and interpret technical documents, diagrams, and decision trees.	14%	71%	14%	35
A-9	Ability to record data in knowledge bases using proper key words.	11%	86%	3%	36
A-10	Ability to listen and understand what people say.	8%	92%	0%	36
A-11	Ability to recognize and understand details.	6%	92%	3%	36
A-12	Ability to speak clearly.	6%	92%	3%	36
A-13	Ability to make order out of ambiguity.	3%	85%	12%	34
A-14	Ability to use rules to solve problems.	8%	83%	8%	36
A-15	Ability to communicate by writing.	6%	92%	3%	36
A-16	Ability to create appropriate presentation visuals for technical material.	3%	86%	11%	36
A-17	Ability to adjust to changing technology.	6%	92%	3%	36

DATA ANALYTICS AND PREDICTIVE MODELING

The definition for Data Analytics and Predictive Modeling as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

> Data Analytics and Predictive Modeling includes inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Business intelligence (BI) specifically focuses on extracting business information for use by decision makers. Common functions of business intelligence include reporting, data mining, process mining, benchmarking, and text mining. This definition was adapted from Wikipedia with input from IT Thought Leaders.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 109).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster. More specific definitions can be found within the KSA list. The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 113).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 114).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 116).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 119).

A pool of 23 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Data Analytics and Predictive Modeling Tasks and KSAs

	Task SPECIFIC THINGS an entry level person would BE EXPECTED TO PERFORM on the job WITH LITTLE SUPERVISION.	AVG
Business Problem (Question) Framing		
T-1	Assist in obtaining or receiving problem statement and usability requirements.	2.9
T-2	Assist in determining if the problem is amenable to an analytics solution.	3.1
Analytics Problem Framing		
T-3	Assist in reformulating the problem statement as an analytics problem.	3.4
T-4	Assist in developing a proposed set of drivers and relationships to outputs.	2.8
T-5	Assist in stating the set of assumptions related to the problem.	3.3
T-6	Assist with collecting metrics and trending data.	3.3
T-7	Assist in obtaining stakeholder agreement on analytical approach by providing detailed analysis.	2.6
Data		
T-8	Assist with identifying and prioritizing data needs and sources.	3.2
T-9	Assist with assessing the validity of source data and subsequent findings.	3.4
T-10	Assist in acquiring data.	2.9
T-11	Assist in harmonizing, rescaling, cleaning, and sharing data.	3.6
T-12	Assist with identifying relationships in the data.	3.6
T-13	Assist with documenting and reporting findings (e.g., insights, results, business performance).	3.4
T-14	Assist with refining the business and analytics problem statements.	2.9
Methodology (Approach) Selection		
T-15	Assist with identifying available problem-solving approaches (methods).	3.2
T-16	Assist in conferring with systems analysts, engineers, programmers, and others to design applications.	2.9
T-17	Assist in using basic and contemporary software tools.	3.1
T-18	Assist in reading, interpreting, writing, modifying, and executing simple scripts/code.	3.2
T-19	Assist in utilizing different programming languages to write code, open files, read files, and write output to different files.	3.3
T-20	Assist in utilizing open-source language or software applications to apply quantitative techniques.	3.3
T-21	Assist with developing and implementing data mining and data programs.	3.4
T-22	Assist with testing approaches (methods).	3.0
T-23	Assist in conducting hypothesis testing using statistical processes.	3.4
T-24	Assist with providing analyses and support for effectiveness assessment.	3.2
Model Building		
T-25	Assist with selecting approaches (methods).	3.0
T-26	Assist with identifying model structures.	3.2
T-27	Assist in running and evaluating the models.	3.1
T-28	Assist with integrating the models.	2.6
T-29	Assist with documenting and communicating findings (including assumptions, limitations, and constraints).	3.2
T-30	Assist with performing internal business verification and validation of test cases.	2.8
Deployment		
T-31	Assist with publishing validation and verification report.	2.6
T-32	Assist in developing recommendations to the supervisor based on data analysis and findings.	3.1
T-33	Assist with deploying application codes and analytical models.	2.3
T-34	Assist with presenting technical information to technical and non-technical audiences.	2.8
T-35	Assist with presenting data in creative formats.	3.0
T-36	Assist with delivering reports with findings.	3.1
Model Lifecycle Management		
T-37	Assist with creating modules and usability via experience and exposure.	2.6
T-38	Assist in supporting deployment.	2.8
T-39	Assist with documenting initial structure (data modeling).	2.8

T-40	Assist in tracking model quality.	2.9
T-41	Assist with providing input and assist in post-action effectiveness assessments.	2.6
T-42	Assist in the identification of information collection shortfalls.	3.1
T-43	Assist with evaluating the business benefit of the model over time.	2.5
T-44	Assist with developing strategic insights from large data sets.	3.3

Knowledge
Knowledge focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.

K-1	Knowledge of risk management processes as part of Software Development Life Cycle.	2.7
K-2	Knowledge of computer algorithms.	2.9
K-3	Knowledge of computer programming principles.	3.4
K-4	Knowledge of data administration and data standardization policies.	2.8
K-5	Knowledge of data mining and data management principles.	3.2
K-6	Knowledge of database management systems, query languages, table relationships, and views.	3.7
K-7	Knowledge of a broad and just-in-time understanding of mathematical concepts (e.g., logarithms, trigonometry, linear algebra, calculus, statistics, and operational analysis).	2.9
K-8	Knowledge of programming language structures and logic.	3.2
K-9	Knowledge of query languages such as SQL (structured query language) and NOSQL.	3.5
K-10	Knowledge of sources, characteristics, and data assets.	2.7
K-11	Knowledge of the various technologies for organizing and managing information (e.g., databases, bookmarking engines).	2.8
K-12	Knowledge of command-line tools (e.g., mkdir, mv, ls, passwd, grep).	2.5
K-13	Knowledge of interpreted and compiled computer languages.	2.7
K-14	Knowledge of how to utilize current popular frameworks and languages.	3.1
K-15	Awareness of machine learning and AI.	2.9
K-16	Knowledge of Personally Identifiable Information (PII) data security standards and how to mask the data.	3.0
K-17	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	3.3
K-18	Knowledge of data mining techniques.	3.0
K-19	Knowledge of relational database framework and why relation databases are used.	3.2
K-20	Knowledge of how to extract, analyze, and use metadata.	3.3
K-21	Awareness of a variety of machine learning techniques (clustering, decision tree learning, artificial neural networks, etc.) and their real-world advantages/drawbacks.	3.0
K-22	Knowledge of advanced statistical techniques and concepts and when to apply them.	3.3
K-23	Knowledge of the underlying theory and concepts of Relational Databases (e.g., Microsoft SQL Server, Oracle, Teradata MySQL).	3.5
K-24	Knowledge of data analysis concepts.	3.5
K-25	Knowledge of how to identify and document potential ethical concerns for application of model outputs.	3.1
K-26	Knowledge in implementing/developing basic data modules using existing tools.	3.0
K-27	Knowledge in Regression Analysis (e.g., Hierarchical Stepwise, Generalized Linear Model, Ordinary Least Squares, Tree-Based Methods, Logistic).	3.0
K-28	Knowledge of refining the problem statement and delineate.	2.7
K-29	Knowledge of tuning models and data.	2.9
K-30	Knowledge of how to clearly articulate information requirements into well-formulated research questions and data tracking variables for inquiry tracking purposes.	2.9
K-31	Knowledge of ethics as it applies to data analytics and how to apply ethical judgment when policies are not well-defined.	2.8
K-32	Knowledge in determining if a difference in values is significant (statistical and common sense) or not.	3.6

K-33	Knowledge of the landscape of BI tools (Power BI, Google) and data preparation tools and understanding of the data platform associated with each.	3.0

Skills
The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course to gain knowledge of concepts without developing the skills to apply those concepts. Development of skills requires hands-on application of the concepts.

S-1	Skill in conducting queries and developing algorithms to analyze data structures.	3.4
S-2	Skill in creating and utilizing mathematical or statistical models.	3.3
S-3	Skill in data mining techniques (e.g., searching file systems) and analysis.	3.1
S-4	Skill in using and contributing content to data dictionaries and documentation.	3.0
S-5	Skill in generating queries and reports.	3.6
S-6	Skill in writing code in a currently supported programming language (e.g., Python).	3.3
S-7	Skill in data pre-processing (e.g., imputation, dimensionality reduction, normalization, transformation, extraction, filtering, smoothing).	3.4
S-8	Skill in identifying patterns or relationships.	3.5
S-9	Skill in performing sentiment analysis.	2.8
S-10	Skill in using basic descriptive statistics and techniques (e.g., normality, model distribution, scatter plots).	3.5
S-11	Skill in using data analysis tools (e.g., Excel, Python).	3.7
S-12	Skill in using data mapping tools.	2.9
S-13	Skill in using outlier identification and removal techniques.	3.1
S-14	Skill in writing scripts in contemporary/popular languages.	3.3
S-15	Skill to identify sources, characteristics, and uses of the data assets.	2.9
S-16	Skill in conducting information searches.	3.0
S-17	Skill in developing or recommending analytic approaches or solutions to problems and situations for which information is incomplete or for which no precedent exists.	2.7
S-18	Skill in evaluating information for reliability, validity, and relevance.	3.1
S-19	Skill in preparing and presenting briefings.	2.8
S-20	Skill in tailoring analysis to the necessary levels (e.g., classification and organizational).	2.9
S-21	Skill in using multiple search engines (e.g., Google, Yahoo, LexisNexis, DataStar) and tools such as ChatGPT in conducting open-source searches.	2.7
S-22	Skill in utilizing feedback to improve processes, products, and services.	3.1
S-23	Skill in performing data analysis including applying statistics.	3.5
S-24	Skill in using statistical / other popular computer languages and frameworks to manipulate.	3.3
S-25	Skill in Visualization using R, Python, or other languages and frameworks.	3.3
S-26	Skill in problem-solving skills and critical thinking ability.	3.7
S-27	Skill in collaboration and communication skills within and across teams.	3.3
S-28	Skill in analytics problem framing (e.g., define geometric sets).	3.1

Abilities
Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.

A-1	Ability to dissect a problem and examine the interrelationships between data that may appear unrelated.	3.3
A-2	Ability to identify basic common coding flaws at a high level.	2.9
A-3	Ability to use popular/contemporary data visualization tools.	3.2
A-4	Ability to source data used in information, assessment, and/or planning products.	2.9
A-5	Ability to communicate complex information, concepts, or ideas in a confident and well-organized manner through verbal, written, and/or visual means.	3.2
A-6	Ability to effectively collaborate via virtual teams.	3.3

A-7	Ability to evaluate information for reliability, validity, and relevance.	3.3
A-8	Ability to focus research efforts to meet the customer's decision-making needs.	3.0
A-9	Ability to adapt to a dynamic environment.	3.3
A-10	Ability to function in a collaborative environment, seeking continuous consultation with other analysts and experts—both internal and external to the organization—to leverage analytical and technical expertise.	3.3
A-11	Ability to identify information gaps.	3.2
A-12	Ability to recognize and assist in mitigating cognitive biases which may affect analysis.	2.9
A-13	Ability to recognize and assist in mitigating deception in reporting and analysis.	3.1
A-14	Ability to think critically.	3.7
A-15	Ability to understand objectives and effects.	3.3
A-16	Ability to utilize multiple information sources across all information disciplines.	3.3
A-17	Ability to effectively communicate ideas to team members with varying levels of technical expertise.	3.1
A-18	Ability to understand a business problem.	3.3
A-19	Ability to understand and use the databases and tools to run queries to solve the business problem.	3.5
A-20	Ability to identify patterns.	3.5
A-21	Ability to present and tell the story with data.	3.7
A-22	Ability to drive confidence in numbers they are presenting by indicating probabilities of the numbers being accurate.	3.7

Data Analytics and Predictive Modeling Employability Skills

Workplace Professionalism and Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively.
Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor.

Data Analytics and Predictive Modeling Key Performance Indicators

For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some

	Task	Key Performance Indicators
Business Problem (Question) Framing		
T-1	Assist in obtaining or receiving problem statement and usability requirements.	Problem statement and usability requirements are obtained in a timely manner and properly documented.
T-2	Assist in determining if the problem is amenable to an analytics solution.	Determination of the applicability of an analytics solution is accurate. Business and analytics problem statements are clear, and are continuously refined.
Analytics Problem Framing		
T-3	Assist in reformulating the problem statement as an analytics problem.	The alternatives to the analytics problem statement are documented and ranked according to best match with current problem and rationale for choices is clearly stated.
T-4	Assist in developing a proposed set of drivers and relationships to outputs.	
T-5	Assist in stating the set of assumptions related to the problem.	Assumptions related to the problem are stated clearly and concisely. Criteria for success are clearly identified.
T-6	Assist with collecting metrics and trending data.	Accurate and relevant analysis is provided regarding analytical approach.
T-7	Assist in obtaining stakeholder agreement on analytical approach by providing detailed analysis.	
Data		
T-8	Assist with identifying and prioritizing data needs and sources.	Sources and methods for acquiring data are efficient and information is accurate and complete.
T-9	Assist with assessing the validity of source data and subsequent findings.	Data is secured from reliable and respected sources.
T-10	Assist in acquiring data.	Data is correctly harmonized, rescaled, and cleaned and relationships in the data are correctly identified.
T-11	Assist in harmonizing, rescaling, cleaning, and sharing data.	
T-12	Assist with identifying relationships in the data.	
T-13	Assist with documenting and reporting findings (e.g., insights, results, business performance).	Findings are documented and communicated in a clear and timely manner; company procedures may vary.
T-14	Assist with refining the business and analytics problem statements.	Data definitions are fully developed and agreed upon in accordance with company procedures.
Methodology (Approach) Selection		
T-15	Assist with identifying available problem-solving approaches (methods).	Sources and methods for acquiring data are efficient and information is accurate and complete.
T-16	Assist in conferring with systems analysts, engineers, programmers, and others to design applications.	The alternatives to the methodology are documented and ranked. Data is secured from reliable and respected sources.
T-17	Assist in using basic and contemporary software tools.	Findings are documented and communicated in a clear and timely manner; company procedures may vary.
T-18	Assist in reading, interpreting, writing, modifying, and executing simple scripts/code.	
T-19	Assist in utilizing different programming languages to write code, open files, read files, and write output to different files.	Data definitions are fully developed and agreed upon in accordance with company procedures. Problem-solving approaches and methods are affordable and relevant.
T-20	Assist in utilizing open-source language or software applications to apply quantitative techniques.	Analysis processes and conclusions are clearly and concisely documented.
T-21	Assist with developing and implementing data mining and data programs.	Effective software tools and problem-solving methods are used. Scripts are complete, relevant, and congruent.
T-22	Assist with testing approaches (methods).	Appropriate testing methodology is identified and planned, and scope of testing is clearly identified.
T-23	Assist in conducting hypothesis testing using statistical processes.	Algorithms, programming principles, statistical processes are used correctly.
T-24	Assist with providing analyses and support for effectiveness assessment.	
Model Building		
T-25	Assist with selecting approaches (methods).	Models are evaluated, and integrated using the proper procedures. Data model is laid out clearly.
T-26	Assist with identifying model structures.	
T-27	Assist in running and evaluating the models.	Performance criteria for the data model have verifiable assumptions. Scope and purpose of model are defined.
T-28	Assist with integrating the models.	Code is developed using efficient software design processes. Reusable components are employed whenever possible.
T-29	Assist with documenting and communicating findings (including assumptions, limitations, and constraints).	Code is well documented so that it can be understood by others. Tests accurately assess the functions the module is designed to perform.
T-30	Assist with performing internal business verification and validation of test cases.	Ethics reviews are routinely accomplished.

	Deployment	
T-31	Assist with publishing validation and verification report.	Presentations are well-organized, utilize creative formats, and meet the needs of technical and non-technical audiences. Enterprise goals are taken into account when drawing conclusions from data analysis and making recommendations to supervisor. Model and usability are evaluated in accordance with company procedures; company procedures may vary.
T-32	Assist in developing recommendations to the supervisor based on data analysis and findings.	
T-33	Assist with deploying application codes and analytical models.	
T-34	Assist with presenting technical information to technical and non-technical audiences.	
T-35	Assist with presenting data in creative formats.	
T-36	Assist with delivering reports with findings.	
	Model Lifecycle Management	
T-37	Assist with creating modules and usability via experience and exposure.	Initial structure of the model (data modeling) is documented in accordance with company standards. Tracking of model quality and model recalibration and maintenance are conducted in a timely manner. Effectiveness testing is based on specification criteria. Recommendations are fed back into the modeling process. Computer data administration, data standardization, data mining, and data management are conducted in accordance with industry and company procedures and standards.
T-38	Assist in supporting deployment.	
T-39	Assist with documenting initial structure (data modeling).	
T-40	Assist in tracking model quality.	
T-41	Assist with providing input and assist in post-action effectiveness assessments.	
T-42	Assist in the identification of information collection shortfalls.	
T-43	Assist with evaluating the business benefit of the model over time.	
T-44	Assist with developing strategic insights from large data sets.	

Data Analytics and Predictive Modeling Student Learning Outcomes

	Knowledge	Student Learning Outcomes
K-1	Knowledge of risk management processes as part of Software Development Life Cycle.	Explain information security fundamentals. Demonstrate an understanding of the importance of ethics and privacy with data. Describe the functions of database recovery, security and administration, and basic data warehousing concepts.
K-16	Knowledge of Personally Identifiable Information (PII) data security standards and how to mask the data.	
K-4	Knowledge of data administration and data standardization policies.	Describe the principles, techniques, and business policies for collecting, organizing, managing, analyzing, and reporting data. Describe the process of data science analytics from data acquisition to recommendations based on data. Describe different methods and tools for data collection and their impact on analysis of data. Identify the concepts of the relational model, normalization, dependencies, integrity, and constraints.
K-11	Knowledge of the various technologies for organizing and managing information (e.g., databases, bookmarking engines).	
K-5	Knowledge of data mining and data management principles.	
K-18	Knowledge of data mining techniques.	
K-24	Knowledge of data analysis concepts.	
K-2	Knowledge of computer algorithms.	Apply the basics of programming principles. Demonstrate problem-solving skills by developing and implementing algorithms to solve problems.
K-3	Knowledge of computer programming principles.	
K-8	Knowledge of programming language structures and logic.	
K-12	Knowledge of command-line tools (e.g., mkdir, mv, ls, passwd, grep).	
K-13	Knowledge of interpreted and compiled computer languages.	
K-6	Knowledge of database management systems, query languages, table relationships, and views.	Identify and explain concepts and frameworks relating to different major types of database systems, including major query languages. Understand query languages and how to use some of the popular query languages such as MySQL.
K-19	Knowledge of relational database framework and why relational databases are used.	
K-23	Knowledge of the underlying theory and concepts of Relational Databases (e.g., Microsoft SQL Server, Oracle, Teradata MySQL).	
K-9	Knowledge of query languages such as SQL (structured query language) and NOSQL.	
K-7	Knowledge of a broad and just-in-time understanding of mathematical concepts (e.g., logarithms, trigonometry, linear algebra, calculus, statistics, and operational analysis).	Select appropriate mathematical and statistical tools used for data analytics.
K-22	Knowledge of advanced statistical techniques and concepts and when to apply them.	
K-10	Knowledge of sources, characteristics, and data assets.	Describe the data acquisition process. Explain data warehousing architectures, processes, and operations.
K-20	Knowledge of how to extract, analyze, and use metadata.	
K-14	Knowledge of how to utilize current popular frameworks and languages.	Describe tools and techniques to store and process data.
K-17	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	Compare and contrast different tools available for gathering and analyzing data. Explain existing tools available for developing data modules.
K-33	Knowledge of the landscape of BI tools (Power BI, Google) and data preparation tools and understanding of the data platform associated with each.	
K-26	Knowledge in implementing/developing basic data modules using existing tools.	
K-29	Knowledge of tuning models and data.	Discuss various aspects of data including how to determine when data is statistically significant. Demonstrate how to use various tuning models and how data tuning works.
K-32	Knowledge in determining if a difference in values is significant (statistical and common sense) or not.	
K-25	Knowledge of how to identify and document potential ethical concerns for application of model outputs.	Select AI tools to analyze data and differentiate between ethical and unethical use of AI.
K-31	Knowledge of ethics as it applies to data analytics and how to apply ethical judgment when policies are not well-defined.	With respect to data analysis, explain what is meant by ethical judgment and the factors to consider when applying ethical judgment. Differentiate knowing right from wrong.

K-27	Knowledge in Regression Analysis (e.g., Hierarchical Stepwise, Generalized Linear Model, Ordinary Least Squares, Tree-Based Methods, Logistic).	Explain the differences between various types of Regression Analysis Tools (e.g., Hierarchical Stepwise, Generalized Linear Model, Ordinary Least Squares, Tree-Based Methods, Logistic).
K-28	Knowledge of refining the problem statement and delineate.	Explain how to refine a problem statement, delineating the steps required to do so.
K-30	Knowledge of how to clearly articulate information requirements into well-formulated research questions and data tracking variables for inquiry tracking purposes.	Summarize project proposal analysis and experience writing project design documents as well as project life cycle tracking.
K-21	Awareness of a variety of machine learning techniques (clustering, decision tree learning, artificial neural networks, etc.) and their real-world advantages/drawbacks.	Discuss the pros and cons of different machine learning techniques in real-world applications.
Skills		**Student Learning Outcomes**
S-1	Skill in conducting queries and developing algorithms to analyze data structures.	Perform queries and develop reports.
S-5	Skill in generating queries and reports.	
S-3	Skill in data mining techniques (e.g., searching file systems) and analysis.	Create data models and use data mining techniques, models, and tools using data dictionaries, mapping tools, and search tools—document results. Cleanse and prepare data for analysis. Identify and address outliers.
S-4	Skill in using and contributing content to data dictionaries and documentation.	
S-12	Skill in using data mapping tools.	
S-13	Skill in using outlier identification and removal techniques.	
S-7	Skill in data pre-processing (e.g., imputation, dimensionality reduction, normalization, transformation, extraction, filtering, smoothing).	
S-8	Skill in identifying patterns or relationships.	Develop or discover analytical patterns from data models.
S-9	Skill in performing sentiment analysis.	
S-10	Skill in using basic descriptive statistics and techniques (e.g., normality, model distribution, scatter plots).	Perform data analysis using statistical models and tools. Demonstrate knowledge of statistical and mathematical models by analyzing a problem and formulating solution using geometric sets. Develop data analysis models using statistics for optimal solution and provide documentation explaining your results.
S-23	Skill in performing data analysis including applying statistics.	
S-2	Skill in creating and utilizing mathematical or statistical models.	
S-28	Skill in analytics problem framing (e.g., define geometric sets).	
S-20	Skill in tailoring analysis to the necessary levels (e.g., classification and organizational).	
S-11	Skill in using data analysis tools (e.g., Excel, Python).	Demonstrate coding and scripting techniques using data analytics programming languages. Use appropriate programming language, data structures, and concepts to solve data analysis problems. Build arrays, data frames, dictionaries, and perform basic calculations using programming languages. Develop a software statistical modeling project and present the solution. Use data visualization tools to analyze data and produce dashboards.
S-6	Skill in writing code in a currently supported programming language (e.g., Python).	
S-14	Skill in writing scripts in contemporary/popular languages.	
S-24	Skill in using statistical/other popular computer languages and frameworks to manipulate.	
S-25	Skill in Visualization using R, Python, or other languages and frameworks.	
S-15	Skill to identify sources, characteristics, and uses of the data assets.	Interpret and analyze the data relevance, reliability, and validity from multiple sources. Integrate the business intelligence methodology and concepts and relate them to decision support.
S-21	Skill in using multiple search engines (e.g., Google, Yahoo, LexisNexis, DataStar) and tools such as ChatGPT in conducting open-source searches.	
S-16	Skill in conducting information searches.	
S-17	Skill in developing or recommending analytic approaches or solutions to problems and situations for which information is incomplete or for which no precedent exists.	
S-18	Skill in evaluating information for reliability, validity, and relevance.	
S-22	Skill in utilizing feedback to improve processes, products, and services.	Demonstrate effective collaboration and communication skills to improve team productivity. Derive problem specifications from problem statements.
S-26	Skill in problem-solving skills and critical thinking ability.	
S-27	Skill in collaboration and communication skills within and across teams.	
S-19	Skill in preparing and presenting briefings.	Demonstrate presentation preparation and delivery skill by preparing a well-balanced briefing of a project showing comprehensive analysis and outcomes.

Abilities		Student Learning Outcomes
A-1	Ability to dissect a problem and examine the interrelationships between data that may appear unrelated.	Solve business problems by identifying data gaps and synthesizing data to deliver quality output. Structure SQL and QBE commands to define, query, and manipulate a relational database. Apply databases to actual situations and business problems.
A-4	Ability to source data used in information, assessment, and/or planning products.	
A-7	Ability to evaluate information for reliability, validity, and relevance.	
A-11	Ability to identify information gaps.	
A-18	Ability to understand a business problem.	
A-20	Ability to identify patterns.	
A-13	Ability to recognize and mitigate deception in reporting and analysis.	
A-16	Ability to utilize multiple information sources across all information disciplines.	
A-2	Ability to identify basic common coding flaws at a high level.	Use data analytics programming and visualization tools. Use data visualization tools to analyze data and produce reports. Develop steps to design and implement a dashboard.
A-3	Ability to use popular/contemporary data visualization tools.	
A-5	Ability to communicate complex information, concepts, or ideas in a confident and well-organized manner through verbal, written, and/or visual means.	Collaborate, communicate, and listen effectively to explain and solve business problems to a diverse audience. Develop algorithms using modular design principles to meet stated specifications. Identify, evaluate, and suggest solutions to problems encountered in a team communication context.
A-6	Ability to effectively collaborate via virtual teams.	
A-9	Ability to adapt to a dynamic environment.	
A-10	Ability to function in a collaborative environment, seeking continuous consultation with other analysts and experts—both internal and external to the organization—to leverage analytical and technical expertise.	
A-17	Ability to effectively communicate ideas to team members with varying levels of technical expertise.	
A-14	Ability to think critically.	
A-12	Ability to recognize and mitigate cognitive biases which may affect analysis.	Maintain high standards of professional competence, conduct, and ethical practice.
A-8	Ability to focus research efforts to meet the customer's decision-making needs.	Competently identify and evaluate data relevance, reliability, and validity from multiple sources to meet customer's needs. Research and utilize validated data to logically construct a report based on customer's needs.
A-15	Ability to understand objectives and effects.	
A-19	Ability to understand and use the databases and tools to run queries to solve the business problem.	Demonstrate understanding of databases and query tools by completing multiple projects using realistic data sets (i.e., formulate a project story).
A-21	Ability to present and tell the story with data.	Run various queries and present results in story format so that concepts and results can be easily understood. Explain the problem to be solved, how it was solved, and what are the results.
A-22	Ability to drive confidence in numbers they are presenting by indicating probabilities of the numbers being accurate.	Confidently use presentation skills that provide an accurate depiction of your analysis. Demonstrate your confidence in your analysis by providing an accuracy analysis (What is the probability of your analysis being accurate. It could be in the form of a percentage).

Data Analytics Degree Expectations

A pool of 23 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
			% Best Estimate		
T-1	Assist in obtaining or receiving problem statement and usability requirements.	35%	57%	9%	23
T-2	Assist in determining if the problem is amenable to an analytics solution.	22%	52%	26%	23
T-3	Assist in reformulating the problem statement as an analytics problem.	22%	35%	44%	23
T-4	Assist in developing a proposed set of drivers and relationships to outputs.	14%	41%	46%	22
T-5	Assist in stating the set of assumptions related to the problem.	23%	55%	23%	22
T-6	Assist with collecting metrics and trending data.	30%	57%	13%	23
T-7	Assist in obtaining stakeholder agreement on analytical approach by providing detailed analysis.	9%	36%	55%	22
T-8	Assist with identifying and prioritizing data needs and sources.	17%	61%	22%	23
T-9	Assist with assessing the validity of source data and subsequent findings.	17%	61%	22%	23
T-10	Assist in acquiring data.	30%	65%	4%	23
T-11	Assist in harmonizing, rescaling, cleaning, and sharing data.	23%	50%	27%	22
T-12	Assist with identifying relationships in the data.	18%	55%	27%	22
T-13	Assist with documenting and reporting findings (e.g., insights, results, business performance).	13%	57%	30%	23
T-14	Assist with refining the business and analytics problem statements.	13%	22%	65%	23
T-15	Assist with identifying available problem-solving approaches (methods).	17%	65%	17%	23
T-16	Assist in conferring with systems analysts, engineers, programmers, and others to design applications.	5%	29%	67%	21
T-17	Assist in using basic and contemporary software tools.	26%	70%	4%	23
T-18	Assist in reading, interpreting, writing, modifying, and executing simple scripts/code.	35%	61%	4%	23
T-19	Assist in utilizing different programming languages to write code, open files, read files, and write output to different files.	26%	61%	13%	23
T-20	Assist in utilizing open-source language or software applications to apply quantitative techniques.	14%	41%	46%	22
T-21	Assist with developing and implementing data mining and data programs.	24%	29%	48%	21
T-22	Assist with testing approaches (methods).	14%	57%	29%	21
T-23	Assist in conducting hypothesis testing using statistical processes.	14%	23%	64%	22
T-24	Assist with providing analyses and support for effectiveness assessment.	15%	25%	60%	20
T-25	Assist with selecting approaches (methods).	10%	48%	43%	21
T-26	Assist with identifying model structures.	14%	32%	55%	22
T-27	Assist in running and evaluating the models.	18%	46%	36%	22
T-28	Assist with integrating the models.	9%	46%	46%	22
T-29	Assist with documenting and communicating findings (including assumptions, limitations and constraints).	18%	55%	27%	23

T-30	Assist with performing internal business verification and validation of test cases.	9%	44%	48%	23
T-31	Assist with publishing validation and verification report.	9%	35%	57%	23
T-32	Assist in developing recommendations to the supervisor based on data analysis and findings.	14%	55%	32%	23
T-33	Assist with deploying application codes and analytical models.	13%	35%	52%	23
T-34	Assist with presenting technical information to technical and non-technical audiences.	10%	62%	29%	21
T-35	Assist with presenting data in creative formats.	13%	70%	17%	23
T-36	Assist with delivering reports with findings.	22%	70%	9%	23
T-37	Assist with creating modules and usability via experience and exposure.	10%	52%	38%	21
T-38	Assist in supporting deployment.	22%	74%	4%	23
T-39	Assist with documenting initial structure (data modeling).	14%	55%	32%	22
T-40	Assist in tracking model quality.	14%	36%	50%	22
T-41	Assist with providing input and assist in post-action effectiveness assessments.	14%	29%	57%	21
T-42	Assist in the identification of information collection shortfalls.	17%	35%	48%	23
T-43	Assist with evaluating the business benefit of the model over time.	13%	26%	61%	23
T-44	Assist with developing strategic insights from large data sets.	14%	32%	55%	22
Knowledge					
K-1	Knowledge of risk management processes as part of Software Development Life Cycle.	4%	61%	35%	23
K-2	Knowledge of computer algorithms.	9%	65%	26%	23
K-3	Knowledge of computer programming principles.	17%	70%	13%	23
K-4	Knowledge of data administration and data standardization policies.	9%	59%	32%	22
K-5	Knowledge of data mining and data management principles.	9%	55%	36%	22
K-6	Knowledge of database management systems, query languages, table relationships, and views.	13%	83%	4%	23
K-7	Knowledge of a broad and just-in-time understanding of mathematical concepts (e.g., logarithms, trigonometry, linear algebra, calculus, statistics, and operational analysis).	5%	23%	73%	22
K-8	Knowledge of programming language structures and logic.	13%	74%	13%	23
K-9	Knowledge of query languages such as SQL (structured query language) and NOSQL.	17%	70%	13%	23
K-10	Knowledge of sources, characteristics, and data assets.	13%	70%	17%	23
K-11	Knowledge of the various technologies for organizing and managing information (e.g., databases, bookmarking engines).	17%	78%	4%	23
K-12	Knowledge of command-line tools (e.g., mkdir, mv, ls, passwd, grep).	13%	70%	17%	23
K-13	Knowledge of interpreted and compiled computer languages.	5%	68%	27%	22
K-14	Knowledge of how to utilize current popular frameworks and languages.	14%	77%	9%	22
K-15	Awareness of machine learning and AI.	14%	68%	18%	22
K-16	Knowledge of Personally Identifiable Information (PII) data security standards and how to mask the data.	9%	73%	18%	22
K-17	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	13%	70%	17%	23
K-18	Knowledge of data mining techniques.	10%	57%	33%	21
K-19	Knowledge of relational database framework and why relation databases are used.	13%	83%	4%	23
K-20	Knowledge of how to extract, analyze, and use metadata.	14%	67%	19%	21
K-21	Awareness of a variety of machine learning techniques (clustering, decision tree learning, artificial neural networks, etc.) and their real-world advantages/drawbacks.	5%	24%	71%	21

K-22	Knowledge of advanced statistical techniques and concepts and when to apply them.	0%	4%	96%	23
K-23	Knowledge of the underlying theory and concepts of Relational Databases (e.g., Microsoft SQL Server, Oracle, Teradata MySQL).	18%	41%	41%	22
K-24	Knowledge of data analysis concepts.	17%	74%	9%	23
K-25	Knowledge of how to identify and document potential ethical concerns for application of model outputs.	9%	61%	30%	23
K-26	Knowledge in implementing/developing basic data modules using existing tools.	18%	64%	18%	22
K-27	Knowledge in Regression Analysis (e.g., Hierarchical Stepwise, Generalized Linear Model, Ordinary Least Squares, Tree-Based Methods, Logistic).	0%	24%	76%	21
K-28	Knowledge of refining the problem statement and delineate.	4%	70%	26%	23
K-29	Knowledge of tuning models and data.	9%	36%	55%	22
K-30	Knowledge of how to clearly articulate information requirements into well-formulated research questions and data tracking variables for inquiry tracking purposes.	0%	46%	55%	22
K-31	Knowledge of ethics as it applies to data analytics and how to apply ethical judgment when policies are not well-defined.	9%	64%	27%	22
K-32	Knowledge in determining if a difference in values is significant (statistical and common sense) or not.	5%	68%	27%	22
K-33	Knowledge of the landscape of BI tools (power BI, Google) and data preparation tools (pull from recording) and understanding of the data platform associated with each.	14%	62%	24%	21
Skills					
S-1	Skill in conducting queries and developing algorithms to analyze data structures.	14%	68%	18%	22
S-2	Skill in creating and utilizing mathematical or statistical models.	9%	35%	57%	23
S-3	Skill in data mining techniques (e.g., searching file systems) and analysis.	17%	52%	30%	23
S-4	Skill in using and contributing content to data dictionaries and documentation.	9%	65%	26%	23
S-5	Skill in generating queries and reports.	22%	78%	0%	23
S-6	Skill in writing code in a currently supported programming language (e.g., Python).	13%	83%	4%	23
S-7	Skill in data pre-processing (e.g., imputation, dimensionality reduction, normalization, transformation, extraction, filtering, smoothing).	5%	57%	38%	21
S-8	Skill in identifying patterns or relationships.	9%	74%	17%	23
S-9	Skill in performing sentiment analysis.	5%	35%	60%	20
S-10	Skill in using basic descriptive statistics and techniques (e.g., normality, model distribution, scatter plots).	17%	61%	22%	23
S-11	Skill in using data analysis tools (e.g., Excel, Python).	22%	70%	9%	23
S-12	Skill in using data mapping tools.	10%	52%	38%	21
S-13	Skill in using outlier identification and removal techniques.	14%	41%	46%	22
S-14	Skill in writing scripts in contemporary/popular languages.	18%	77%	5%	22
S-15	Skill to identify sources, characteristics, and uses of the data assets.	9%	68%	23%	22
S-16	Skill in conducting information searches.	13%	78%	9%	23
S-17	Skill in developing or recommending analytic approaches or solutions to problems and situations for which information is incomplete or for which no precedent exists.	4%	22%	74%	23
S-18	Skill in evaluating information for reliability, validity, and relevance.	4%	65%	30%	23
S-19	Skill in preparing and presenting briefings.	9%	78%	13%	23
S-20	Skill in tailoring analysis to the necessary levels (e.g., classification and organizational).	10%	50%	40%	20

S-21	Skill in using multiple search engines (e.g., Google, Yahoo, LexisNexis, DataStar) and tools such as ChatGPT in conducting open-source searches.	17%	74%	9%	23
S-22	Skill in utilizing feedback to improve processes, products, and services.	10%	71%	19%	21
S-23	Skill in performing data analysis including applying statistics.	13%	48%	39%	23
S-24	Skill in using statistical / other popular computer languages and frameworks to manipulate.	9%	57%	35%	23
S-25	Skill in Visualization using R, Python, or other languages and frameworks.	9%	73%	18%	22
S-26	Skill in problem-solving skills and critical thinking ability.	4%	83%	13%	23
S-27	Skill in collaboration and communication skills within and across teams.	0%	87%	13%	23
S-28	Skill in analytics problem framing (e.g., define geometric sets).	0%	33%	67%	21
Abilities					
A-1	Ability to dissect a problem and examine the interrelationships between data that may appear unrelated.	5%	41%	55%	22
A-2	Ability to identify basic common coding flaws at a high level.	4%	57%	39%	23
A-3	Ability to use popular/contemporary data visualization tools.	9%	70%	22%	23
A-4	Ability to source data used in information, assessment, and/or planning products.	10%	48%	43%	21
A-5	Ability to communicate complex information, concepts, or ideas in a confident and well-organized manner through verbal, written, and/or visual means.	4%	48%	48%	23
A-6	Ability to effectively collaborate via virtual teams.	9%	87%	4%	23
A-7	Ability to evaluate information for reliability, validity, and relevance.	0%	73%	27%	22
A-8	Ability to focus research efforts to meet the customer's decision-making needs.	5%	50%	46%	22
A-9	Ability to adapt to a dynamic environment.	9%	78%	13%	23
A-10	Ability to function in a collaborative environment, seeking continuous consultation with other analysts and experts—both internal and external to the organization—to leverage analytical and technical expertise.	9%	57%	35%	23
A-11	Ability to identify information gaps.	9%	68%	23%	22
A-12	Ability to recognize and assist in mitigating cognitive biases which may affect analysis.	5%	38%	57%	21
A-13	Ability to recognize and assist in mitigating deception in reporting and analysis.	5%	48%	48%	21
A-14	Ability to think critically.	9%	91%	0%	23
A-15	Ability to understand objectives and effects.	9%	91%	0%	22
A-16	Ability to utilize multiple information sources across all information disciplines.	5%	82%	14%	22
A-17	Ability to effectively communicate ideas to team members with varying levels of technical expertise.	0%	78%	22%	23
A-18	Ability to understand a business problem.	13%	70%	17%	23
A-19	Ability to understand and use the databases and tools to run queries to solve the business problem.	22%	70%	9%	23
A-20	Ability to identify patterns.	13%	74%	13%	23
A-21	Ability to present and tell the story with data.	13%	61%	26%	23
A-22	Ability to drive confidence in numbers they are presenting by indicating probabilities of the numbers being accurate.	9%	55%	36%	22

DATA MANAGEMENT AND ENGINEERING

The definition for Data Management and Engineering as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

> Database Management and Engineering typically utilizes specialized software to store, organize and secure data in both relational databases and in other non-relational formats. It includes capacity planning, installation, configuration, database design, migration, performance monitoring, security, and troubleshooting, as well as backup and data recovery. This definition was adapted from Wikipedia.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 125).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

More specific definitions can be found within the KSA list.

The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 129).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 130).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards

and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 132).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 135).

A pool of 21 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Data Management and Engineering Tasks and KSAs

	Task SPECIFIC THINGS an entry level person would BE EXPECTED TO PERFORM on the job WITH LITTLE SUPERVISION.	AVG
Monitor, Install, Configure, Maintain		
T-1	Support maintenance of database management systems software.	3.1
T-2	Assist with monitoring and maintaining databases to ensure optimal performance.	2.7
T-3	Monitor and report the usage of database assets and resources.	2.6
T-4	Support the installation and configuration of database management systems and software.	2.8
T-5	Access database performance.	2.9
T-6	Modify software programs to improve performance.	2.9
T-7	Implement security measures for computer or information systems.	3.3
T-8	Create databases to store data.	3.4
T-9	Make and test modifications to database structure when needed.	3.5
T-10	Merge old databases into new ones.	3.0
Support Database Operations		
T-11	Assist with constructing access paths to suites of information (e.g., link pages) to facilitate access by end-users.	3.1
T-12	Support directory replication services that enable information to replicate automatically from rear servers to forward units via optimized routing.	2.8
T-13	Support information exchanges through publish, subscribe, and alert functions that enable users to send and receive critical information as required.	3.0
T-14	Support the management of compilation, cataloging, caching, distribution, and retrieval of data.	3.4
T-15	Perform backup and recovery of databases to ensure data integrity.	3.1
T-16	Support configuration management, problem management, capacity management, and financial management for databases and data management systems.	3.3
T-17	Support incident management, service-level management, change management, release management, continuity management, and availability management for databases and data management systems.	3.2
T-18	Assist in managing the indexing/cataloging, storage, and access of explicit organizational knowledge (e.g., hard copy documents, digital files).	3.2
T-19	Assist in data mining and data warehousing applications.	3.0
T-20	Update computer database information.	3.2
T-21	Write computer programming code (e.g., Python and R).	3.2
T-22	Support efforts for data consistency and integration including deduplication, standardization, combining records, and database comparison.	3.5
T-23	Assist with analysis and plans for anticipated changes in data capacity requirements.	2.6
Research/Analysis and Recommendations		
T-24	Assist with developing an understanding of the needs and requirements of information for end-users.	3.3
T-25	Provide recommendations on data structures and databases that ensure correct and quality production of reports/management information.	3.1
T-26	Provide assistance in the identification of recommendations on new database technologies and architectures.	2.7
T-27	Analyze data to identify trends or relationships among variables.	3.0
Administration		
T-28	Support data management processes following data management standards, requirements, and specifications.	3.8
T-29	Develop database parameters or specifications.	2.9
T-30	Provide input for development of guidelines for system implementation.	2.8

	Knowledge Knowledge focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.	
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	3.1
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	3.2
K-3	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	3.2
K-4	Knowledge of Data Governance topics and their relationship to Information Governance, IT Governance, IT Service Management, Business Management PMO, Business Operations, and Risk Management.	3.6
K-5	Knowledge of Overall Data Management Maturity Model.	3.1
K-6	Knowledge of ethics.	3.5
K-7	Knowledge of data architecture frameworks such as Zachman Framework for Enterprise Architecture.	3.0
K-8	Knowledge of data modeling techniques.	3.1
K-9	Knowledge of conceptual/logical modeling.	3.1
K-10	Knowledge of physical modeling.	3.1
K-11	Knowledge of how to document the model and its use as a data governance tool.	3.2
K-12	Knowledge of data storage and operations.	3.2
K-13	Knowledge of data integration and interoperability for both structured and unstructured data.	3.7
K-14	Knowledge of cybersecurity and privacy principles.	3.5
K-15	Knowledge of cyber threats and vulnerabilities.	3.4
K-16	Knowledge of specific operational impacts of cybersecurity lapses.	2.9
K-17	Knowledge of cyber defense and vulnerability assessment tools and their capabilities.	2.9
K-18	Knowledge of data administration and data standardization policies.	3.5
K-19	Knowledge of data backup and recovery.	3.2
K-20	Knowledge of data mining and data warehousing principles.	3.2
K-21	Knowledge of database management systems, query languages, table relationships, and views.	3.5
K-22	Knowledge of digital rights management.	3.1
K-23	Knowledge of network access, identity, and access management (e.g., public key infrastructure, Oauth, OpenID, SAML, SPML).	2.6
K-24	Knowledge of operating systems (Linux, UNIX, Windows).	3.1
K-25	Knowledge of policy-based and risk adaptive access controls.	2.8
K-26	Knowledge of query languages such as SQL (structured query language).	2.5
K-27	Knowledge of sources, characteristics, and uses of the organization's data assets.	3.6
K-28	Knowledge of the capabilities and functionality associated with content creation technologies (e.g., wikis, social networking, content management systems, blogs).	3.2
K-29	Knowledge of the capabilities and functionality associated with various technologies for organizing and managing information (e.g., databases, bookmarking engines).	2.9
K-30	Knowledge of the capabilities and functionality of various collaborative technologies (e.g., groupware, SharePoint).	3.1
K-31	Knowledge of the characteristics of physical and virtual data storage media.	2.8
K-32	Knowledge of how IT supports the organization's core business/mission processes.	2.8
K-33	Knowledge of cloud-based knowledge management technologies and concepts related to security, governance, procurement, and administration.	3.1
K-34	Knowledge of data classification standards and methodologies based on sensitivity and other risk factors.	2.8
K-35	Knowledge of database access application programming interfaces (e.g., Java Database Connectivity [JDBC]).	3.1
K-36	Knowledge of Personally Identifiable Information (PII) data security standards.	3.0
K-37	Knowledge of Payment Card Industry (PCI) data security standards.	3.5
K-38	Knowledge of Personal Health Information (PHI) data security standards.	2.9
K-39	Knowledge of current and emerging data encryption (e.g., Column and Tablespace Encryption, file and disk encryption) security features in databases (e.g., built-in cryptographic key management features).	3.0

K-40	Knowledge of current and emerging data remediation security features in databases.	3.1
K-41	Knowledge of use cases related to collaboration and content synchronization across platforms (e.g., Mobile, PC, Cloud).	3.2
K-42	Knowledge of an organization's information classification program and procedures for information compromise.	2.7
K-43	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	2.8
K-44	Knowledge of data mining techniques.	3.2
K-45	Knowledge of database theory.	2.8
K-46	Knowledge of maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	3.2
K-47	Knowledge of understanding data ownership, data stewardship, and data stakeholders.	3.2
K-48	Knowledge of replication services.	3.4
K-49	Knowledge of scripting languages.	2.9
K-50	Awareness of the broad range of tools available to retrieve data.	3.6
K-51	Awareness of business analytics tools (e.g., Power BI, Excel,Tableau, and others).	3.6
K-52	Awareness of data privacy, data protection legislation, and the general role and status of relevant state and federal laws.	3.4
K-53	Awareness of the Gen AI, its role in data management and engineering and related ethical and liability issues. More specifically, how to place boundaries around queries when using AI.	3.4

Skills		
The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course to gain knowledge of concepts without developing the skills to apply those concepts. Development of skills requires hands-on application of the concepts.		
S-1	Skill in allocating storage capacity in the design of data management systems.	2.7
S-2	Skill in conducting information searches.	3.3
S-3	Skill in conducting knowledge mapping (e.g., map of knowledge repositories).	2.8
S-4	Skill in conducting queries and developing algorithms to analyze data structures.	3.3
S-5	Skill in generating data queries and reports.	3.5
S-6	Skill in maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	3.2
S-7	Skill in optimizing database performance.	2.7
S-8	Skill in using knowledge management technologies.	3.1
S-9	Skill in problem solving from an entry-level viewpoint: Noticing a problem and figuring out the best way to solve it. Includes investigation and evaluation of new technology against core business processes and mission.	3.4
S-10	Skill in judgment and ethical decision making: Thinking about the pros and cons of different options and picking the best one.	3.4
S-11	Skill in systems evaluation: Measuring how well a system is working and how to improve it.	2.9
S-12	Skill in programming: Writing computer programs, including scripting.	3.2
S-13	Skill in consistency when modeling data (attention to data details).	3.4
S-14	Skill in using various operating systems (e.g., Linux, UNIX, Windows).	2.8
S-15	Skill in API design to retrieve data including languages such as REST, GraphQL, and capabilities such as Power BI and Tableau.	2.8

	Abilities	
Abilities Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.	
A-1	Ability to match the appropriate knowledge repository technology for a given application or environment.	3.3
A-2	Ability to order and arrange information.	3.7
A-3	Ability to demonstrate self-driven inquisitive data discovery.	3.6
A-4	Ability to see systems holistically (data systems rarely exist in a silo).	3.2

Data Management and Engineering Employability Skills

Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers. Level 2 - Employee demonstrates commitment, enthusiasm and supports team members. Employee follows up on assigned tasks and leads by example.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving. Level 2 - With minimal supervision, employee analyzes underlying causes, considers risks and implications, and uses logic to draw conclusions. Employee applies rules and principles to processes and recommends solutions.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight. Level 2 - Employee makes inquiries of co-workers regarding possible changes needed in ways of doing work and adapts accordingly. Observes co-workers increasing work productivity under pressure and follows their lead.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively.
Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor. Level 2 - Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor. Employee completes development plan without prompting from supervisor.

Data Management and Engineering Key Performance Indicators

For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with verification after the employee has more experience. All tasks are done according to company guidelines.

	Task	Key Performance Indicators
Monitor, Install, Configure, Maintain		
T-1	Support maintenance of database management systems software.	Monitoring criteria are identified and agreed upon with design and user groups and are consistent with business requirements.
T-2	Assist with monitoring and maintaining databases to ensure optimal performance.	Performance metrics, systems usage, and response times are properly monitored, recorded, and reported.
T-3	Monitor and report the usage of database assets and resources.	Performance deviations are identified and reported for corrective measures.
T-4	Support the installation and configuration of database management systems and software.	Database management software and other data management software are installed and configured according to plan and specifications.
T-5	Access database performance.	Proper testing is performed, and testing methods follow company guidelines.
T-6	Modify software programs to improve performance.	Database is thoroughly tested to ensure proper installation. Performance metrics are documented in accordance with company procedures.
T-7	Implement security measures for computer or information systems.	Data management software modifications are tested and applied in a timely manner with minimal disruptions to clients/users and service as directed.
T-8	Create databases to store data.	Security measures minimize unauthorized access and address security tradeoffs and risks.
T-9	Make and test modifications to database structure when needed.	Users are notified about changes in their security access in accordance with company procedures.
T-10	Merge old databases into new ones.	Security breaches are accurately identified and communicated effectively to appropriate personnel.
Support Database Operations		
T-11	Assist with constructing access paths to suites of information (e.g., link pages) to facilitate access by end-users.	
T-12	Support directory replication services that enable information to replicate automatically from rear servers to forward units via optimized routing.	
T-13	Support information exchanges through publish, subscribe, and alert functions that enable users to send and receive critical information as required.	Support to client/user is delivered effectively and efficiently. Directory replication services perform efficiently.
T-14	Support the management of compilation, cataloging, caching, distribution, and retrieval of data.	Internal and external feedback and user issues are presented clearly and concisely, and user questions about configuration are completely and professionally answered.
T-15	Perform backup and recovery of databases to ensure data integrity.	Access issues are properly addressed, and ease of access is facilitated.
T-16	Support configuration management, problem management, capacity management, and financial management for databases and data management systems.	Continuous efforts are made to identify and address problems before they become critical.
T-17	Support incident management, service-level management, change management, release management, continuity management, and availability management for databases and data management systems.	Error, performance, and availability metrics are accurately documented and demonstrate a trend of improvements. Data management and security operations are effectively supported.
T-18	Assist in managing the indexing/cataloging, storage, and access of explicit organizational knowledge (e.g., hard copy documents, digital files).	Integrity errors are detected, measured, documented, and demonstrate a trend of improvement.
T-19	Assist in data mining and data warehousing applications.	Errors in data management software development are correctly analyzed and resolved.
T-20	Update computer database information.	Backups are consistently performed and tested for recovery.

T-21	Write computer programming code (e.g., Python and R).	
T-22	Support efforts for data consistency and integration, including deduplication, standardization, combining records, and database comparison.	
T-23	Assist with analysis and plans for anticipated changes in data capacity requirements.	
Research/Analysis and Recommendations		
T-24	Assist with developing an understanding of the needs and requirements of information for end-users.	Plans are developed to accommodate future capacity with respect to data and user-growth needs. Capacity planning utilizes the appropriate performance metrics.
T-25	Provide recommendations on data structures and databases that ensure correct and quality production of reports/management information.	Analysis processes and conclusions are clearly and concisely documented. Customer requirements gathered are complete, accurate, and documented in a timely manner. Ethical decision-making processes are used.
T-26	Provide assistance in the identification of recommendations on new database technologies and architectures.	Proper tools and metrics are used to measure user trends. Current and emerging tools and technologies are evaluated. Continuous efforts are made to identify and address problems before they become critical.
T-27	Analyze data to identify trends or relationships among variables.	Error, performance, and availability metrics are accurately documented and communicated to supervisors/team.
Administration		
T-28	Support data management processes following data management standards, requirements, and specifications.	Data management systems are monitored to check that applications meet company standards on a continuous basis. Data processes, procedures, and environment configuration comply with company standards.
T-29	Develop database parameters or specifications.	Computer database information and specifications are clearly and concisely documented.
T-30	Provide input for development of guidelines for system implementation.	Guidelines for database application development are identified, and application of methodology and modeling techniques are effectively communicated.

Data Management and Engineering Student Learning Outcomes

Knowledge		Student Learning Outcomes
K-35	Knowledge of database access application programming interfaces (e.g., Java Database Connectivity [JDBC]).	Demonstrate how to access and connect different databases using application programming interfaces (API) and scripting languages.
K-49	Knowledge of scripting languages.	
K-32	Knowledge of how IT supports the organization's core business/mission processes.	Explain how IT supports the organization's core business processes.
K-43	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	Identify methods, procedures, and techniques of gathering and sharing information.
K-33	Knowledge of cloud-based knowledge management technologies and concepts related to security, governance, procurement, and administration.	Explain different technologies and concepts as they relate to security, governance, procurement, and administration in a cloud-based environment.
K-3	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	Describe laws, regulations, and ethical behavior related to cybersecurity and privacy.
K-14	Knowledge of cybersecurity and privacy principles.	
K-6	Knowledge of ethics.	
K-52	Awareness of data privacy, data protection legislation, and the general role and status of relevant state and federal laws.	
K-15	Knowledge of cyber threats and vulnerabilities.	Identify how to assess cyber threats and vulnerabilities.
K-16	Knowledge of specific operational impacts of cybersecurity lapses.	Discuss the operational implications to the organization of cybersecurity lapses.
K-17	Knowledge of cyber defense and vulnerability assessment tools and their capabilities.	Identify capabilities of cyber defense and vulnerabilities tools.
K-36	Knowledge of Personally Identifiable Information (PII) data security standards.	Discuss data security standards such as PII, PCI, and PHI.
K-37	Knowledge of Payment Card Industry (PCI) data security standards.	
K-38	Knowledge of Personal Health Information (PHI) data security standards.	
K-7	Knowledge of data architecture frameworks such as Zachman Framework for Enterprise Architecture.	Explain different data architecture frameworks and protocols for data governance.
K-30	Knowledge of the capabilities and functionality of various collaborative technologies (e.g., groupware, SharePoint).	Compare and contrast capabilities and functionality of different collaborative technologies.
K-41	Knowledge of use cases related to collaboration and content synchronization across platforms (e.g., Mobile, PC, Cloud).	Discuss collaboration and content synchronization use cases across hardware platforms.
K-45	Knowledge of database theory.	Explain relevant database theories.
K-19	Knowledge of data backup and recovery.	Document the data backup and recovery processes.
K-4	Knowledge of Data Governance topics and their relationship to Information Governance, IT Governance, IT Service Management, Business Management PMO, Business Operations, and Risk Management.	Discuss the role of data governance and its relationship to an organization's business operations.
K-5	Knowledge of Overall Data Management Maturity Model.	Explain how an organization's Data Management Maturity Model (DMMM) helps benchmark organizational performance.
K-18	Knowledge of data administration and data standardization policies.	Discuss data administration and standardization policies.
K-22	Knowledge of digital rights management.	List and describe the organization's data assets and digital rights management.
K-27	Knowledge of sources, characteristics, and uses of the organization's data assets.	
K-47	Knowledge of understanding data ownership, data stewardship, and data stakeholders.	Differentiate between data owner and data stakeholder.
K-46	Knowledge of maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	Maintain databases by updating, adding, deleting, and appending records as necessary for business operations.
K-48	Knowledge of replication services.	Describe the process of data replication services.
K-8	Knowledge of Data Modeling Techniques.	State and describe different data modeling methodologies and capabilities for organizing and managing information.
K-29	Knowledge of the capabilities and functionality associated with various technologies for organizing and managing information (e.g., databases, bookmarking engines).	

K-9	Knowledge of conceptual/logical modeling.	Compare and contrast the conceptual, logical, and physical data models and document its use in a data governance tool.
K-10	Knowledge of physical modeling.	
K-11	Knowledge of how to document the model and its use as a data governance tool.	
K-44	Knowledge of data mining techniques.	Explain data mining and data warehousing principles and techniques.
K-20	Knowledge of data mining and data warehousing principles.	
K-34	Knowledge of data classification standards and methodologies based on sensitivity and other risk factors.	Differentiate data classification standards and methodologies based on sensitivity and risk factors.
K-40	Knowledge of current and emerging data remediation security features in databases.	Identify and describe various current and emerging database security principles and methods including data encryption.
K-42	Knowledge of an organization's information classification program and procedures for information compromise.	Explain the organization's IT security and privacy policies and procedures for data governance.
K-12	Knowledge of Data Storage and Operations.	Explain data storage operations including physical and virtual data storage media.
K-31	Knowledge of the characteristics of physical and virtual data storage media.	
K-28	Knowledge of the capabilities and functionality associated with content creation technologies (e.g., wikis, social networking, content management systems, blogs).	Describe the capabilities and functionality associated with content creation technologies.
K-39	Knowledge of current and emerging data encryption (e.g., Column and Tablespace Encryption, file and disk encryption) security features in databases (e.g., built-in cryptographic key management features).	Identify and describe various current information technologies and emerging database security principles and methods.
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	Identify security methodologies using different networking environments and protocols.
K-23	Knowledge of network access, identity, and access management (e.g., public key infrastructure, OAuth, OpenID, SAML, SPML).	Explain the importance of network identity and access management policies and risk controls.
K-25	Knowledge of policy-based and risk adaptive access controls.	
K-24	Knowledge of operating systems (Linux, UNIX, Windows).	Explain the usage of different operating systems.
K-21	Knowledge of database management systems, query languages, table relationships, and views.	Demonstrate the use and function of relational database management systems, query languages, table relationships, and views.
K-26	Knowledge of query languages such as SQL (structured query language).	
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	Document processes for risk assessment and mitigation.
K-13	Knowledge of data integration and interoperability for both structured and unstructured data.	Explain the process of integrating and interoperability of structured and unstructured databases.
K-50	Awareness of the broad range of tools available to retrieve data.	Identify various tools commonly used for data retrieval purposes.
K-51	Awareness of business intelligence tools such as Power BI, Excel and Tableau.	Recognize and differentiate between various business intelligence tools including Power BI, Excel, and Tableau.
K-53	Awareness of the Gen AI, its role in data management and engineering and related ethical and liability issues. More specifically, how to place boundaries around queries when using AI.	Analyze ethical and liability issues related to the use of Gen AI in data management, with a focus on boundary-setting in queries.
Skills		**Student Learning Outcomes**
S-4	Skill in conducting queries and developing algorithms to analyze data structures.	Perform queries and develop reports to analyze data.
S-5	Skill in generating data queries and reports.	
S-10	Skill in judgment and ethical decision making: Thinking about the pros and cons of different options and picking the best one.	Use and justify proper judgement while using pros and cons of different options when making an ethical decision.
S-6	Skill in maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	Operate and modify databases by updating, adding, deleting, and appending records as necessary for business operations.
S-3	Skill in conducting knowledge mapping (e.g., map of knowledge repositories).	Build a map of an organization's knowledge management repositories.
S-8	Skill in using knowledge management technologies.	
S-13	Skill in consistency when modeling data (attention to data details).	Apply consistency when designing data modeling.
S-1	Skill in allocating storage capacity in the design of data management systems.	Employ data storage capacity when designing data management systems.

S-14	Skill in using various operating systems (e.g., Linux, UNIX, Windows).	Evaluate the use of appropriate operating systems to solve a problem.
S-11	Skill in systems evaluation: Measuring how well a system is working and how to improve it.	Devise an effective system performance baseline measures to identify and improve system performance.
S-7	Skill in optimizing database performance.	
S-9	Skill in problem solving from an entry-level viewpoint: Noticing a problem and figuring out the best way to solve it. Includes investigation and evaluation of new technology against core business processes and mission.	Apply troubleshooting skills by investigating and evaluating new technologies to solve a problem.
S-12	Skill in programming: Writing computer programs, including scripting.	Design and develop program to access, connect, and retrieve data from multiple database sources using application programming interfaces(API) and scripting languages.
S-15	Skill in API design to retrieve data including languages such as REST, GraphQL, and capabilities such as Power BI and Tableau.	
S-2	Skill in conducting information searches.	Perform information searches as necessary to solve a problem.
Abilities		**Student Learning Outcomes**
A-1	Ability to match the appropriate knowledge repository technology for a given application or environment.	Choose appropriate knowledge repository technology for a given environment.
A-2	Ability to order and arrange information.	Evaluate and assemble information in proper order.
A-3	Ability to demonstrate self-driven inquisitive data discovery.	Independently seeks and discovers relevant data.
A-4	Ability to see systems holistically (data systems rarely exist in a silo).	Construct and formulate a holistic view of data systems.

	Data Management Degree Expectations				
	A pool of 21 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.				
			% Best Estimate		
	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
T-1	Support maintenance of database management systems software.	19%	76%	5%	21
T-2	Assist with monitoring and maintaining databases to ensure optimal performance.	29%	47%	24%	21
T-3	Monitor and report the usage of database assets and resources.	19%	43%	38%	21
T-4	Support the installation and configuration of database management systems and software.	14%	62%	24%	21
T-5	Access database performance.	14%	57%	29%	21
T-6	Modify software programs to improve performance.	15%	40%	45%	20
T-7	Implement security measures for computer or information systems.	5%	62%	33%	21
T-8	Create databases to store data.	19%	71%	10%	21
T-9	Make and test modifications to database structure when needed.	14%	57%	29%	21
T-10	Merge old databases into new ones.	10%	52%	38%	21
T-11	Assist with constructing access paths to suites of information (e.g., link pages) to facilitate access by end-users.	25%	25%	50%	20
T-12	Support directory replication services that enable information to replicate automatically from rear servers to forward units via optimized routing.	16%	16%	68%	19
T-13	Support information exchanges through publish, subscribe, and alert functions that enable users to send and receive critical information as required.	5%	40%	55%	20
T-14	Support the management of compilation, cataloging, caching, distribution, and retrieval of data.	14%	57%	29%	21
T-15	Perform backup and recovery of databases to ensure data integrity.	24%	67%	9%	21
T-16	Support configuration management, problem management, capacity management, and financial management for databases and data management systems.	5%	33%	62%	21
T-17	Support incident management, service-level management, change management, release management, continuity management, and availability management for databases and data management systems.	9%	48%	43%	21
T-18	Assist in managing the indexing/cataloging, storage, and access of explicit organizational knowledge (e.g., hard copy documents, digital files).	5%	70%	25%	20
T-19	Assist in data mining and data warehousing applications.	10%	55%	35%	20
T-20	Update computer database information.	19%	67%	14%	21
T-21	Write computer programming code (e.g., Python and R).	14%	62%	24%	21
T-22	Support efforts for data consistency and integration including deduplication, standardization, combining records, and database comparison.	10%	52%	38%	21
T-23	Assist with analysis and plans for anticipated changes in data capacity requirements.	0%	33%	67%	21
T-24	Assist with developing an understanding of the needs and requirements of information for end-users.	9%	62%	29%	21

T-25	Provide recommendations on data structures and databases that ensure correct and quality production of reports/management information.	0%	52%	48%	21
T-26	Provide assistance in the identification of recommendations on new database technologies and architectures.	5%	43%	52%	21
T-27	Analyze data to identify trends or relationships among variables.	9%	62%	29%	21
T-28	Support data management processes following data management standards, requirements, and specifications.	19%	57%	24%	21
T-29	Develop database parameters or specifications.	16%	63%	21%	19
T-30	Provide input for development of guidelines for system implementation.	5%	30%	60%	20
Knowledge					
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	14%	81%	5%	21
K-2	Knowledge of risk management processes (e.g., methods for assessing and mitigating risk).	10%	71%	19%	21
K-3	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy.	5%	81%	14%	21
K-4	Knowledge of Data Governance topics and their relationship to Information Governance, IT Governance, IT Service Management, Business Management PMO, Business Operations, and Risk Management.	5%	43%	52%	21
K-5	Knowledge of Overall Data Management Maturity Model.	0%	60%	40%	20
K-6	Knowledge of ethics.	5%	95%	0%	21
K-7	Knowledge of data architecture frameworks such as Zachman Framework for Enterprise Architecture.	0%	45%	55%	20
K-8	Knowledge of data modeling techniques.	5%	75%	25%	20
K-9	Knowledge of data modeling techniques.	5%	76%	19%	21
K-10	Knowledge of physical modeling.	5%	76%	19%	21
K-11	Knowledge of how to document the model and its use as a data governance tool.	5%	57%	38%	21
K-12	Knowledge of data storage and operations.	14%	67%	19%	21
K-13	Knowledge of data integration and interoperability for both structured and unstructured data.	5%	62%	33%	21
K-14	Knowledge of cybersecurity and privacy principles.	5%	90%	5%	21
K-15	Knowledge of cyber threats and vulnerabilities.	5%	90%	5%	21
K-16	Knowledge of specific operational impacts of cybersecurity lapses.	5%	65%	30%	20
K-17	Knowledge of cyber defense and vulnerability assessment tools and their capabilities.	5%	85%	10%	20
K-18	Knowledge of data administration and data standardization policies.	5%	67%	28%	21
K-19	Knowledge of data backup and recovery.	0%	90%	10%	21
K-20	Knowledge of data mining and data warehousing principles.	5%	57%	38%	21
K-21	Knowledge of database management systems, query languages, table relationships, and views.	14%	67%	19%	21
K-22	Knowledge of digital rights management.	5%	75%	20%	20
K-23	Knowledge of network access, identity, and access management (e.g., public key infrastructure, Oauth, OpenID, SAML, SPML).	5%	55%	40%	20
K-24	Knowledge of operating systems (Linux, UNIX, Windows).	9%	81%	10%	21
K-25	Knowledge of policy-based and risk adaptive access controls.	9%	48%	43%	21
K-26	Knowledge of query languages such as SQL (structured query language).	9%	86%	5%	21
K-27	Knowledge of sources, characteristics, and uses of the organization's data assets.	5%	55%	40%	20

K-28	Knowledge of the capabilities and functionality associated with content creation technologies (e.g., wikis, social networking, content management systems, blogs).	10%	58%	32%	19
K-29	Knowledge of the capabilities and functionality associated with various technologies for organizing and managing information (e.g., databases, bookmarking engines).	10%	50%	40%	20
K-30	Knowledge of the capabilities and functionality of various collaborative technologies (e.g., groupware, SharePoint).	5%	58%	37%	19
K-31	Knowledge of the characteristics of physical and virtual data storage media.	14%	72%	14%	21
K-32	Knowledge of how IT supports the organization's core business/mission processes.	9%	86%	5%	21
K-33	Knowledge of cloud-based knowledge management technologies and concepts related to security, governance, procurement, and administration.	10%	55%	35%	20
K-34	Knowledge of data classification standards and methodologies based on sensitivity and other risk factors.	10%	71%	19%	21
K-35	Knowledge of database access application programming interfaces (e.g., Java Database Connectivity [JDBC]).	0%	38%	62%	21
K-36	Knowledge of Personally Identifiable Information (PII) data security standards.	9%	86%	5%	21
K-37	Knowledge of Payment Card Industry (PCI) data security standards.	10%	75%	15%	20
K-38	Knowledge of Personal Health Information (PHI) data security standards.	10%	75%	15%	20
K-39	Knowledge of current and emerging data encryption (e.g., Column and Tablespace Encryption, file and disk encryption) security features in databases (e.g., built-in cryptographic key management features).	5%	52%	43%	21
K-40	Knowledge of current and emerging data remediation security features in databases.	5%	40%	55%	20
K-41	Knowledge of use cases related to collaboration and content synchronization across platforms (e.g., Mobile, PC, Cloud).	5%	57%	38%	21
K-42	Knowledge of an organization's information classification program and procedures for information compromise.	5%	57%	38%	21
K-43	Knowledge of the principal methods, procedures, and techniques of gathering information and producing, reporting, and sharing information.	5%	81%	14%	21
K-44	Knowledge of data mining techniques.	5%	60%	35%	20
K-45	Knowledge of database theory.	5%	62%	33%	21
K-46	Knowledge of maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	10%	81%	9%	21
K-47	Knowledge of understanding data ownership, data stewardship, and data stakeholders.	5%	66%	29%	21
K-48	Knowledge of replication services.	5%	68%	27%	19
K-49	Knowledge of scripting languages.	5%	71%	24%	21
K-50	Awareness of the broad range of tools available to retrieve data.	5%	60%	35%	20
K-51	Awareness of business analytics tools (e.g., Power BI, Excel, Tableau, and others).	5%	67%	28%	21
K-52	Awareness of data privacy, data protection legislation, and the general role and status of relevant state and federal laws.	5%	75%	20%	20
K-53	Awareness of the Gen AI, its role in data management and engineering and related ethical and liability issues. More specifically, how to place boundaries around queries when using AI.	5%	63%	32%	19

	Skills				
S-1	Skill in allocating storage capacity in the design of data management systems.	15%	50%	35%	20
S-2	Skill in conducting information searches.	19%	76%	5%	21
S-3	Skill in conducting knowledge mapping (e.g., map of knowledge repositories).	10%	45%	45%	20
S-4	Skill in conducting queries and developing algorithms to analyze data structures.	10%	52%	38%	21
S-5	Skill in generating data queries and reports.	24%	76%	0%	21
S-6	Skill in maintaining databases (i.e., backup, restore, delete data, transaction log files, etc.).	14%	76%	10%	21
S-7	Skill in optimizing database performance.	14%	33%	53%	21
S-8	Skill in using knowledge management technologies.	10%	65%	25%	20
S-9	Skill in problem solving from an entry-level viewpoint: Noticing a problem and figuring out the best way to solve it. Includes investigation and evaluation of new technology against core business processes and mission.	10%	65%	25%	20
S-10	Skill in judgment and ethical decision making: Thinking about the pros and cons of different options and picking the best one.	5%	86%	9%	21
S-11	Skill in systems evaluation: Measuring how well a system is working and how to improve it.	5%	48%	47%	21
S-12	Skill in programming: Writing computer programs, including scripting.	5%	71%	24%	21
S-13	Skill in consistency when modeling data (attention to data details).	9%	62%	29%	21
S-14	Skill in using various operating systems (e.g., Linux, UNIX, Windows).	9%	86%	5%	21
S-15	Skill in API design to retrieve data including languages such as REST, GraphQL, and capabilities such as Power BI and Tableau.	5%	35%	60%	20
	Abilities				
A-1	Ability to match the appropriate knowledge repository technology for a given application or environment.	10%	60%	30%	20
A-2	Ability to order and arrange information.	19%	71%	10%	21
A-3	Ability to demonstrate self-driven inquisitive data discovery.	9%	48%	43%	21
A-4	Ability to see systems holistically (data systems rarely exist in a silo).	5%	57%	38%	21

INFRASTRUCTURE CONNECTIVITY, MANAGEMENT AND ENGINEERING

The definition for Infrastructure Connectivity, Management and Engineering as developed by approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) through three meetings and follow-up surveys to gain consensus is:

Infrastructure Connectivity covers hardware, wired, optical, wireless, satellite, cloud, and any other means of connectivity for data transmission.

Infrastructure Management and Engineering ensures that the Information Technology and Communications Infrastructure is sufficiently robust, scalable, secure and efficient to deliver integrated services. It supports the design installation processes, physical resources, and operations required for developing, integrating, operating, and sustaining IT applications. It also addresses the day-to-day management and maintenance of IT services, systems, and applications. This definition was adapted from mitre.org with input from national IT Thought Leaders.

This packet includes...

Job skills as developed by subject matter experts (SMEs) via multiple synchronous meetings (Page 141).

The tasks, knowledge, skills and abilities (KSAs) were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

More specific definitions can be found within the KSA list.

The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum.

Employability Skills as developed by SMEs via multiple synchronous meetings (Page 148).

Employability competencies are essential for every IT job and are based on what the work requires. SMEs were offered three clearly-defined "levels of proficiency" for each employability skill. The proficiency scale is defined as Level 1 – basic: Level 2- intermediate; and Level 3 - advanced. The levels are cumulative, so a "Level 3" assumes the employee can perform all characteristics of "Level 1" and "Level 2."

For each employability skill, SMEs selected the competency level that best aligned with what would be expected from an entry-level worker for the job cluster in question.

Key Performance Indicators (KPIs) as developed by SMEs (Page 149).

Key Performance Indicators answer the question, "How do we know when a task is performed well?"

A search was performed to locate validated/verified KPIs for technician level work in IT fields. Sources included the Texas Skill Standards System, National Skill Standards Board, National Institute of Standards and Technology and other sources. The identified KPIs were then cross-referenced to the tasks for the ITSS 2020 job clusters. They were reviewed and revised by a group of the same subject matter experts who developed the tasks and KSAs for the cluster in a structured, facilitated verification session.

Student Learning Outcomes (SLOs) as identified by educators attending the KSA meetings (Page 151).

The SLOs are for use in the creation of curriculum to help define what the students will know and be able to demonstrate. Each of these SLOs can be observed, measured, and demonstrated.

Degree Expectations as identified by educators (Page 158).

A pool of 20 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

Infrastructure Connectivity Management and Engineering Tasks and KSAs

	Tasks	
	SPECIFIC THINGS an entry level person would BE EXPECTED TO PERFORM on the job WITH LITTLE SUPERVISION.	

	Install	Avg
T-1	Configure network, routers, and switches (e.g., higher-level protocols, tunneling).	3.00
T-2	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware) which would include patch network vulnerabilities to safeguard information.	3.35
T-3	Install or replace network, routers, and switches.	3.40
T-4	Implement group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	2.86
T-5	Validate/update baseline system security according to organizational policies.	3.10
T-6	Install, update, and troubleshoot systems/servers.	3.24
T-7	Installation, implementation, configuration, and support of system components.	3.33
	Troubleshoot	
T-8	Diagnose network connectivity problem.	3.20
T-9	Troubleshoot hardware/software interface and interoperability problems.	3.10
	Document	
T-10	Follow SOP and validate/update documentation of compliance.	3.38
	Monitor, Maintain, Operate	
T-11	Integrate new systems into existing network architecture.	2.90
T-12	Monitor network capacity and performance.	3.05
T-13	Test and maintain network infrastructure including software and hardware devices.	3.15
T-14	Conduct functional and connectivity testing to ensure continuing operability.	3.48
T-15	Follow group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	2.90
T-16	Manage basic functionality around accounts, network rights, and access to systems and equipment.	2.95
T-17	Provide ongoing optimization and problem-solving support.	3.15
T-18	Check system hardware availability, functionality, integrity, and efficiency.	3.33
T-19	Conduct periodic system maintenance including cleaning (both physically and electronically), disk checks, routine reboots, data dumps, and testing.	3.19
T-20	Implement local network usage policies and procedures.	2.90
T-21	Manage system/server resources including performance, capacity, availability, serviceability, and recoverability.	3.05
T-22	Monitor and maintain system/server configuration.	3.24

	Knowledge	
	Knowledge focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.	
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	3.90

K-2	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy (e.g. PCI, PII, PHI, GDPR).	2.76
K-3	Knowledge of cybersecurity and privacy principles.	3.33
K-4	Knowledge of cyber threats and vulnerabilities.	3.24
K-5	Knowledge of impacts of cybersecurity lapses.	3.19
K-6	Knowledge of communication methods, principles, and concepts that support the network infrastructure.	3.57
K-7	Knowledge of capabilities and applications of network equipment including routers, switches, bridges, servers, transmission media, and related hardware.	3.65
K-8	Knowledge of risk management, cybersecurity and privacy principles used to manage risks related to the use, processing, storage, and transmission of information or data.	3.10
K-9	Knowledge of information technology (IT) security principles and methods (e.g., firewalls, demilitarized zones, encryption).	3.62
K-10	Knowledge of local area and wide area networking principles and concepts including bandwidth management.	3.43
K-11	Knowledge of measures or indicators of system performance and availability.	3.24
K-12	Knowledge of remote access technology concepts.	3.19
K-13	Knowledge of server administration and systems engineering theories, concepts, and methods.	3.19
K-14	Knowledge of Virtual Private Network (VPN) security.	3.43
K-15	Knowledge of concepts, terminology, and operations of a wide range of baseband and broadband communications transmission media and protocols (computer and telecommunications networks, satellite, fiber, wireless).	3.43
K-16	Knowledge of network tools (e.g., ping, traceroute, nslookup).	3.71
K-17	Knowledge of the range of existing networks (e.g., PBX, LANs, WANs, WIFI, SCADA).	3.38
K-18	Knowledge of Voice over IP (VoIP).	3.14
K-19	Knowledge of the common attack vectors on the network layer.	3.29
K-20	Knowledge of network security architecture concepts including topology, protocols, components, and principles (e.g., application of defense-in-depth).	3.33
K-21	Knowledge of network and systems management principles, models, methods (e.g., end-to-end systems performance monitoring), and tools (NOC and SOC).	3.24
K-22	Knowledge of concepts of certificates, key management and usage.	3.19
K-23	Knowledge of where to find details on wired and wireless transmission standards (e.g. Ethernet, Bluetooth, Radio Frequency Identification (RFID), Infrared Networking (IR), Wireless Fidelity (Wi-Fi). paging, cellular, and satellite communications.)	3.10
K-24	Knowledge of jamming and interference patterns so they can be recognized as a challenge for the network itself applied to wireless networkds.	2.81
K-25	Knowledge of network protocols such as TCP/IP, Dynamic Host Configuration, Domain Name System (DNS), and directory services.	3.71
K-26	Knowledge of controls related to the use, processing, storage, and transmission of data.	3.24
K-27	Knowledge of performance tuning tools and techniques.	2.95
K-28	Knowledge of the enterprise information technology (IT) architecture.	3.24
K-29	Knowledge of the type and frequency of routine hardware maintenance (e.g. Linux/Unix OS, Windows Server OS).	3.24

K-30	Knowledge of file system implementations (e.g., New Technology File System [NTFS], File Allocation Table [FAT], File Extension [EXT]) including network storage and servers with emphasis on extensions.	3.05
K-31	Knowledge of virtualization technologies and virtual machine development and maintenance.	3.29
K-32	Knowledge of system administration, network, and operating system hardening techniques.	3.14
K-33	Knowledge of system/server diagnostic tools and fault identification techniques.	3.24
K-34	Knowledge of operating system command-line tools.	3.33
K-35	Knowledge of principles and methods for integrating system components including network storage and servers.	3.24
K-36	Knowledge of script automation and application programming interfaces.	3.24
K-37	Knowledge of network backup and recovery procedures.	3.19
K-38	Knowledge of how to patch network vulnerabilities to ensure that information is safeguarded against outside parties.	3.38
K-39	Knowledge of system administration, network, and operating system concepts and hardening techniques.	3.43
K-40	Knowledge of asset management and why it's important to the business.	2.95
K-41	Knowledge of risks associated with storing various types of data in different physical locations.	3.05
K-42	Knowledge of infrastructure data storage capabilities and storage clusters.	3.10
K-43	Knowledge of IoT end devices and connectivity.	3.05
K-44	Knowledge of Software Defined Networking concepts.	3.19
K-45	Knowledge of Continuous Quality Improvement Principles (of particular value: Lean and Agile).	2.43
K-46	Knowledge of how to identify organizational goals that align with architecture and how do you identify your value to the organization.	2.71
K-47	Knowledge of Python or other scripting languages.	3.05
K-48	Knowledge of the differences or similarities between Private, Public, and Hybrid Cloud Implementations.	3.48
K-49	Knowledge of the difference or similarities between Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	3.43
K-50	Awareness of framework concepts, their selection and use.	2.90
K-51	Awareness of the pros or cons behind using Frameworks.	2.86
K-52	Knowledge of the term benchmarks and the reasons for their use.	3.10
K-53	Knowledge of the term resilience and how resilience can be designed into a project, program, infrastructure or organization.	3.19
K-54	Knowledge of the concept of Service Level Agreement, why they are used, when they are used, and its application within Cloud implementations.	3.38
K-55	Knowledge of who owns or should own the data/information in a Cloud implementation.	3.00
K-56	Knowledge of the key Management/Operational/Security/Privacy challenges potential faced when considering or implementing a Cloud capability.	3.10
K-57	Knowledge of the different organizational roles needed as one plans for Cloud implementation or manages an existing Cloud capability.	2.85
K-58	Knowledge of the incident response challenges potentially faced within a Cloud implementation.	2.95
K-59	Knowledge of Web Services technologies.	2.90
K-60	Knowledge of cloud network storage including cloud object -based storage and local system storage.	3.05

K-61	Knowledge of the different Cloud computing database types (RDS).	2.76
K-62	Knowledge of how to scale a Cloud database.	2.43
K-63	Knowledge of region failover and redundancy vs local failover and redundancy and how that needs to be applied to your data centers (cloud, hybrid, on-prem).	3.14
K-64	Knowledge of the differences between SQL and Non-SQL Databases.	2.76
K-65	Knowledge of Cloud IAM (Identity and Access Management) - cloud and hybrid.	3.14
K-66	Knowledge of Cloud IAM users, groups, roles and policies - cloud and hybrid.	3.14
K-67	Knowledge of Cloud Computing shared security responsibility model - cloud and hybrid.	3.19
K-68	Knowledge of Cloud Regions - cloud and hybrid.	3.29
K-69	Knowledge of Cloud Availability Zone - cloud and hybrid.	3.10
K-70	Knowledge of Recovery Time Objective (RTO).	2.95
K-71	Knowledge of Recovery Point Objective (RPO).	3.00
K-72	Knowledge of High Availability factors (Fault-tolerance, recoverability, and scalability).	3.19
K-73	Knowledge of microservices and containerization (e.g. Kubernetes and Docker).	2.90
K-74	Knowledge of Auto Scaling and Load Balancing.	2.95
K-75	Knowledge of the differences between Cloud vs. On-Premises.	3.67
K-76	Knowledge in preparing and deploying a cloud database solution that meets application requirements.	2.32
K-77	Knowledge of database management systems, query languages, table relationships, and views.	2.33
K-78	Knowledge of Azure.	3.14
K-79	Knowledge of AWS.	3.24
K-80	Knowledge of Google Cloud.	2.95
K-81	Knowledge of emerging technology (e.g. blockchain, quantum computing)	2.71
K-82	Knowledge of making recommendations for migration of a physical network to a cloud-based architecture.	2.67
K-83	Knowledge of creating a cloud-based network infrastructure to meet requirements for a software application.	2.76
K-84	Knowledge of the OSI model and understand that OSI is the framework for all problem solving and troubleshooting. Provide basic framework for how it all works, including how cloud computing has impacted the conceptualization of the seven layers. Plus an awareness of IP multimedia services.	3.67
K-85	Knowledge of preparing and deploying a Cloud High Availability and Business Continuity Solution.	2.57
K-86	Knowledge of implementing auto scaling and load balancing.	2.57
K-87	Knowledge of assessing and evaluating the technical benefits of implementation of a cloud computing architecture.	2.43
Skills The capabilities or proficiencies developed through training or hands-on experience. Skills are the practical application of theoretical knowledge. Someone can take a course to gain knowledge of concepts without developing the skills to apply those concepts. Development of skills requires hands-on application of the concepts.		
S-1	Understand that OSI is the framework for all problem solving and troubleshooting	3.48
S-2	Skill in establishing a routing schema.	3.29
S-3	Skill in implementing, maintaining established network security practices.	3.38

S-4	Skill in installing, configuring, and troubleshooting LAN and WAN components such as routers, and switches.	3.62
S-5	Skill in using network management tools to analyze network traffic patterns (e.g., simple network management protocol).	3.38
S-6	Skill in securing network communications. (e.g., logical)	3.38
S-7	Skill in protecting a network against malware. (e.g., NIPS, anti-malware, restrict/prevent external devices, spam filters).	3.48
S-8	Skill in basic configuring and utilizing network protection components (e.g., Firewalls, VPNs, network intrusion detection systems).	3.52
S-9	Skill in testing network infrastructure contingency and recovery plans.	3.10
S-10	Skill in applying various subnet techniques (e.g., CIDR).	3.05
S-11	Skill in configuring and utilizing computer protection components (e.g., hardware firewalls, servers, routers, as appropriate).	3.38
S-12	Skill in configuring and basic optimizing software.	2.90
S-13	Skill in diagnosing connectivity problems.	3.71
S-14	Skill in maintaining directory services. (e.g., Microsoft Active Directory, LDAP, etc.).	2.86
S-15	Skill in using virtual machines. (e.g., Microsoft Hyper-V, VMWare vSphere, Citrix XenDesktop/Server, Amazon Elastic Compute Cloud, etc.).	3.24
S-16	Skill in using Cloud (e.g. Amazon Elastic Compute Cloud).	3.05
S-17	Skills in using microservices and containers (e.g., Docker, Kubernetes, ECS) and understanding monitoring dashboards.	2.62
S-18	Skill in configuring and utilizing software-based computer protection tools (e.g., software firewalls, antivirus software, anti-spyware).	3.43
S-19	Skill in interfacing with customers.	3.29
S-20	Skill in conducting system/server management and maintenance.	3.10
S-21	Skill in correcting physical and technical problems that impact system/server performance.	3.19
S-22	Skill in troubleshooting failed system components (i.e., servers).	3.38
S-23	Skill in identifying system/server performance, availability, capacity, or configuration problems.	3.29
S-24	Skill in installing system and component upgrades. (i.e., servers, appliances, network devices).	3.43
S-25	Skill in monitoring and optimizing basic system/server/cloud performance.	3.24
S-26	Skill in recovering failed systems/servers. (e.g., recovery software, failover clusters, replication, etc.).	3.19
S-27	Skill in operating system administration. (e.g., account maintenance, data backups, maintain system performance, install and configure new hardware/software).	3.05
S-28	Skill in applying Software Defined Networking concepts.	3.05
S-29	Skill in identifying and distinguishing Private, Public, and Hybrid Cloud Implementations.	3.19
S-30	Skill in identifying and distinguishing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	3.29
S-31	Skill in executing Test Cases for identified functional or non-functional requirements.	3.00
S-32	Skill in documenting results of executed test cases showing whether according to developed success criteria the test case passes, fails, or partially passes.	3.05
S-33	Skill in documenting and determining root cause failure(s) for items that failed or partially passed.	3.00
S-34	Skill in preparing written reports.	3.14
S-35	Skill in preparing presentations.	3.10

S-36	Skill in producing Virtual Machines from a Cloud image.	3.00
S-37	Skill in producing Virtual Machines within a Cloud region.	2.76
S-38	Skill in demonstrating how to customize virtual networks with IP Address Range, subnets, routing tables and gateways.	3.05
S-39	Skill in analyzing and troubleshooting Cloud Virtual Networks.	2.86
S-40	Skill in preparing and deploying virtual machines in a virtual network (private or public subnet).	3.10
S-41	Skill in deploying cloud storage technologies with the assistance of a senior technician.	3.00
S-42	Skill in analyzing and troubleshooting different cloud storage technologies.	2.81
S-43	Skill in applying permissions from the IAM (Identity and Access Management).	3.05
S-44	Skill in applying permissions for IAM (Identity and Access Management) Group(s).	3.10
S-45	Skill in applying permissions for IAM (Identity and Access Management) user(s).	3.10
S-46	Skill in analyzing and troubleshooting containers.	2.74
S-47	Skill in using tools like Chef, Puppet, etc.	2.48
S-48	Skill in managing changes/updates for both internal and external customers when policies and procedures change.	2.90
S-49	Skill in assessing or monitoring system for cyberattacks.	3.05
S-50	Skill in identifying possible causes of degradation of system performance or availability and initiating actions needed to mitigate this degradation.	3.05
S-51	Skill in identifying areas where there are issues/gaps in a cloud implementation and develop a working solution.	2.52
S-52	Skill in leveraging cloud/hybrid managed services to enable greater flexibility and resilience in an secure infrastructure.	2.76
S-53	Skill in identifying appropriate cloud services that provide the compute power needed to solve a technical business problem while optimizing cost.	2.71
S-54	Skill in reading, interpreting, writing, modifying, and executing simple scripts (e.g., Perl, VBScript) on Windows and UNIX systems (e.g., those that perform tasks such as: parsing large data files, automating manual tasks, and fetching/processing remote data).	2.95
S-55	Skill in importing/ exporting/migrating/protecting/securing data from one data source to another.	2.19
S-56	Skill in applying security concepts in the automation of resource provisioning.	3.00
S-57	Skill in identifying the necessary components of a physical network and a cloud-based network.	3.05
S-58	Skill in using Azure .	2.86
S-59	Skill in using AWS.	2.95
S-60	Skill in Google Cloud.	2.57
Abilities Abilities have historically been used to describe the innate traits or talents that a person brings to a task or situation. Many people can learn to negotiate competently by acquiring knowledge about it and practicing the skills it requires. A few are brilliant negotiators because they have the innate ability to persuade. In reality, abilities may be included under skills or may be separated out.		
A-1	Ability to install network equipment including routers, switches, servers, transmission media, and related hardware.	3.52
A-2	Ability to operate common network tools (e.g., ping, traceroute, nslookup).	3.62
A-3	Ability to execute OS command line (e.g., ipconfig, netstat, dir, nbtstat).	3.65
A-4	Ability to operate the organization's LAN/WAN pathways.	3.14

A-5	Ability to monitor measures or indicators of system performance and availability.	3.33
A-6	Ability to operate different electronic communication systems and methods (e.g., e-mail, VOIP, IM, web forums, Direct Video Broadcasts).	3.05
A-7	Ability to monitor traffic flows across the network.	3.38
A-8	Ability to recognize and escalate the information collected by network tools (e.g. Nslookup, Ping, and Traceroute).	3.52
A-9	Ability to interpret and clarify incidents, problems, and events submitted in the trouble ticketing system.	3.29
A-10	Ability to apply an organization's goals and objectives to maintain architecture.	3.00
A-11	Ability to update, and/or maintain standard operating procedures (SOPs).	3.05
A-12	Ability to collaborate effectively with others.	3.81
A-13	Ability to function effectively in a dynamic, fast-paced environment.	3.75
A-14	Ability to apply cybersecurity and privacy principles to organizational requirements (relevant to confidentiality, integrity, availability, authentication, non-repudiation).	3.33
A-15	Ability to maintain automated security control assessments.	3.00
A-16	Ability to communicate effectively (written and oral) within and among team members and associated stakeholders (i.e. different audiences and organizational levels). This includes communicating complex technical issues and business implications.	3.62
A-17	Ability to work under stress.	3.81
A-18	Ability to problem solve.	3.86
A-19	Ability to analyze and interpret customer input for expressed and implied requirements.	3.38
A-20	Ability to translate technical language into lay terminology when needed.	3.48
A-21	Ability to read and interpret technical documents, diagrams, and decision trees.	3.71
A-22	Ability to listen and understand what people say.	3.95
A-23	Ability to recognize and understand details.	3.76
A-24	Ability to order and arrange items.	3.52
A-25	Ability to create appropriate presentation visuals for technical material.	3.24

Infrastructure Connectivity Management and Engineering Employability Skills

Workplace Professionalism & Work Ethics	Level 1 - Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance. Level 2 - Employee exhibits sound professionalism, judgment, and integrity and accepts responsibility for own behavior. Employee exhibits these qualities without guidance but occasionally refers to policies as needed.
Written Communication	Level 1 - Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing. Level 2 - Employee comprehends and executes written instructions with minimal guidance. Employee composes well-organized written documents.
Oral Communication	Level 1 - Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills. Level 2 - Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills. Employee clarifies for meaning without needing prompting from supervisor.
Teamwork	Level 1 - With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks, and establishes rapport with co-workers.
Problem Solving & Critical Thinking	Level 1 - Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving. Level 2 - With minimal supervision, employee analyzes underlying causes, considers risks and implications, and uses logic to draw conclusions. Employee applies rules and principles to processes and recommends solutions.
Organization and Planning	Level 1 - Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor. Level 2 - Employee manages timelines and recommends timeline adjustments. Employee escalates timeline-impacting issues as appropriate.
Adaptability and Flexibility	Level 1 - With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight.
Initiative	Level 1 - Employee finishes a step in a project and waits for direction before going on to the next step. Level 2 - Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.
Accuracy	Level 1 - Employee makes mistakes routinely but is committed to learning to adjust work habits to prevent them in the future. Level 2 - Employee occasionally makes mistakes but quickly makes adjustments to work habits to avoid making the same mistake twice.
Cultural Competence	Level 1 - Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships. Level 2 - Employee is committed to working with diverse teams but struggles when differences arise. Employee identifies those challenges and works with colleagues to find ways to work effectively.
Self and Career Development	Level 1 - Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor. Level 2 - Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor. Employee completes development plan without prompting from supervisor.

For the entry-level employee, all tasks are typically done under supervision for much of the first year and then with some independence with verification after the employee has more experience. All tasks are done according to company guidelines.

	Task	Key Performance Indicators
Install		
T-1	Configure and optimize network, routers, and switches (e.g., higher-level protocols, tunneling).	Installation or upgrade plan is complete and accurate and company guidelines are followed.
T-2	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware) which would include patching network vulnerabilities to safeguard information.	All components and devices (including IoT) are properly connected. Operating system and application software and upgrades are installed and configured according to specifications. Required network protocols are correctly installed and tested. System hardware and software are configured to specification.
T-3	Install or replace network, routers, and switches.	Network interfaces (e.g. LAN to WAN) are correctly connected and configured.
T-4	Implement group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	Network security devices and software (e.g., firewall, routers, anti-virus software) are correctly installed by peer reviews or supervisor. Accounts are set up following standard operating procedures. Final overall tests to ensure full network resilience and functionality are properly performed.
T-5	Validate/update baseline system security according to organizational policies.	Current software upgrades including operating system patches anti-virus database are installed.
T-6	Install, update, and troubleshoot systems/servers.	Requirements for systems security are properly identified by peer reviews or supervisor.
T-7	Installation, implementation, configuration, and support of system components.	Communication regarding changes in procedures is distributed to all necessary parties in a timely manner.
Troubleshoot		
T-8	Diagnose network connectivity problems.	Appropriate data analysis and troubleshooting techniques per organizational standard are used to diagnose the problem. Problem is correctly identified and causes are isolated per organizational standard. Solutions are thoroughly tested and implemented with minimal risk to network performance per organizational standard.
T-9	Troubleshoot hardware/software interface and interoperability problems.	Problems, solutions, and implementation processes are thoroughly documented and clearly communicated per organizational standard.
Document		
T-10	Follow SOP and validate/update documentation of compliance.	New configuration, system specifications, installation, and test results are clearly and completely documented. Systems security procedures are properly documented and approved in accordance with company guidelines. Documentation follows company format and standards and is at the appropriate level of detail. Inventory of parts includes accurate identification, tagging, and location. Accurate and up-to-date records (e.g., device configuration and user accounts) are maintained to ensure system integrity.

	Monitor, Maintain, Operate	
T-11	Integrate new systems into existing network architecture.	Integration and testing are performed according to project and company schedules, priorities, and guidelines.
T-12	Monitor network capacity and performance.	Preventive maintenance plan and monitoring procedures are updated.
T-13	Test and maintain network infrastructure, including software and hardware devices.	Documented performance requirements are used to monitor network and recommend system improvement. System configuration is optimized to meet user needs with minimal disruption.
T-14	Conduct functional and connectivity testing to ensure continuing operability.	Performance is monitored according to procedures and is compared to baseline performance for discrepancies; reports are generated.
T-15	Follow group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	Traffic capacity and performance characteristics are monitored, and technician knows how to involve others to handle concerns. Component and connectivity problems are monitored and reported.
T-16	Manage basic functionality around accounts, network rights, and access to systems and equipment.	Functional verifications, system audits, and backups are performed according to proper procedures.
T-17	Provide ongoing optimization and problem-solving support.	Patches are applied to affected software and hardware in a timely manner, and are properly tested.
T-18	Check system hardware availability, functionality, integrity, and efficiency.	Disruptions, outages, security violations, and attacks of network services are monitored, recognized, and escalated in a timely manner according to company procedures. Diagnostic software is run to verify that the components are operating, and tests are performed.
T-19	Conduct periodic system maintenance including cleaning (both physically and electronically), disk checks, routine reboots, data dumps, and testing.	System backups and other maintenance tasks are performed and documented according to scope, schedule, and procedure. System back-ups are verified and periodic test restores are performed.
T-20	Implement local network usage policies and procedures.	Components are correctly programmed, integrated into the system and backed up, and all security procedures are followed.
T-21	Manage system/server resources including performance, capacity, availability, serviceability, and recoverability.	Tests for functionality and safety of equipment and systems are completed.
T-22	Monitor and maintain system/server configuration.	Communication regarding changes in procedures is distributed to all necessary parties in a timely manner.

Infrastructure Connectivity Management and Engineering Student Learning Outcomes

	Knowledge	Student Learning Outcomes
K-8	Knowledge of risk management, cybersecurity, and privacy principles used to manage risks related to the use, processing, storage, and transmission of information or data.	Explain information security principles and fundamentals. Describe laws, regulations, and ethical behavior related to cybersecurity and privacy globally.
K-2	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy (e.g., PCI, PII, PHI, GDPR).	
K-3	Knowledge of cybersecurity and privacy principles.	
K-4	Knowledge of cyber threats and vulnerabilities.	Explain how to assess network vulnerabilities and attacks. Describe the operational implications to the organization resulting from cybersecurity lapses.
K-5	Knowledge of impacts of cybersecurity lapses.	
K-40	Knowledge of asset management and why it's important to the business.	Describe the network system components and their inter-relationships. Summarize the key role asset management plays in organizational operations. Explain the components of storage infrastructure including subsystems
K-42	Knowledge of infrastructure data storage capabilities and storage clusters.	
K-17	Knowledge of the range of existing networks (e.g., PBX, LANs, WANs, WIFI, SCADA).	Differentiate between different enterprise network architecture and topologies, such as Local Area Networks (LANs), Wide Area Networks (WANs).
K-28	Knowledge of the enterprise information technology (IT) architecture.	
K-12	Knowledge of remote access technology concepts.	Explain the OSI model and different network protocols, such as TCPIP. Describe technology concepts for remote access.
K-26	Knowledge of controls related to the use, processing, storage, and transmission of data.	Explain the controls related to the use, processing, storage, and transmission of data. List resources for gaining more information on wired and wireless transmission standards.
K-23	Knowledge of where to find details on wired and wireless transmission standards (e.g., Ethernet, Bluetooth, Radio Frequency Identification (RFID), Infrared Networking (IR), Wireless Fidelity (Wi-Fi). paging, cellular, and satellite communications).	
K-25	Knowledge of network protocols such as TCP/IP, Dynamic Host Configuration, Domain Name System (DNS), and directory services.	Install and configure TCPIP protocols such as DHCP, DNS, and directory services. Describe the current concepts of telecommunications. Explain the capabilities of different electronic communication systems and methods.
K-6	Knowledge of communication methods, principles, and concepts that support the network infrastructure.	
K-15	Knowledge of concepts, terminology, and operations of a wide range of communications media (computer and telephone networks, satellite, fiber, wireless).	
K-43	Knowledge of IoT end devices and connectivity.	Describe commonly used IoT end devices and their connectivity.
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	Identify and summarize techniques and protocols related to networks, including network security.
K-18	Knowledge of Voice over IP (VoIP).	Explain the principles of Voice over IP (VoIP).
K-7	Knowledge of capabilities and applications of network equipment including routers, switches, bridges, servers, transmission media, and related hardware.	Discuss appropriate uses of different network hardware equipment in a business environment. Discuss concepts of bandwidth management in a LAN/WAN networks.
K-10	Knowledge of local area and wide area networking principles and concepts including bandwidth management.	
K-13	Knowledge of server administration and systems engineering theories, concepts, and methods.	Explain the concepts and methods of server administration.
K-16	Knowledge of network tools (e.g., ping, traceroute, nslookup).	Explain how different network commands and tools can be used to monitor and manage network performance.
K-21	Knowledge of network and systems management principles, models, methods (e.g., end-to-end systems performance monitoring), and tools (NOC and SOC).	
K-27	Knowledge of performance tuning tools and techniques.	
K-39	Knowledge of system administration, network, and operating system concepts and hardening techniques.	Explain concepts and hardening techniques for systems administration, network, and operating systems.
K-29	Knowledge of the type and frequency of routine hardware maintenance (e.g., Linux/Unix OS, Windows Server OS).	Summarize a typical organization's recommended schedule and procedures for routine hardware maintenance. Explain different file systems and extensions, including network storage, servers, and file transfer protocols.
K-30	Knowledge of file system implementations (e.g., New Technology File System [NTFS], File Allocation Table [FAT], File Extension [EXT]) including network storage and servers.	

K-31	Knowledge of virtualization technologies and virtual machine development and maintenance.	Outline the concepts of network virtualization, including virtual machine development and maintenance.
K-32	Knowledge of system administration, network, and operating system hardening techniques.	Describe how to administer a network operating system, including hardening techniques.
K-33	Knowledge of system/server diagnostic tools and fault identification techniques.	Explain a typical organization's recommended system/server diagnostic tools and fault identification techniques.
K-34	Knowledge of operating system command-line tools.	Explain commonly used operating system command-line tools.
K-35	Knowledge of principles and methods for integrating system components including network storage and servers.	Describe the principles and methods used to integrate network system components.
K-37	Knowledge of network backup and recovery procedures.	Describe the organization's network backup and restoration process.
K-55	Knowledge of metrics, how they are developed in general, their purpose, and why they are used.	Discuss the latest tools for network traffic metrics and system performance.
K-11	Knowledge of measures or indicators of system performance and availability.	Explain typical measures used to evaluate system performance and availability.
K-19	Knowledge of the common attack vectors on the network layer.	Explain common attack vectors on the network layer.
K-20	Knowledge of network security architecture concepts including topology, protocols, components, and principles (e.g., application of defense-in-depth).	Describe concepts of network security architecture, including Network Security Devices, Protocols, and Topologies.
K-14	Knowledge of Virtual Private Network (VPN) security.	Explain the administration of a Virtual Private Network (VPN).
K-22	Knowledge of concepts of certificates, key management, and usage.	Explain the concepts of Key Management and Certificate Lifecycles.
K-9	Knowledge of information technology (IT) security principles and methods (e.g., firewalls, demilitarized zones, encryption).	Identify and describe various information technology security principles and methods.
K-38	Knowledge of how to patch network vulnerabilities to ensure that information is safeguarded against outside parties.	Explain Network Vulnerability Assessment and Data Security at physical and cloud locations, including how and when to patch network vulnerabilities.
K-41	Knowledge of risks associated with storing various types of data in different physical locations.	
K-36	Knowledge of script automation and application programming interfaces.	Describe the importance of APIs and use of script automation in network environment.
K-48	Knowledge of the differences or similarities between private, public, and hybrid cloud implementations.	Compare and contrast public, private, and hybrid cloud.
K-49	Knowledge of the difference or similarities between Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	Compare and contrast different XaaS tools and technology models.
K-50	Awareness of framework concepts, their selection, and use.	Discuss the selection and use of cloud framework concepts, including the pros and cons of using frameworks.
K-51	Awareness of the pros or cons behind using frameworks.	
K-52	Knowledge of the term benchmarks and the reasons for their use.	Describe benchmarks as performance metrics.
K-53	Knowledge of the term resilience and how resilience can be designed into a project, program, infrastructure, or organization.	Explain how to design resilience into projects and components of an organization.
K-54	Knowledge of the concept of service level agreement (SLA), why they are used, when they are used, and their application within cloud implementations.	Describe how, why, and when Service Level Agreements (SLA) are implemented in a cloud environment. Define and explain the applicability of high availability service levels.
K-55	Knowledge of who owns or should own the data/information in a cloud implementation.	Explain data ownership in a cloud implementation.
K-56	Knowledge of the key Management/Operational/Security/Privacy challenges potential faced when considering or implementing a Cloud capability.	Describe management, operational, security, and privacy challenges when considering cloud implementation.
K-57	Knowledge of the different organizational roles needed as one plans for Cloud implementation or manages an existing Cloud capability.	Classify organizational roles needed for a planned cloud implementation. Discuss incident response challenges typically encountered in a cloud implementation.
K-58	Knowledge of the incident response challenges potentially faced within a Cloud implementation.	
K-60	Knowledge of cloud network storage including cloud object-based storage and local system storage.	Describe different cloud storage systems including local, network, and object-based.

K-61	Knowledge of the different Cloud computing database types (RDS).	Differentiate and describe the scalability of cloud-based databases such as RDS, SQL, and Non-SQL.
K-62	Knowledge of how to scale a cloud database.	Describe how to implement a cloud database solution that can scale and meet the requirements.
K-64	Knowledge of the differences between SQL and Non-SQL databases.	Document best practices in database fail-over processes.
K-65	Knowledge of Cloud IAM (Identity and Access Management) - cloud and hybrid.	Summarize and explain the life cycle of users with Identity and Access Management in both Cloud and Hybrid environments.
K-66	Knowledge of Cloud IAM users, groups, roles, and policies - cloud and hybrid.	
K-67	Knowledge of Cloud Computing shared security responsibility model - cloud and hybrid.	Describe the cloud computing shared security responsibility model.
K-68	Knowledge of Cloud Regions - cloud and hybrid.	Explain cloud regions and availability zones in cloud infrastructure.
K-69	Knowledge of Cloud Availability Zone - cloud and hybrid.	
K-70	Knowledge of Recovery Time Objective (RTO).	Compare and contrast Recovery Time Objective (RTO) and Recovery Point Objective (RPO).
K-71	Knowledge of Recovery Point Objective (RPO).	
K-72	Knowledge of High Availability factors (fault-tolerance, recoverability, and scalability).	Explain high availability factors in a cloud environment.
K-74	Knowledge of Auto Scaling and Load Balancing.	Describe capabilities of cloud auto-scaling and load balancing.
K-75	Knowledge of the differences between Cloud vs. On-Premise.	Describe the difference between cloud technologies and traditional networks.
K-24	Knowledge of jamming and interference patterns so they can be recognized as a challenge for the network itself applied to wireless networks.	Define the concept of jamming in the context of wireless networks. Explain the various types of interference patterns that can affect wireless networks.
K-44	Knowledge of Software Defined Networking concepts.	Define Software Defined Networking (SDN) and articulate its fundamental concepts.
K-45	Knowledge of Continuous Quality Improvement Principles (of particular value: Lean and Agile).	Describe Continuous Quality Improvement (CQI) and articulate its importance in organizational processes. Explain the key principles of Lean and Agile methodologies and their relevance to CQI.
K-46	Knowledge of how to identify organizational goals that align with architecture and how do you identify your value to the organization.	Identify key elements of organizational architecture and articulate their alignment with broader organizational goals. Define the concept of personal and professional value within an organizational context.
K-47	Knowledge of Python or other scripting languages.	Discuss the role and importance of scripting languages, with a focus on Python.
K-59	Knowledge of Web Services technologies.	Define the concept of web services and their role in modern software development.
K-63	Knowledge of region failover and redundancy vs local failover and redundancy and how that needs to be applied to your data centers (cloud, hybrid, on-prem).	Define the concept of region failover and redundancy in the context of data center architecture. Define the concept of local failover and redundancy in the context of data center architecture. Differentiate between local failover and redundancy and region failover and redundancy.
K-76	Knowledge in preparing and deploying a cloud database solution that meets application requirements.	Define the fundamentals of cloud databases and their role in modern application architecture.
K-77	Knowledge of database management systems, query languages, table relationships, and views.	Explain the purpose, functions, and key components of a Database Management System (DBMS). Define the concept of query languages in the context of databases.
K-78	Knowledge of Azure.	Identify and differentiate the cloud services provided by Azure, AWS, and Google Cloud.
K-79	Knowledge of AWS.	
K-80	Knowledge of Google Cloud.	
K-81	Knowledge of emerging technology (e.g., blockchain, quantum computing).	Define the key concepts and principles of blockchain technology. Identify the fundamental principles of quantum computing.
K-82	Knowledge of making recommendations for migration of a physical network to a cloud-based architecture.	Describe the benefits of migrating from a physical network to a cloud-based architecture.
K-87	Knowledge of assessing and evaluating the technical benefits of implementation of a cloud computing architecture.	

K-83	Knowledge of creating a cloud-based network infrastructure to meet requirements for a software application.	Summarize the fundamental concepts of cloud-based network infrastructure in terms of meeting the needs of a given application.
K-84	Knowledge of the OSI model and understand that OSI is the framework for all problem solving and troubleshooting. Provide basic framework for how it all works, including how cloud computing has impacted the conceptualization of the seven layers. Plus an awareness of IP multimedia services.	Explain the OSI (Open Systems Interconnection) model and identify its different layers. Differentiate the purpose of each OSI layer and the interactions between layers during data communication as well as how it applies to cloud computing.
K-85	Knowledge of preparing and deploying a Cloud High Availability and Business Continuity Solution.	Describe the concepts of High Availability (HA) and Business Continuity (BC) in the context of cloud computing architecture.
K-86	Knowledge of implementing auto scaling and load balancing.	Explain auto-scaling and load balancing concepts.
Skills		**Student Learning Outcomes**
S-4	Skill in installing, configuring, and troubleshooting LAN and WAN components such as routers and switches.	Install network components and perform configuration. Effectively test network security configuration backup and recovery plans.
S-9	Skill in testing network infrastructure contingency and recovery plans.	
S-2	Skill in establishing a routing schema.	Establish a routing schema and apply subnetting TCP/IP consents to that schema.
S-10	Skill in applying various subnet techniques (e.g., CIDR).	
S-11	Skill in configuring and utilizing computer protection components (e.g., hardware firewalls, servers, routers, as appropriate).	Demonstrate skills in installing and configuring network hardware, software, and cable, including firewalls and other devices. Demonstrate skill in diagnosing network connectivity problems.
S-12	Skill in configuring and basic optimizing software.	
S-13	Skill in diagnosing connectivity problems.	
S-14	Skill in maintaining directory services (e.g., Microsoft Active Directory, LDAP, etc.).	Operate and articulate file system and directory services operations. Design and develop different types of virtual machines. Design and develop apps using containerized software tools.
S-15	Skill in using virtual machines (e.g., Microsoft Hyper-V, VMWare vSphere, Citrix XenDesktop/Server, Amazon Elastic Compute Cloud, etc.).	
S-17	Skills in using microservices and containers (e.g., Docker, Kubernetes, ECS) and understanding monitoring dashboards.	
S-18	Skill in configuring and utilizing software-based computer protection tools (e.g., software firewalls, antivirus software, anti-spyware).	Apply basic software security measures to protect network devices. Perform troubleshooting services including software upgrade/downgrade and installation of appropriate network devices. Perform system/server management and maintenance.
S-20	Skill in conducting system/server management and maintenance.	
S-22	Skill in troubleshooting failed system components (i.e., servers).	
S-24	Skill in installing system and component upgrades (i.e., servers, appliances, network devices).	
S-25	Skill in monitoring and optimizing basic system/server/cloud performance.	Create and maintain an effective network performance baseline by monitoring and troubleshooting network performance.
S-23	Skill in identifying system/server performance, availability, capacity, or configuration problems.	
S-21	Skill in correcting physical and technical problems that impact system/server performance.	
S-26	Skill in recovering failed systems/servers (e.g., recovery software, failover clusters, replication, etc.).	Perform the recovery process for a failed system or server. Create, administer, and maintain user accounts and groups in a network environment.
S-27	Skill in operating system administration (e.g., account maintenance, data backups, maintain system performance, install and configure new hardware/software).	
S-1	Understand that OSI is the framework for all problem solving and troubleshooting.	Utilize the latest tools to analyze network traffic and identify patterns to improve performance using the OSI model as a reference.
S-5	Skill in using network management tools to analyze network traffic patterns (e.g., simple network management protocol).	
S-6	Skill in securing network communications (e.g., logical).	Take appropriate actions to mitigate vulnerability and risk from potential network attacks.
S-7	Skill in protecting a network against malware (e.g., NIPS, anti-malware, restrict/prevent external devices, spam filters).	
S-8	Skill in basic configuring and utilizing network protection components (e.g., firewalls, VPNs, network intrusion detection systems).	
S-3	Skill in implementing, maintaining established network security practices.	Apply established practices to secure a network.
S-19	Skill in interfacing with customers.	Demonstrate effective interactions with customers.

S-29	Skill in identifying and distinguishing private, public, and hybrid cloud implementations.	Evaluate public, private, and hybrid cloud technologies. Assess and apply different XaaS tools and technologies models. Operate and manage cloud technologies.
S-30	Skill in identifying and distinguishing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	
S-16	Skill in using cloud (e.g., Amazon Elastic Compute Cloud).	
S-31	Skill in executing test cases for identified functional or non-functional requirements.	Perform different functional and non-functional cloud tests to ensure business requirements. Summarize and document cloud testing results against developed criteria.
S-32	Skill in documenting results of executed test cases showing whether according to developed success criteria the test case passes, fails, or partially passes.	
S-33	Skill in documenting and determining root cause failure(s) for items that failed or partially passed.	
S-36	Skill in producing virtual machines from a cloud image.	Demonstrate setting up virtual machine(s) using cloud technologies.
S-37	Skill in producing virtual machines within a cloud region.	
S-38	Skill in demonstrating how to customize virtual networks with IP address range, subnets, routing tables and gateways.	Devise customized virtual machine(s) based on different network topologies. Detect troubleshoot issues with virtual machine(s).
S-39	Skill in analyzing and troubleshooting cloud virtual networks.	
S-40	Skill in preparing and deploying virtual machines in a virtual network (private or public subnet).	
S-43	Skill in applying permissions from the IAM (Identity and Access Management).	Apply permissions for IAM (Identify and Access Management) for groups and users.
S-44	Skill in applying permissions for IAM (Identity and Access Management) group(s).	
S-45	Skill in applying permissions for IAM (Identity and Access Management) user(s).	
S-46	Skill in analyzing and troubleshooting containers.	Analyze and troubleshoot containers.
S-41	Skill in deploying cloud storage technologies with the assistance of a senior technician.	Deploy different cloud storage systems with assistance from a senior technician. Analyze and troubleshoot different cloud storage systems.
S-42	Skill in analyzing and troubleshooting different cloud storage technologies.	
S-47	Skill in using management tools like Chef, Puppet, etc.	Utilize management tools for improving infrastructure automation.
S-34	Skill in preparing written reports.	Deliver information in an appropriate manner to each type of audience.
S-35	Skill in preparing presentations.	
S-28	Skill in applying Software Defined Networking concepts.	Deploy SDN components such as OpenFlow protocols to enable communication between the control and data planes.
S-48	Skill in managing changes/updates for both internal and external customers when policies and procedures change.	Apply established change management processes to assess the impact of policy and procedure changes.
S-49	Skill in assessing or monitoring system for cyberattacks.	Apply knowledge of cybersecurity tools and technologies used for system assessment and monitoring (e.g., intrusion detection systems, antivirus software, firewalls). Configure and use security information and event management (SIEM) tools for log analysis and correlation.
S-50	Skill in identifying possible causes of degradation of system performance or availability and initiating actions needed to mitigate this degradation.	Detect system performance degradation using data to pinpoint potential bottlenecks. Use performance trends and anomalies to determine the root causes of degradation.
S-51	Skill in identifying areas where there are issues/gaps in a cloud implementation and develop a working solution.	Apply knowledge of cloud service models (IaaS, PaaS, SaaS) to identify issues specific to each model. Evaluate cloud architectures to identify potential gaps in scalability, redundancy, and fault tolerance.
S-52	Skill in leveraging cloud/hybrid managed services to enable greater flexibility and resilience in an secure infrastructure.	Implement cloud/management services that enhance the flexibility of the infrastructure, allowing for rapid adaptation to business needs. Apply knowledge of managed security services to enhance the overall security posture of a hybrid cloud infrastructure.
S-53	Skill in identifying appropriate cloud services that provide the compute power needed to solve a technical business problem while optimizing cost.	Compare cost structures of different compute services and models in the cloud that are needed to solve technical business problems.

S-54	Skill in reading, interpreting, writing, modifying, and executing simple scripts (e.g., Perl, VBScript) on Windows and UNIX systems (e.g., those that perform tasks such as: parsing large data files, automating manual tasks, and fetching/processing remote data).	Write simple scripts in Perl and VBScript on Windows and UNIX systems to perform specified tasks based on specific requirements.
S-55	Skill in importing/ exporting/migrating/protecting/securing data from one data source to another.	Apply techniques for importing data into various data sources. Choose methods for exporting data from different sources. Apply strategies for migrating data between different systems or platforms. Formulate security measures to protect sensitive data during transfer.
S-56	Skill in applying security concepts in the automation of resource provisioning.	Investigate security best practices when designing and implementing automated resource provisioning workflows.
S-57	Skill in identifying the necessary components of a physical network and a cloud-based network.	Identify and label physical network components within a given infrastructure. Demonstrate the ability to trace physical connections and understand their roles in data transmission. Identify and configure virtualized components in a cloud-based network, including virtual machines, virtual networks, and subnets. Implement and manage load balancers, firewalls, and other cloud-specific components.
S-58	Skill in using Azure.	Create and manage virtual machines, storage, and networking components in a cloud environment for Azure, AWS, and GCP.
S-59	Skill in using AWS.	
S-60	Skill in Google Cloud.	
Abilities		**Student Learning Outcomes**
A-6	Ability to operate different electronic communication systems and methods (e.g., e-mail, VOIP, IM, web forums, Direct Video Broadcasts).	Apply techniques and protocols to data communication network systems.
A-1	Ability to install network equipment including routers, switches, servers, transmission media, and related hardware.	Integrate LAN/WAN network connectivity by installing network hardware, software, and cabling. Operate the organization's LAN/WAN pathways.
A-4	Ability to operate the organization's LAN/WAN pathways.	
A-10	Ability to apply an organization's goals and objectives to maintain architecture.	Ensure network architecture aligns with organization's goals and objectives. Demonstrate the use of OS command line tools.
A-3	Ability to execute OS command line (e.g., ipconfig, netstat, dir, nbtstat).	
A-9	Ability to interpret and clarify incidents, problems, and events submitted in the trouble ticketing system.	Assess and troubleshoot issues submitted to the organization's ticketing system.
A-2	Ability to operate common network tools (e.g., ping, traceroute, nslookup).	Measure network system traffic by using network tools to monitor network performance.
A-5	Ability to monitor measures or indicators of system performance and availability.	
A-7	Ability to monitor traffic flows across the network.	
A-8	Ability to recognize and escalate the information collected by network tools (e.g., nslookup, ping, and traceroute).	Analyze the data collected from network tools to identify problems and escalate when needed.
A-14	Ability to apply cybersecurity and privacy principles to organizational requirements (relevant to confidentiality, integrity, availability, authentication, non-repudiation).	Execute organization's cybersecurity, privacy, and security controls for the network environment.
A-15	Ability to maintain automated security control assessments.	
A-11	Ability to update and/or maintain standard operating procedures (SOPs).	Update the organization's standard operating procedures (SOPs) as needed.
A-12	Ability to collaborate effectively with others.	Demonstrate effective collaboration skills to work with a team to achieve project goals.
A-16	Ability to communicate effectively (written and oral) within and among team members and associated stakeholders (i.e., different audiences and organizational levels). This includes communicating complex technical issues and business implications.	Demonstrate effective communication skills (both oral and written) when working with team members and stakeholders. Effectively communicate technical jargon in simple terms to team members and stakeholders. Demonstrate effective listening skills. Analyze and interpret input to determine implicit and explicit customer requirements.
A-20	Ability to translate technical language into lay terminology when needed.	
A-22	Ability to listen and understand what people say.	
A-19	Ability to analyze and interpret customer input for expressed and implied requirements.	

A-13	Ability to function effectively in a dynamic, fast-paced environment.	Demonstrate the ability to successfully perform job functions in a fast-paced and dynamic work environment.
A-17	Ability to work under stress.	Demonstrate the ability to successfully perform job functions in stressful situations.
A-18	Ability to problem solve.	Demonstrate the ability to understand details, prioritize items, and use available information to solve problems.
A-23	Ability to recognize and understand details.	
A-24	Ability to order and arrange items.	
A-21	Ability to read and interpret technical documents, diagrams, and decision trees.	Analyze and interpret technical documents and diagrams. Develop presentation visuals to deliver technical information to an appropriate audience.
A-25	Ability to create appropriate presentation visuals for technical material.	

Infrastructure Degree Expectations

A pool of 20 community college and four-year university faculty members from across the country were asked to categorize each knowledge, skill, ability, and task below. The question posed to them: would these KSA+Ts be reasonably included in a two-year AAS program, a four-year Bachelor's program, both, or neither? These results provide another tool for educators to use in assessing how to best incorporate each knowledge, skill, ability, and task.

	Tasks	2 Year AAS	Both 2 yr AAS and 4 yr Academic Degree	4 Year Academic Degree	Number of responses
			% Best Estimate		
T-1	Configure network, routers, and switches.	35%	50%	15%	20
T-2	Diagnose network connectivity problem.	35%	65%	0%	20
T-3	Install and maintain network infrastructure device operating system software (e.g., IOS, firmware) which would include patch network vulnerabilities to safeguard information.	35%	55%	10%	20
T-4	Install or replace network, routers, and switches.	50%	45%	5%	20
T-5	Integrate new systems into existing network architecture.	20%	40%	40%	20
T-6	Monitor basic network capacity and performance.	35%	55%	10%	20
T-7	Test and maintain network infrastructure including software, hardware devices, software-defined networks, and network applications.	26%	58%	16%	19
T-8	Conduct functional and connectivity testing to ensure continuing operability.	37%	63%	0%	20
T-9	Implement group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	20%	65%	15%	20
T-10	Support group policies and access control lists to ensure compatibility with organizational standards, business rules, and needs.	20%	45%	35%	20
T-11	Follow SOP and validate/update documentation of compliance.	15%	45%	40%	20
T-12	Validate/update baseline system security according to organizational policies.	20%	55%	25%	20
T-13	Manage accounts, network rights, and access to systems and equipment.	40%	55%	5%	20
T-14	Provide ongoing optimization and problem-solving support.	15%	65%	20%	20
T-15	Install, update, and troubleshoot systems/servers.	30%	70%	0%	20
T-16	Check system hardware availability, functionality, integrity, and efficiency.	25%	50%	20%	20
T-17	Conduct periodic system maintenance including cleaning (both physically and electronically), disk checks, routine reboots, data dumps, and testing.	50%	45%	5%	20
T-18	Implement local network usage policies and procedures.	30%	50%	20%	20
T-19	Manage system/server resources including performance, capacity, availability, serviceability, and recoverability.	35%	40%	25%	20
T-20	Monitor and maintain system/server configuration.	45%	55%	0%	20
T-21	Installation, implementation, configuration, and support of system components.	30%	65%	5%	20
T-22	Troubleshoot hardware/software interface and interoperability problems.	30%	60%	10%	20
Knowledge					
K-1	Knowledge of computer networking concepts and protocols, and network security methodologies.	35%	55%	10%	20
K-2	Knowledge of laws, regulations, policies, and ethics as they relate to cybersecurity and privacy (e.g. PCI, PII, PHI, GDPR). Note connection to K-8 below.	20%	45%	35%	20
K-3	Knowledge of cybersecurity and privacy principles.	30%	70%	0%	20
K-4	Knowledge of cyber threats and vulnerabilities.	25%	70%	5%	20
K-5	Knowledge of specific operational impacts of cybersecurity lapses.	20%	75%	5%	20

K-6	Knowledge of communication methods, principles, and concepts that support the network infrastructure.	25%	60%	15%	20
K-7	Knowledge of capabilities and applications of network equipment including routers, switches, bridges, servers, transmission media, and related hardware.	35%	60%	5%	20
K-8	Knowledge of risk management, cybersecurity and privacy principles used to manage risks related to the use, processing, storage, and transmission of information or data.	15%	65%	20%	20
K-9	Knowledge of information technology (IT) security principles and methods (e.g., firewalls, demilitarized zones, encryption).	25%	75%	0%	20
K-10	Knowledge of local area and wide area networking principles and concepts including bandwidth management.	35%	65%	0%	20
K-11	Knowledge of measures or indicators of system performance and availability.	26%	58%	16%	19
K-12	Knowledge of remote access technology concepts.	35%	65%	0%	20
K-13	Knowledge of server administration and systems engineering theories, concepts, and methods.	25%	65%	10%	20
K-14	Knowledge of Virtual Private Network (VPN) security.	30%	65%	5%	20
K-15	Knowledge of concepts, terminology, and operations of a wide range of baseband and broadband communications transmission media and protocols (computer and telecommunications networks, satellite, fiber, wireless).	25%	70%	5%	20
K-16	Knowledge of network tools (e.g., ping, traceroute, nslookup).	45%	55%	0%	20
K-17	Knowledge of the range of existing networks (e.g., PBX, LANs, WANs, WIFI, SCADA).	25%	65%	10%	20
K-18	Knowledge of Voice over IP (VoIP).	33%	50%	17%	18
K-19	Knowledge of the common attack vectors on the network layer.	35%	55%	10%	20
K-20	Knowledge of network security architecture concepts including topology, protocols, components, and principles (e.g., application of defense-in-depth).	26%	68%	5%	20
K-21	Knowledge of network and systems management principles, models, methods (e.g., end-to-end systems performance monitoring), and tools (NOC and SOC).	15%	60%	25%	20
K-22	Knowledge of concepts of certificates, key management and usage.	30%	65%	5%	20
K-23	Knowledge of wired and wireless transmission standards (e.g. Ethernet, Bluetooth, Radio Frequency Identification (RFID), Infrared Networking (IR), Wireless Fidelity (Wi-Fi). paging, cellular, and satellite communications.)	26%	68%	5%	20
K-24	Knowledge of jamming and interference patterns so they can be recognized as a challenge for the network itself, especially as this applies to wireless networks.	16%	58%	26%	19
K-25	Knowledge of network protocols such as TCP/IP, Dynamic Host Configuration, Domain Name System (DNS), and directory services.	35%	65%	0%	20
K-26	Knowledge of controls related to the use, processing, storage, and transmission of data.	25%	65%	10%	20
K-27	Knowledge of performance tuning tools and techniques.	20%	60%	20%	20
K-28	Knowledge of the enterprise information technology (IT) architecture.	22%	50%	28%	18
K-29	Knowledge of the type and frequency of routine hardware maintenance (e.g. Linux/Unix OS, Windows Server OS).	37%	63%	0%	19
K-30	Knowledge of file system implementations (e.g., New Technology File System [NTFS], File Allocation Table [FAT], File Extension [EXT]) including network storage and servers.	35%	60%	5%	20
K-31	Knowledge of virtualization technologies and virtual machine development and maintenance.	25%	70%	5%	20
K-32	Knowledge of system administration, network, and operating system hardening techniques.	30%	65%	5%	20
K-33	Knowledge of system/server diagnostic tools and fault identification techniques.	21%	58%	21%	19

K-34	Knowledge of operating system command-line tools.	30%	70%	0%	20
K-35	Knowledge of principles and methods for integrating system components including network storage and servers.	26%	58%	16%	19
K-36	Knowledge of script automation and application programming interfaces.	20%	50%	30%	20
K-37	Knowledge of network backup and recovery procedures.	30%	70%	0%	20
K-38	Knowledge of patch network vulnerabilities to ensure that information is safeguarded against outside parties.	30%	70%	0%	20
K-39	Knowledge of system administration, network, and operating system concepts and hardening techniques.	35%	60%	5%	20
K-40	Knowledge of asset management and why it's important to the business.	15%	50%	35%	20
K-41	Knowledge of risks associated with storing various types of data in different physical locations.	26%	68%	5%	19
K-42	Knowledge of infrastructure data storage capabilities and storage clusters.	25%	55%	20%	20
K-43	Knowledge of IoT end devices and connectivity.	30%	65%	5%	20
K-44	Knowledge of Software Defined Networking concepts.	15%	50%	35%	20
K-45	Knowledge of database theory as it relates both to network latency and replication and also to the three states of data (in the data center, in the cloud, and in a co-location).	16%	53%	32%	19
K-46	Knowledge of Continuous Quality Improvement Principles (of particular value: Lean and Agile).	10%	30%	60%	20
K-47	Knowledge of how to identify organizations goals that align with system architecture (i.e. know your business)	10%	40%	50%	20
K-48	Knowledge of Python or other scripting languages.	30%	65%	5%	20
K-49	Knowledge of the differences or similarities between Private, Public, and Hybrid Cloud Implementations.	32%	58%	11%	20
K-50	Knowledge of the difference or similarities between Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	30%	65%	5%	20
K-51	Awareness of framework concepts, their selection and use.	11%	72%	17%	18
K-52	Awareness of the pros or cons behind using Frameworks.	17%	50%	33%	18
K-53	Knowledge of the term benchmarks and the reasons for their use.	25%	70%	5%	20
K-54	Knowledge of the term resilience and how resilience can be designed into a project, program, infrastructure or organization.	20%	65%	15%	20
K-55	Knowledge of the concept of Service Level Agreement, why they are used, when they are used, and its application within Cloud implementations.	15%	75%	10%	20
K-56	Knowledge of who owns or should own the data/information in a Cloud implementation.	15%	70%	15%	20
K-57	Knowledge of the key Management/Operational/Security/Privacy challenges potential faced when considering or implementing a Cloud capability.	15%	65%	20%	20
K-58	Knowledge of the different organizational roles needed as one plans for Cloud implementation or manages an existing Cloud capability.	10%	55%	35%	20
K-59	Knowledge of the incident response challenges potentially faced within a Cloud implementation.	15%	60%	25%	20
K-60	Knowledge of Web Services technologies.	30%	55%	15%	20
K-61	Knowledge of cloud network storage including cloud object -based storage and local system storage.	25%	60%	15%	20
K-62	Knowledge of the different Cloud computing database types (RDS).	15%	50%	35%	20
K-63	Knowledge of how to scale a Cloud database.	15%	40%	45%	20
K-64	Knowledge of region failover and redundancy vs local failover and redundancy and how that needs to be applied to your data centers (cloud, hybrid, on-prem).	10%	75%	15%	20
K-65	Knowledge of the differences between SQL and Non-SQL Databases.	25%	45%	30%	20
K-66	Knowledge of Cloud IAM (Identity and Access Management) - cloud and hybrid.	16%	58%	26%	20

K-67	Knowledge of Cloud IAM users, groups, roles and policies - cloud and hybrid.	21%	53%	26%	20
K-68	Knowledge of Cloud Computing shared security responsibility model - cloud and hybrid.	16%	53%	32%	19
K-69	Knowledge of Cloud Regions - cloud and hybrid.	16%	58%	26%	19
K-70	Knowledge of Cloud Availability Zone - cloud and hybrid.	16%	53%	32%	19
K-71	Knowledge of Recovery Time Objective (RTO).	10%	80%	10%	20
K-72	Knowledge of Recovery Point Objective (RPO).	11%	79%	11%	19
K-73	Knowledge of High Availability factors (Fault-tolerance, recoverability, and scalability).	21%	74%	5%	19
K-74	Knowledge of microservices and containerization (e.g. Kubernetes and Docker).	11%	47%	42%	19
K-75	Knowledge of Auto Scaling and Load Balancing.	20%	55%	25%	20
K-76	Knowledge of the differences between Cloud vs. On-Premises.	40%	60%	0%	20
K-77	Knowledge in preparing and deploying a cloud database solution that meets application requirements.	10%	50%	40%	20
K-78	Knowledge of database impacts to network systems.	20%	60%	20%	20
K-79	Knowledge of Azure.	35%	60%	5%	20
K-80	Knowledge of AWS.	35%	60%	5%	20
K-81	Knowledge of Google Cloud.	35%	60%	5%	20
K-82	Knowledge of emerging technology (e.g. blockchain, quantum computing)	10%	65%	25%	20
K-83	Knowledge of building scalable distributed systems supporting parallel processing of customer jobs on a large fleet of devices.	11%	37%	53%	19
K-84	Knowledge of making recommendations for migration of a physical network to a cloud-based architecture.	15%	40%	45%	20
K-85	Knowledge of creating a cloud-based network infrastructure to meet requirements for a software application.	10%	35%	55%	20
K-86	Knowledge of assessing and evaluating the technical benefits of implementation of a cloud computing architecture.	10%	50%	40%	20
K-87	Knowledge of the OSI model and understand that OSI is the framework for all problem solving and troubleshooting. Provide basic framework for how it all works, including how cloud computing has impacted the conceptualization of the seven layers. Plus an awareness of IP multimedia services.	35%	60%	5%	20
K-88	Knowledge of preparing and deploying a Cloud High Availability and Business Continuity Solution.	16%	47%	37%	19
K-89	Knowledge of implementing auto scaling and load balancing.	16%	68%	16%	20
K-90	Knowledge of DevSecOps concepts.	11%	42%	47%	19
K-91	Knowledge of the trend of technology's increasing "interconnectivity" and the end of rigid workplace silos.	10%	55%	35%	20
K-92	Knowledge of online professional resource forums (e.g. GitHub, Reddit, Signal) and an understanding of both the benefits and risks associated with using them.	16%	79%	5%	19
K-93	Knowledge of basic AI and machine learning concepts/tools (e.g. ChatGPT).	20%	65%	15%	20
Skills					
S-1	Understand that OSI is the framework for all problem solving and troubleshooting	44%	56%	0%	18
S-2	Skill in establishing a routing schema.	35%	45%	20%	20
S-3	Skill in implementing, maintaining established network security practices.	45%	50%	5%	20
S-4	Skill in installing, configuring, and troubleshooting LAN and WAN components such as routers, and switches.	40%	60%	0%	20
S-5	Skill in using network management tools to analyze network traffic patterns (e.g., simple network management protocol).	40%	55%	5%	20
S-6	Skill in securing network communications. (e.g., logical)	32%	58%	11%	19

S-7	Skill in protecting a network against malware. (e.g., NIPS, anti-malware, restrict/prevent external devices, spam filters).	37%	53%	11%	19
S-8	Skill in basic configuring and utilizing network protection components (e.g., Firewalls, VPNs, network intrusion detection systems).	40%	50%	10%	20
S-9	Skill in testing network infrastructure contingency and recovery plans.	30%	35%	35%	20
S-10	Skill in applying various subnet techniques (e.g., CIDR).	35%	65%	0%	20
S-11	Skill in configuring and utilizing computer protection components (e.g., hardware firewalls, servers, routers, as appropriate).	35%	60%	5%	20
S-12	Skill in configuring and basic optimizing software.	47%	42%	11%	19
S-13	Skill in diagnosing connectivity problems.	45%	55%	0%	20
S-14	Skill in maintaining directory services. (e.g., Microsoft Active Directory, LDAP, etc.).	42%	58%	0%	19
S-15	Skill in using virtual machines. (e.g., Microsoft Hyper-V, VMWare vSphere, Citrix XenDesktop/Server, Amazon Elastic Compute Cloud, etc.).	35%	50%	15%	20
S-16	Skill in using Cloud (e.g. Amazon Elastic Compute Cloud).	30%	55%	15%	20
S-17	Skills in using microservices and containers (e.g., Docker, Kubernetes, ECS) and understanding monitoring dashboards.	16%	47%	37%	20
S-18	Skill in configuring and utilizing software-based computer protection tools (e.g., software firewalls, antivirus software, anti-spyware).	35%	60%	5%	20
S-19	Skill in interfacing with customers.	11%	89%	0%	19
S-20	Skill in conducting system/server management and maintenance.	35%	55%	10%	20
S-21	Skill in correcting physical and technical problems that impact system/server performance.	20%	55%	20%	20
S-22	Skill in troubleshooting failed system components (i.e., servers).	37%	58%	5%	19
S-23	Skill in identifying system/server performance, availability, capacity, or configuration problems.	37%	53%	11%	19
S-24	Skill in installing system and component upgrades. (i.e., servers, appliances, network devices).	45%	50%	5%	20
S-25	Skill in monitoring and optimizing basic system/server/cloud performance.	37%	47%	16%	19
S-26	Skill in recovering failed systems/servers. (e.g., recovery software, failover clusters, replication, etc.).	35%	35%	30%	20
S-27	Skill in operating system administration. (e.g., account maintenance, data backups, maintain system performance, install and configure new hardware/software).	40%	45%	15%	20
S-28	Skill in applying Software Defined Networking concepts.	21%	47%	32%	19
S-29	Skill in identifying and distinguishing Private, Public, and Hybrid Cloud Implementations.	20%	65%	15%	20
S-30	Skill in identifying and distinguishing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.	20%	65%	15%	20
S-31	Skill in executing Test Cases for identified functional or non-functional requirements.	10%	45%	45%	20
S-32	Skill in documenting results of executed test cases showing whether according to developed success criteria the test case passes, fails, or partially passes.	16%	47%	37%	19
S-33	Skill in documenting and determining root cause failure(s) for items that failed or partially passed.	11%	58%	32%	19
S-34	Skill in preparing written reports.	10%	80%	10%	20
S-35	Skill in preparing presentations.	15%	75%	10%	20
S-36	Skill in producing Virtual Machines from a Cloud image.	29%	53%	18%	17
S-37	Skill in producing Virtual Machines within a Cloud region.	22%	44%	33%	18
S-38	Skill in demonstrating how to customize virtual networks with IP Address Range, subnets, routing tables and gateways.	25%	60%	15%	20
S-39	Skill in analyzing and troubleshooting Cloud Virtual Networks.	15%	40%	45%	20

S-40	Skill in preparing and deploying virtual machines in a virtual network (private or public subnet).	25%	50%	25%	20
S-41	Skill in deploying cloud storage technologies with the assistance of a senior technician.	35%	50%	15%	20
S-42	Skill in analyzing and troubleshooting different cloud storage technologies.	32%	37%	32%	19
S-43	Skill in applying permissions from the IAM (Identity and Access Management).	30%	45%	25%	20
S-44	Skill in applying permissions for IAM (Identity and Access Management) Group(s).	32%	42%	26%	19
S-45	Skill in applying permissions for IAM (Identity and Access Management) user(s).	30%	45%	25%	20
S-46	Skill in analyzing and troubleshooting containers.	25%	35%	40%	20
S-47	Skill in using tools like Chef, Puppet, Ansible, etc.	5%	37%	58%	19
S-48	Skill in managing changes/updates for both internal and external customers when policies and procedures change.	16%	47%	37%	19
S-49	Skill in assessing or monitoring system for cyberattacks.	21%	68%	11%	19
S-50	Skill in identifying possible causes of degradation of system performance or availability and initiating actions needed to mitigate this degradation.	11%	47%	42%	19
S-51	Skill in leveraging cloud/hybrid managed services to enable greater flexibility and resilience in an secure infrastructure.	11%	32%	58%	19
S-52	Skill in identifying appropriate cloud services that provide the compute power needed to solve a technical business problem while optimizing cost.	11%	33%	56%	18
S-53	Skill in building, and operating key pieces of serverless and cloud native applications using appropriate cloud services.	11%	42%	47%	19
S-54	Skill in using a continuous integration (CI) / continuous delivery (CD) pipeline to deploy applications.	6%	39%	56%	18
S-55	Skill in reading, interpreting, writing, modifying, and executing simple scripts (e.g., Perl, VBScript) on Windows and UNIX systems (e.g., those that perform tasks such as: parsing large data files, automating manual tasks, and fetching/processing remote data).	15%	55%	30%	20
S-56	Skill in importing, exporting, migrating, protecting, and securing data from one data source to another.	20%	55%	25%	20
S-57	Skill in applying security concepts in the automation of resource provisioning.	15%	25%	60%	20
S-58	Skill in identifying the necessary components of a physical network and a cloud-based network.	25%	60%	15%	20
S-59	Skill in using Azure.	26%	58%	16%	19
S-60	Skill in using AWS.	30%	55%	15%	20
S-61	Skill in Google Cloud.	33%	44%	22%	18
S-62	Skill in using IBM Cloud.	17%	42%	42%	12
S-63	Skill in using Oracle Cloud.	23%	39%	39%	13
S-64	Skill in using Cisco Cloud.	33%	33%	33%	15
S-65	Skill in using VirtualBox.	37%	58%	5%	19
Abilities					
A-1	Ability to install network equipment including routers, switches, servers, transmission media, and related hardware.	45%	50%	5%	20
A-2	Ability to operate common network tools (e.g., ping, traceroute, nslookup).	40%	60%	0%	20
A-3	Ability to execute OS command line (e.g., ipconfig, netstat, dir, nbtstat).	45%	55%	0%	20
A-4	Ability to operate the organization's LAN/WAN pathways.	37%	53%	11%	19
A-5	Ability to monitor measures or indicators of system performance and availability.	30%	55%	15%	20

A-6	Ability to operate different electronic communication systems and methods (e.g., e-mail, VOIP, IM, web forums, Direct Video Broadcasts).	26%	47%	26%	19
A-7	Ability to monitor traffic flows across the network.	32%	53%	16%	19
A-8	Ability to recognize and escalate the information collected by network tools (e.g. Nslookup, Ping, and Traceroute).	40%	60%	0%	20
A-9	Ability to interpret and clarify incidents, problems, and events submitted in the trouble ticketing system.	32%	58%	11%	19
A-10	Ability to apply an organization's goals and objectives to maintain architecture.	21%	32%	47%	19
A-11	Ability to update, and/or maintain standard operating procedures (SOPs).	30%	35%	35%	20
A-12	Ability to collaborate effectively with others.	20%	80%	0%	20
A-13	Ability to function effectively in a dynamic, fast-paced environment.	16%	79%	5%	19
A-14	Ability to apply cybersecurity and privacy principles to organizational requirements (relevant to confidentiality, integrity, availability, authentication, non-repudiation).	15%	75%	10%	20
A-15	Ability to maintain automated security control assessments.	25%	50%	25%	20
A-16	Ability to communicate effectively (written and oral) within and among team members and associated stakeholders (i.e. different audiences and organizational levels). This includes communicating complex technical issues and business implications.	15%	70%	15%	20
A-17	Ability to work under stress.	16%	74%	11%	19
A-18	Ability to problem solve.	15%	85%	0%	20
A-19	Ability to analyze and interpret customer input for expressed and implied requirements.	10%	75%	15%	20
A-20	Ability to translate technical language into lay terminology when needed.	10%	85%	5%	20
A-21	Ability to read and interpret technical documents, diagrams, and decision trees.	10%	85%	5%	20
A-22	Ability to listen and understand what people say.	15%	85%	0%	20
A-23	Ability to recognize and understand details.	15%	85%	0%	20
A-24	Ability to order and arrange items.	15%	85%	0%	20
A-25	Ability to create appropriate presentation visuals for technical material.	15%	75%	10%	20

CYBERSECURITY

Approximately 100 Thought Leaders (mostly Chief Technology Officers and Chief Information Officers) agreed that this Cybersecurity Skillset would deliver "awareness plus a little more."

This packet includes **knowledge areas as developed by subject matter experts (SMEs) via multiple synchronous meetings (see next page).**

These were developed with a focus 12 to 36 months in the future for an entry-level employee working in that specific cluster.

"Knowledge" focuses on the understanding of concepts. It is theoretical. An individual may have an understanding of a topic or tool or some textbook knowledge of it but have no experience applying it. For example, someone might have read hundreds of articles on health and nutrition, many of them in scientific journals, but that doesn't make that person qualified to dispense advice on nutrition.

The average was calculated from the subject matter expert votes.

- A vote of "4" indicated the item must be covered in the curriculum.
- A vote of "3" indicated the item should be covered in the curriculum.
- A vote of "2" indicated that it would be nice for the item to be covered in the curriculum.
- A vote of "1" indicated the item should not be covered in the curriculum. itskillstandards.org

Cybersecurity Skillset

		Avg
K-1	Explain why knowledge of cybersecurity is important for all workers.	3.9
K-2	Explain why a computing device such as a laptop, phone, tablet, etc., should never be left such that it can provide unsecured access to sensitive data, regardless of location.	3.0
K-3	Explain why you should not leave your laptop at your desk overnight without a physical lock and a digital lock.	3.4
K-4	Explain why you should not "hold the door" for someone behind you entering an office.	3.4
K-5	Explain why you should not lend your company ID badge to someone else.	3.8
K-6	Explain how you should secure your laptop when you work from home.	3.3
K-7	Explain why you should be aware of your surroundings when having conversations or virtual meetings to ensure others can't eavesdrop on the conversations and see or hear confidential information.	3.4
K-8	Explain why you need a complex password and several guidelines for strong passwords.	3.6
K-9	Explain what multi-factor authentication is and why you should use it.	3.7
K-10	Explain why you should have a passcode or biometric verification set on your mobile phone.	3.5
K-11	Explain why you should never share your work or personal passwords.	3.8
K-12	Explain why you should not allow your children or others to use your work computer.	3.6
K-13	Explain what a VPN is and why you need to use it if you are not at the office.	3.5
K-14	Explain the risk of why you should never connect your work computing device such as a laptop, phone, bluetooth, or tablet, etc., to an open WiFi network.	2.9
K-15	Explain why your home WiFi should be password protected.	3.6
K-16	Explain why you should lock your screen when you leave your desk.	3.8
K-17	Explain why your work computer's hard drive is encrypted.	3.1
K-18	Explain why your work computer may encrypt the contents of thumb drives.	2.9
K-19	Explain why your work computer might not allow you to use thumb drives.	3.5
K-20	Explain why your work computer might block certain websites, such as personal email, social media, Google, and shared network resources.	3.3
K-21	Explain the need for hardware encryption on one's home computer.	2.4
K-22	Explain how you can tell if the information you type in a browser is safe and secure.	3.8
K-23	Explain why a document could need to be password protected.	3.3
K-24	Explain why you would "sign" a document with a public key certificate.	3.5
K-25	Explain why you would encrypt a document with a public key certificate.	3.3
K-26	Explain what is meant by Personally Identifiable Information.	3.7
K-27	Explain identity theft and methods for prevention or remediation.	3.8
K-28	Explain why you shouldn't read documents with sensitive information where others can see them.	3.4
K-29	Explain why your company may want to manage all or part of your mobile phone if you use it for any company business.	3.2
K-30	Explain why is it essential for your computers (both work and home) to have virus protection running.	3.6
K-31	Explain why your computer regularly needs to install updates and why these updates must be allowed to occur.	3.7
K-32	Explain why you should only use company approved software and programs at work.	3.8
K-33	Explain why computer systems need to be regularly backed up, both those at work and those at home.	3.3
K-34	Explain what HIPAA, PCI, PII, and GDPR are and why are they important.	3.2
K-35	Explain how to identify what public information is (anything in the public domain, or materials that are published to the public to promote the organization).	3.3
K-36	Explain what confidential information is (internal intellectual property, financial information, operating procedures, customer confidential information, and the like; often requiring NDA in place).	3.6
K-37	Explain what is meant by securing personal information (e. g., personally identifiable information, salary information, legally restricted information; requiring strict need-to-know or legal approval).	3.5
K-38	Explain why you need to be careful about clicking on unknown links, media or text links in an email or on websites, as well as the types of damage that can occur if you do.	3.9
K-39	Explain various ways to recognize a fraudulent email and how to avoid damage from it.	3.9

K-40	Explain ways to detect an email that looks like it comes from someone you know and trust, but isn't actually from them.	3.8
K-41	Identify what is meant by social engineering and how it can be used to damage cybersecurity of an organization.	3.7
K-42	Explain what is meant by phishing, spear phishing, whaling, pretexting, tailgating, and baiting and how can you detect, avoid, or mitigate their effects.	3.8
K-43	Identify the impacts of the different types of malware such as Adware, Blastware, Cryptojacking, Ghostware, Exploits, Keylogger, Ransomware, Rootkits, Spyware, Trojans, Viruses, Worms and how can you detect, avoid, or mitigate their effects.	3.3
K-44	Explain ways to tell if a text message is legitimate.	3.2
K-45	Explain how text messages or instant messages from a supposedly trusted sender can be used to gather sensitive data.	3.6
K-46	Identify watering hole attacks and how to verify accuracy of different types of received data (IM, email, or other communications).	2.9
K-47	Explains methods for telling if someone else has accessed your computer.	3.1
K-48	Explain what you should do if you suspect someone else has accessed your computer.	3.5
K-49	Explain why an email program does not show images until you specifically ask to download them.	3.0
K-50	Explain what kinds of information can you give out to people you don't know.	3.3
K-51	Explain the types of information you should NEVER give out, but instead defer to your supervisor, HR, or Legal.	3.5
K-52	Explain the concept of Zero-Trust and why you need to take such precautions.	2.9
K-53	Explain how to handle the situation when someone from work calls, tells you they forgot someone's phone number, and wants you to provide the forgotten number.	3.1
K-54	Explain what you should do if someone calls or emails you, tells you a former co-worker has given you as a reference, and wants to ask you a few questions.	2.9
K-55	Explain how you can tell whether or not someone you do not know should or should not be in the office.	3.2
K-56	Explain why your company may monitor your activity on your work computer.	3.3
K-57	Identify in general how computers, firewalls, wi-fi access points, routers, and other equipment interact with one another and why a professional cybersecurity practitioner should be the one who configures key infrastructure.	3.0
K-58	Explain the need for company rules for browsing the web, emails, and mobile usage.	3.5
K-59	Explain why you need to follow company policies and the risks to you or the company if you don't follow them.	3.6
K-60	Explain the purpose of a company's information security and data management policies.	3.6
K-61	Explain the importance of a company's change management policy.	2.9
K-62	Explain why your company may not allow you to use your company computer for personal tasks.	3.4
K-63	Explain how you should treat company-confidential documents.	3.6
K-64	Explain why you would need to verify vendor or contractor computer security measures and policy.	3.3
K-65	Describe the purpose of an information security risk assessment that evaluates both internal and external cybersecurity risks.	3.1
K-66	Explain what is meant by identity in the digital world as well as the importance of protecting it.	3.5
K-67	Explain why encryption is needed and the basics of what needs to be encrypted, as well as who is responsible for encryption.	3.4
K-68	Explain why backups are important and who is typically responsible for them.	3.4
K-69	Explain the importance of erasing all data and files from any computing device prior to disposing of it.	3.4