NATIONAL CYBERWATCH CENTER

RESOURCE GUIDE

A GUIDE FOR MAPPING COURSES TO KNOWLEDGE UNITS (KUs)

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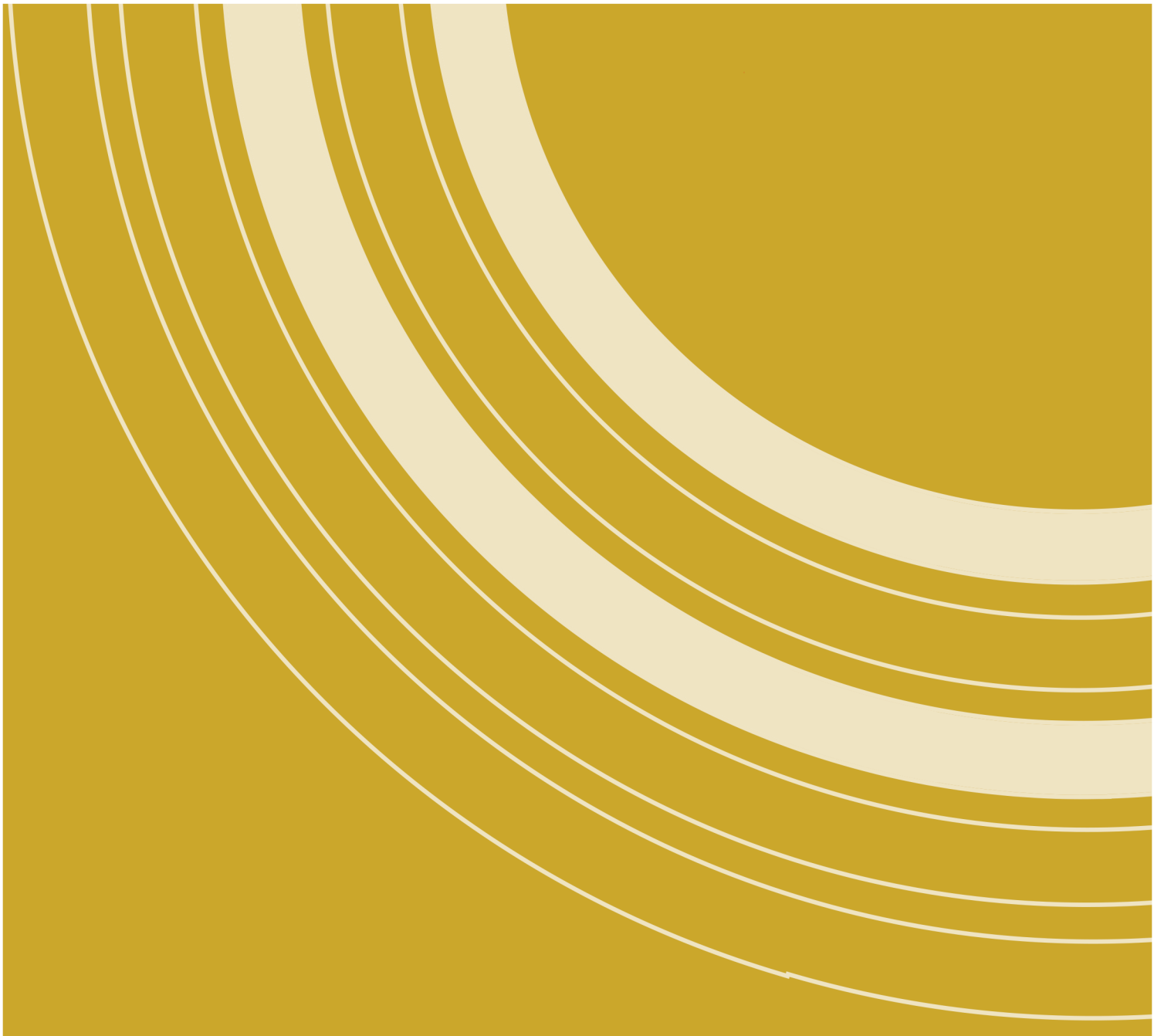

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Introduction

In order to support institutions of higher education and research in information assurance, the National Security Agency and the Department of Homeland Security jointly sponsor the National Centers of Academic Excellence in Information Assurance/ Cyber Defense (IA/CD). The goal of the CAE IA/CD program is to reduce vulnerability in our national information infrastructure by promoting higher education and research in Information Assurance/Cyber Defense (IA/CD) and to produce a growing number of professionals with expertise in IA/CD disciplines. All regionally accredited two-year, four-year and graduate level institutions in the United States (US) can apply for designation as a CAE IA/CD.

The CAE designation is an institutional designation; therefore, the benefits extend beyond the information assurance/ cyber defense program at a school to the entire institution. Current CAE institutions report benefits that include national recognition, strong partnerships, external funding, and grant opportunities.

The CAE IA/CD application is online, but information needs to be collected and organized before the applicant sits down at the computer. The NSA has produced numerous guides and documents to facilitate the collection and organization process. The National CyberWatch Center, the Center for Systems Security and Information Assurance, and CyberWatch West also offer help including example curricula, mapping assistance, and examples of the CAE application made prior to the CAE AI/CD update.

At the heart of the application are the Knowledge Units (KUs). The KU are mandatory topics and associated objectives that must be included in an institution's degree program. The application process requires that the applicant provide evidence that they address each topic and objective of the required KUs. This evidence is provided through a process that is called *mapping*.

This guide is designed to provide detailed instructions for collecting and organizing program artifacts into a format which will facilitate entering an institution's documentation into the online tool. This document also includes a walkthrough of the online application tool.

In order to provide a How-To guide quickly to the higher education information assurance community, this guide has been released before final review and approval from the NSA. However, this guide includes content from the NSA guides and taps into the vast experience of the National CyberWatch Center experts in the application process.

It should also be noted that Section 942, the National Centers of Academic Excellence in Information Assurance Education Matters, part of H.R. 3304: National Defense Authorization Act for

Fiscal Year 2014 (Pub.L. 113-66) was signed by President Obama on December 26, 2013.[1] It is possible that the CAE requirements and application process may change. However, in order to support our members, partners, current CAE designees, and the members and partners of our fellow Advanced Technological Education Centers the National CyberWatch Center has decided to create and disseminate this resource iteratively. This guide is intended to support the many institutions scheduled to redesignate during 2015 and will updated should the process change.

Furthermore, academia, industry and government professionals may propose updates to the knowledge units, focus areas, and criteria for the CAE IA/CD. Suggestions may be emailed to AskCAEIAE@nsa. These proposals will be reviewed by a joint panel of academia, industry and government professionals and any changes will be implemented once a year starting in 2015.

The CAE Program Office has several documents available. They will send them to you if you don't have them. They are also available on the National CyberWatch Center and the Center for Systems Security and Information Assurance website. We have referenced them or included them in this document where appropriate:

- CAE Program Guidance
- Program Criteria
  - CAE IA/CD 2Yr Criteria
  - CAE IA/CD 4Yr Criteria
- KU Mapping Matrices and Checklists:
  - 2-year Core
  - 4-year Core
  - Optional CAE IA/CD Focus Area List and Focus Area-KU Matrix
- CAE KU Mapping Matrix
- Schedule for current NSA/DHS CAEs in IA to apply for CAE in IA/CD designation

The National CyberWatch Center and the author would like recognize the following individuals and organizations for their support, information and help in creating this guide.

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[1] https://www.govtrack.us/congress/bills/113/hr3304

Mapping

Mapping is one of the requirements for an institution to be designated a Center of Academic Excellence (CAE). The required sets of knowledge required for a degree in information assurance are defined by NSA/DHS; these are referred to as Knowledge Units (KUs). The mapping process involves matching the instructional and experiential components of college level courses to the required KUs. This section offers a structured process for performing a mapping and entering this mapping into the online database.

Community College and Other Two Year Institution

KUs are tightly targeted technology areas composed of a set of topics and expected outcomes. They are the fundamental building blocks upon which the CAE in IA/CD rests. Although nearly 70 KUs are defined, fewer than two dozen need be referenced by four year institutions and less than a dozen by community colleges to meet minimum mapping requirements for their respective CAE designations. Specifically, a fixed set of eleven Core KUs make up the foundation of all mappings. Community colleges must map to all eleven of them (shown in Table 1).

1. Basic Data Analysis
2. Basic Scripting or Introductory Programming
3. Cyber Defense
4. Cyber Threats
5. Fundamental Security Design Principles
6. IA Fundamentals
7. Intro to Cryptography
8. IT Systems Components
9. Networking Concepts
10. Policy, Legal, Ethics, and Compliance
11. System Administration

CAE IA/CD 2Yr
Mandatory / CORE Knowledge Units

Table 1

Four Year Institutions

Four year institutions must map to those same eleven Core KUs required of two year institutions, *and* an additional prescribed set of six, *plus* five more optional ones that may be chosen from a set of more than four dozen. Thus, four year institutions are required to map their courses to 22 KUs as indicated in Table 2.

1. Basic Data Analysis
2. Basic Scripting or Introductory Programming
3. Cyber Defense
4. Cyber Threats
5. Fundamental Security Design Principles
6. IA Fundamentals
7. Intro to Cryptography
8. IT Systems Components
9. Policy, Legal, Ethics, and Compliance
10. Networking Concepts
11. System Administration
12. Database Management Systems
13. Network Defense
14. Networking Technology and Protocols
15. Operating Systems Concepts
16. Probability and Statistics
17. Programming

+5 Optional KU (See Table 3)

CAE IA/CD 4Yr
Mandatory / CORE Knowledge Units

Table 2

Optional Knowledge Units

As seen in Table 2, four-year institutions must map their courses to 17 Mandatory/Core KUs. They must also map their courses to an additional five KUs selected from any of the 51 contained in the **Optional Knowledge Unit List** *(*Table 3 below).

1. Advanced Cryptography
2. Advanced Network Technology and Protocols
3. Algorithms
4. Analog Telecommunications
5. Cloud Computing
6. Cybersecurity Planning and Management
7. Data Administration
8. Data Structures
9. Database Management Systems
10. Digital Communications
11. Digital Forensics
12. Device Forensics
13. Host Forensics
14. Media Forensics
15. Network Forensics
16. Embedded Systems
17. Forensic Accounting
18. Formal Methods
19. Fraud Prevention and Management
20. Hardware Reverse Engineering
21. Hardware/Firmware Security
22. IA Architectures
23. IA Compliance
24. IA Standards
25. Independent/Directed Study/Research
26. Industrial Control Systems
27. Intro to Theory of Computation
28. Intrusion Detection
29. Life-Cycle Security
30. Low Level Programming
31. Mobile Technologies
32. Network Security Administration
33. Operating Systems Hardening
34. Operating Systems Theory
35. Overview of Cyber Operations
36. Penetration Testing
37. QA / Functional Testing
38. RF Principles
39. Secure Programming Practices
40. Security Program Management
41. Security Risk Analysis
42. Software Assurance
43. Software Reverse Engineering
44. Software Security Analysis
45. Supply Chain Security
46. Systems Programming
47. Systems Certification and Accreditation
48. Systems Security Engineering
49. Virtualization Technologies
50. Vulnerability Analysis
51. Wireless Sensor Networks

Optional Knowledge Unit List
https://www.iad.gov/NIETP/documents/Requirements/CAE_IA-CD_KU.pdf

Table 3

Focus Areas

In addition to the required mappings discussed above, an institutions may differentiate itself from other institutions by offering one or more Focus Areas (FA). As of this writing, NSA/DHS has defined 17 FAs. The purpose of an FA is to combine a closely related set of KUs that addresses a defined cybersecurity specialty. FAs are built by adding certain combinations of KUs from the Optional Knowledge Unit List (Table 3) to the core CAE KUs. Following are a few examples of designated FAs: Cyber Investigations, Data Management Systems Security, Data Security Analysis, Digital Forensics, etc. A list of all FAs and the specific KU combinations required for each FA can be found at https://www.iad.gov/NIETP/documents/Requirements/CAE_IA-CD_FocusAreas.pdf All CAEs, two and four year institutions, have the option to apply for one or more CAE IA/CD Focus Area (FA) designations.

In order to receive a FA designation for a particular area an institution must:

- Map the institution's curriculum to all of the KUs required in the FA,
- Demonstrate that a student can reasonably complete the necessary course of study to include all KUs identified in the FA, and
- Provide certificates of accomplishment to students who complete the FA course of study. The certificates must clearly identify the specific Focus Area achieved.

Once an institution has decided to apply for a CAE designation, the next step is to review the preceding tables for the level of recognition it wants to obtain. To recap, Community colleges need only comply with Table 1. Four year institutions must comply fully with Tables 1, 2, and at least KUs selected from Table 3.

This document breaks the mapping process into three phases:

1. Data Gathering
2. Course Data Entry
3. Formal Mapping of Courses to KUs.

The first phase is performed off line, the other two, online. The remainder of this document discusses these phases.

Phase 1 – Data Gathering

Resources

Three resources are required to perform mappings:

1. All necessary CAE background materials and a formatted spreadsheet containing all of the KUs. These can be downloaded from the National IA Education & Training Programs site at https://www.iad.gov/NIETP/index.cfm
2. Institution's subject matter experts: professors who teach courses pertaining to the KUs.
3. Course supporting materials that map to the KUs' Topics and Outcomes. Detailed course outlines that include references to KU mapping topics are an excellent resource for this part. Lab exercises, handouts, team projects, etc. are also valuable. For Outcomes evaluation, examples of graded materials such as written tests, homework assignments, after chapter questions, and presentations that test student mastery of topic material are good references.

Getting Started

NSA/DHS has developed and made available a spreadsheet titled, 2014 CAE KU Mapping Matrix, to facilitate an institution's data gathering in support of mapping. This spreadsheet can be found on the sites listed above. This is an especially useful tool. It consists of a main sheet (Fig. 1) displaying the hot-linked names of all Core and Mandatory KUs. The KUs are color coded and grouped into two-year, four-year, and optional categories.

	A	B	C	D	E
1	All links below take you to the datasheet for that KU.				
2	**Core 2Y Knowledge Units**		**Optional Knowledge Units**		
3		Basic Data Analysis	Advanced Cryptography	Hardware Reverse Engineering	Secure Programming Practices
4		Basic Scripting	Advanced Network Technology and Protocols	Hardware/Firmware Security	Security Program Management
5		Cyber Defense	Algorithms	IA Architectures	Security Risk Analysis
6		Cyber Threats	Analog Telecommunications	IA Compliance	Software Assurance
7		Fundamental Security Design Principles	Cloud Computing	IA Standards	Software Reverse Engineering
8		Information Assurance Fundamentals	Cybersecurity Planning and Management	Independent/Directed Study/Research	Software Security Analysis
9		Introduction to Cryptography	Data Administration	Industrial Control Systems	Supply Chain Security
10		Information Technology System Components	Data Structures	Intro to Theory of Computation	Systems Programming
11		Networking Concepts	Database Management Systems	Intrusion Detection	Systems Certification and Accreditation
12		Policy. Legal, Ethics and Compliance	Digital Communications	Life-Cycle Security	Systems Security Engineering
13		Systems Administration	Digital Forensics	Low Level Programming	Virtualization Technologies
14			Device Forensics	Mobile Technologies	Vulnerability Analysis
15	**Core 4Y Knowledge Units**		Host Forensics	Network Security Administration	Wireless Sensor Networks
16		Databases	Media Forensics	Operating Systems Hardening	
17		Network Defense	Network Forensics	Operating Systems Theory	
18		Network Technology and Protocols	Embedded Systems	Overview of Cyber Operations	
19		Operating Systems Concepts	Forensic Accounting	Penetration Testing	
20		Probability and Statistics	Formal Methods	QA / Functional Testing	
21		Programming	Fraud Prevention and Management	RF Principles	

Fig. 1 Main Sheet - 2014 CAE KU Mapping Matrix

A good starting point for two and four year institutions is for a panel of content experts, i.e., professors and instructors of the courses, to review all mandatory and optional (if any) KUs. Before mapping begins, institutions should identify which Optional KUs they wish to map. (Note: Two year institutions may elect, but are not required, to map Optional KUs.) To make this initial determination, the panel can refer to the 2014 CAE KU Mapping Matrix (Fig. 1) or alternatively inspect the 2014 Mandatory

and Optional KU Checklists available for downloading from the source noted above. While both documents contain the same information, the format of the latter may be found easier to reference for this initial step.

The next step can be done individually or collaboratively as a team. Clicking on the name of any KU on the sheet shown in Fig. 1 brings up the topics and expected outcomes in spreadsheet form for that KU (Figs. 2 and 3). Consider the structure of the simplest KU, Basic Data Analysis (Fig. 2). It consists of only four topics: Summary Statistics, Graphing/Charts, Spreadsheet Functions, and Problem Solving. Additionally this KU has just one outcome: "Student will be able to apply standard statistical inference procedures ..."

Through the process of mapping, it is the task of each institution to specify how those KU topics will be met and how the outcome will be determined. Even though other KUs have more topics and more expected outcomes than the Basic Data Analysis KU, their designs are all the same, i.e. a list of topics and a series of expected outcomes. See Fig. 3 as another example of the similar structure.

	A	B	C	D	E
1			Courses	ABC-123	DEF-456
2	Click here to return to KU Listing			(Click Here) READ
3	**Basic Data Analysis**				
4		Provide students with basic abilities to manipulate data into meaningful information.			
5		**Topics**			
6			Summary statistics		
7			Graphing/Charts		
8			Spreadsheet Functions		
9			Problem Solving		
10		**Outcomes**			
11		Students will be able to:			
12			Apply standard statistical inference procedures to draw conclusions from data		

Fig. 2 Basic Data Analysis KU

	A	B	C	D	E
1				ABC-123	DEF-456
2	Click here to return to KU Listing			(Click Here) READ
3	**Basic Scripting**				
4		Provide students with the ability to create simple scripts/programs to automate and perform simple operations. This knowledge should include basic security practices in developing scripts/programs (e.g., bounds checking, input validation).			
5		**Topics**			
6			*Basic Security		
7			Bounds checking, input validation		
8			Program Commands		
9			Program Control Structures		
10			Variable Declaration		
11			Debugging		
12			Scripting Language (e.g. PERL, Python, BASH, VB Scripting, Powershell)		
13			*Basic Boolean logic/operations		
14			AND / OR / XOR / NOT		
15		**Outcomes**			
16		Students will be able to:			
17			Demonstrate their proficiency in the use of scripting languages to write simple scripts (e.g., to automate system administration tasks)		
18			Write simple and compound conditions within a programming language or similar environment (e.g., scripts, macros, SQL)		
19			Write simple linear and looping scripts		

Fig. 3 Basic Scripting KU

Institutions that have never mapped before may find it advantageous to use these spreadsheets to identify courses appropriate for mapping particular KUs. (Institutions that have mapped courses previously in CAE applications will already have a good sense of which courses will be used for mapping and can skip this step.)

In the spaces provided in the spreadsheet (row 1), the institution's content experts enter candidate courses that address the topics (columns B and C). Mapping experts agree that the mapping process is time consuming. Therefore, in order to minimize the time required to complete the application, it is recommended that the content experts select the minimum number of courses necessary to cover a KU's topics. After the content experts list the appropriate courses into the

spreadsheets. The next step is to place an "X" in the cell which indicates the topics or outcomes are included in the course content. Courses may come from any department in the institution. One course may cover more than one KU, and conversely one KU may require more than one course for coverage. The preliminary mapping result will look something like Figs. 4 and 5.

	A	B	C	D	E
1			Courses	MAT 135	CIS 210
2	Click here to return to KU Listing			(Click Here) REA	
3	**Basic Data Analysis**				
4		Provide students with basic abilities to manipulate data into meaningful information.			
5		**Topics**			
6			Summary statistics	X	
7			Graphing/Charts	X	
8			Spreadsheet Functions	X	
9			Problem Solving	X	X
10		**Outcomes**			
11		Students will be able to:			
12			Apply standard statistical inference procedures to draw conclusions from data	X	

Fig. 4 Basic Data Analysis KU "X"d

	A	B	C	D	E
1			Courses	MAT 135	CIS 210
2	Click here to return to KU Listing				(Click H
3	**Basic Scripting**				
4		Provide students with the ability to create simple scripts/programs to automate and perform simple operations. This knowledge should include basic security practices in developing scripts/programs (e.g., bounds checking, input validation).			
5		**Topics**			
6			*Basic Security		
7			Bounds checking, input validation		X
8			Program Commands		X
9			Program Control Structures		X
10			Variable Declaration		X
11			Debugging		X
12			Scripting Language (e.g. PERL, Python, BASH, VB Scripting,		X
13			*Basic Boolean logic/operations		
14			AND / OR / XOR / NOT		X
15		**Outcomes**			
16		Students will be able to:			
17			Demonstrate their proficiency in the use of scripting languages to write simple scripts (e.g., to automate system administration tasks)		X
18			Write simple and compound conditions within a programming language or similar environment (e.g., scripts, macros, SQL)		X
19			Write simple linear and looping scripts		X

Fig. 5 Basic Scripting KU "X"d

Option 1 – Capturing Course Topics and Objectives

In subsequent iterations the cells containing "Xs" may be widened and the "Xs" replaced with references to specific course elements as in an identified textbook, course outline, handout, lab, etc. which covers the topic. Outcomes validation may also be mapped in their respective course cells with statements specifying the course objectives that address the outcomes and test instrument(s) that will be used (Fig. 6).

	A	B	C	D	E
1			Courses	MAT 135	CIS 210
2	Click here to return to KU Listing				(Click Here) READ THIS FIRST: This matrix is fo
3	**Basic Scripting**				
4		Provide students with the ability to create simple scripts/programs to automate and perform simple operations. This knowledge should include basic security practices in developing scripts/programs (e.g., bounds checking, input validation).			
5		**Topics**			
6			*Basic Security		
7			Bounds checking, input validation		Syl: Wk 3, 6
8			Program Commands		Syl: Wk 1, 6, 8
9			Program Control Structures		Syl: Wk 4, 9, 10
10			Variable Declaration		Syl: Wk 4
11			Debugging		Classroom discussions & demonstrations
12			Scripting Language (e.g. PERL, Python, BASH, VB Scripting, Powershell)		Syl: Wk 3, 4
13			*Basic Boolean logic/operations		
14			AND / OR / XOR / NOT		Wk 3
15		**Outcomes**			
16		Students will be able to:			
17			Demonstrate their proficiency in the use of scripting languages to write simple scripts (e.g., to automate system administration tasks)		Graded assignments: Manipulate file permissions, work w/ temporary files, create directories, write batch and interactive scripts
18			Write simple and compound conditions within a programming language or similar environment (e.g., scripts, macros, SQL)		Graded assignments: Parse data, manipulate strings
19			Write simple linear and looping scripts		Graded assignments: Write source code control using RCS

Fig. 6 Basic Scripting KU Mapped

Option 2 - Capturing Course Topics and Objectives

Much of the foregoing in effort in Option 1 can be shortcut, however. A well-structured syllabus containing a detailed outline, i.e., showing course topics and objectives keyed to KU topics and outcomes, can serve as a highly efficient tool for the mapping phase. Fig. 7A proposes a common format used by many instructors.

Network Security Fundamentals
COMSEC 215
Fall Term, 2014

Week	Topics	Chapter Readings	Labs & *Exams*
1	**Introduction to Security** • Challenges of securing information • Importance of information security • Types of attackers – hackers, script kiddies, spies, insiders • Attack types and defenses - 5 basic principles of defense	Chapter 1	Review lab procedures Scan for malware *End of Chapter questions*
2	**Malware and Social Engineering Attacks** • Types of malware • Worms, trojans, rootkits, backdoors, botnets, spyware, adware, keyloggers • Social Engineering – psychological, phishing, impersonation, spam, hoaxes • Physical – dumpster diving, tailgating,	Chapter 2	USB blocking Rootkit scanning Sw keylogger *End of Chapter questions*
3	**Application and Network Attacks** • XSS, SQL and SML injection • Cookies, attachments, hijacking, malicious add-ons, DoS, buffer overflows, man-in-the-middle, replay, ARP and DNS poisoning, privilege escalation	Chapter 3	***Quiz Ch 1 & 2*** Browser security Create HTTP header *End of Chapter questions*
4	**Vulnerability Assessment and Mitigating Attacks** • Identify assets, evaluate threats, appraise vulnerability, assess & mitigate risk • Baseline, sw program development	Chapter 4	Port Scanning Penetration tests
5	**Host, Application, and Data Security** • Physical, hardware, mobile device, OS security • Baselining • Anti-malware, firewalls, logs • Applications, secure coding, hardening, patching • Securing data	Chapter 5	***Quiz Ch 3 & 4*** Setting firewalls MS Event Viewer *End of Chapter questions*

Fig. 7A Example: Segment of Detailed Course Outline

Fig 7B is an example compilation of course objectives that might be provided by a text's author via section headers within chapters of the textbook. It can be trimmed or augmented to address the requirements of the KUs.

Network Security Fundamentals
Objectives - Outcomes

Chapter/Week 1

Describe the challenges of securing information
Define information security and explain why it is important
Identify the types of attackers that are common today
List the basic steps of an attack
Describe the five basic principles of defense

Chapter/Week 2

Describe the differences between a virus and a worm
List the types of malware that conceals its appearance
Identify different kinds of malware that is designed for profit
Describe the types of social engineering psychological attacks
Explain physical social engineering attacks

Chapter/Week 3

List and explain the different types of Web application attacks
Define client-side attacks
Explain how a buffer overflow attack works
List different types of denial of service attacks
Describe interception and poisoning attacks

Chapter/Week 4

Define vulnerability assessment and explain why it is important
List vulnerability assessment techniques and tools
Explain the differences between vulnerability scanning and penetration testing
List techniques for mitigating and deterring attacks

Chapter/Week 5

List the steps for securing a host computer
Define application security
Explain how to secure data using loss prevention

Chapter/Week 6

List the different types of network security devices and explain how they can be used
Define network address translation and network access control
Explain how to enhance security through network design

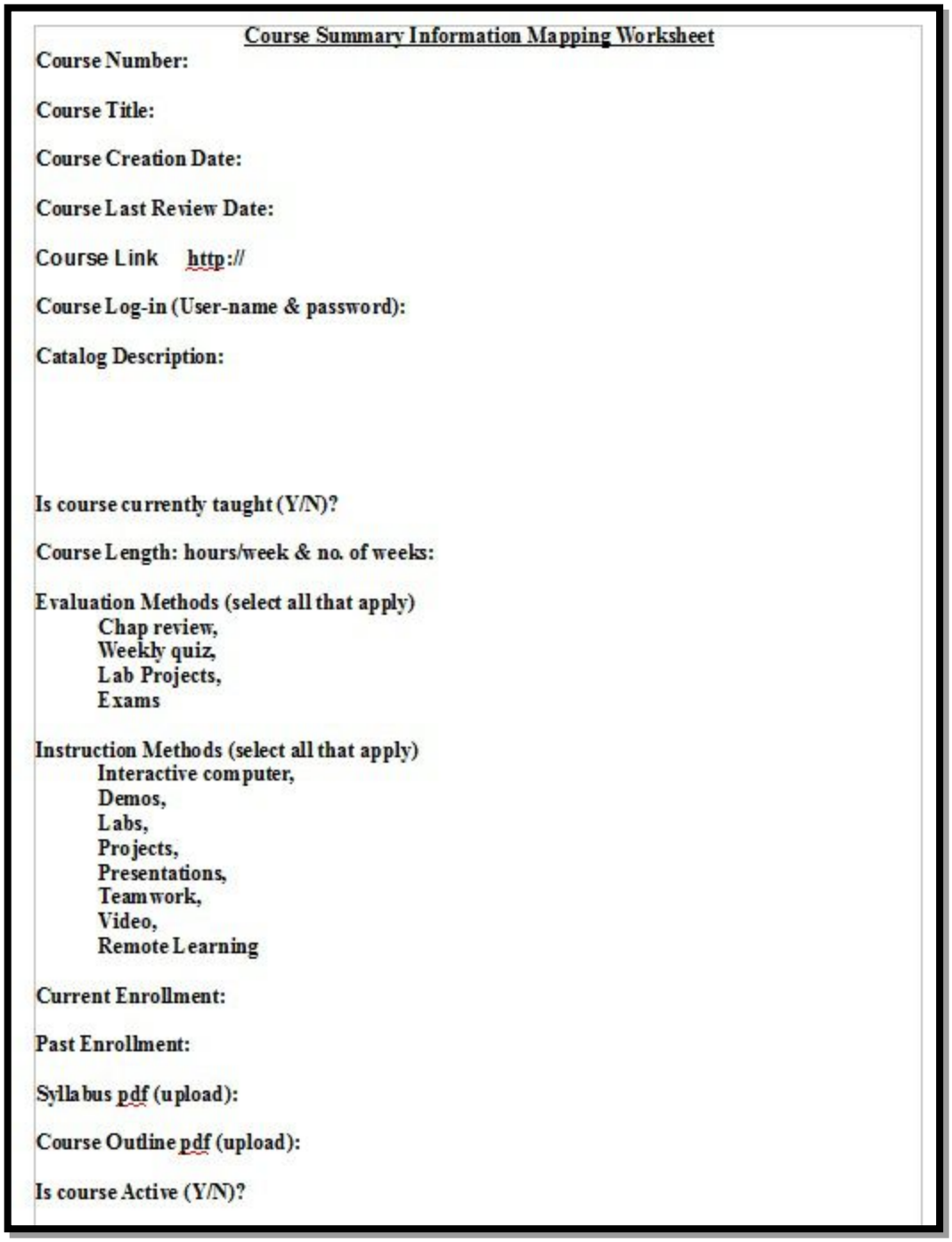
Fig. 7B Example: Segment of List of Weekly/Chapter Objectives

Course outline data in either of these formats (Fig 7A or 7B) will greatly facilitate the data entry process into the NIETP database by using ordinary cut and paste operations.

Also a KU's Topics and Outcomes should be reflected in course outlines. KUs that will be mapped should be reviewed for explicitly required elements; for efficient mapping purposes, those elements should be included in the section of the Detailed Course Outlines where they are addressed. Once all individual content experts' contributions have been gathered and merged for the requisite KUs, culled to remove redundancy, and mapped into the spreadsheet, the spreadsheet may be used as a source document for entering data into the NSA/DHS database.

Course and textbook information also needs to be gathered at this stage for entry during Phase 2. Figs. 8 (The Course Summary Information Mapping Worksheet) and 9 (The Textbook Form) list the comprehensive set of general information that the database requires. Typically, a course syllabus will already contain some of this information. It is recommended that items not included in the syllabus be completed on this form (or one similar to it) for every course and textbook that will be entered into the NSA/DHS database. The following are required:

- Course Number
- Course Title
- Course Creation Date
- Course Last Review Date
- Course Link (http://)
- Course Login (Username and Password
- Course Description
- Is the course currently being taught (Y/N)?
- Course Length: hours/week & no. of weeks
- Evaluation Methods (select all that apply)
    - Chapter review
    - Weekly Quiz
    - Lab Projects
    - Exams
- Instruction Methods (select all that apply)
    - Interactive computer
    - Demos
    - Labs
    - Projects
    - Presentations
    - Teamwork
    - Video
    - Remote Learning
- Current Enrollment:
- Syllabus pdf (upload)
- Course Outline (upload)
- Is course active (Y/N)



Course Summary Information Mapping Worksheet

Course Number:

Course Title:

Course Creation Date:

Course Last Review Date:

Course Link http://

Course Log-in (User-name & password):

Catalog Description:

Is course currently taught (Y/N)?

Course Length: hours/week & no. of weeks:

Evaluation Methods (select all that apply)
- Chap review,
- Weekly quiz,
- Lab Projects,
- Exams

Instruction Methods (select all that apply)
- Interactive computer,
- Demos,
- Labs,
- Projects,
- Presentations,
- Teamwork,
- Video,
- Remote Learning

Current Enrollment:

Past Enrollment:

Syllabus pdf (upload):

Course Outline pdf (upload):

Is course Active (Y/N)?

Fig. 8 Course Summary Information Mapping Worksheet

Textbook Form

1. Title of Book or Supplemental Material
2. Relevant Chapter(s)/Title(s)
3. Author

Fig. 9 Course Textbook/Supplement Information

Mapping Suggestions

Here are some suggestions to keep in mind before and during the mapping process.

- Get as many faculty subject matter experts involved as possible to identify course topics and objectives that satisfy KU topics and outcomes.
- Refer to the textbook table of contents, index and the syllabus/detailed course outline to match course topics with KU topics requirements.
- Copy and paste author provided course objectives from slide show presentations into a text document that can later be used to facilitate entering objectives into the NIETP database.
- Identify how Outcomes will be measured.
- Use the fewest number of courses possible; a single course is more desirable than two.
- One course may be used to map more than one KU.
- Finally, consolidate all of the "mapping work-product" (i.e., completed spreadsheets, course worksheets, detailed course outlines, syllabus) to expedite data entry.

End of Phase 1

Phase 2 – Course Data Entry

Check list of materials to have on hand to begin Phase 2.

- Course Form(s)
- Textbook Form(s)
- Syllabus/Detailed Course Outline(s) in PDF form
- Mapped spreadsheet matrices

Armed with these items, Phase 2 can begin. Figs. 10 and 11 show flow chart and a step-by-step views through the process.

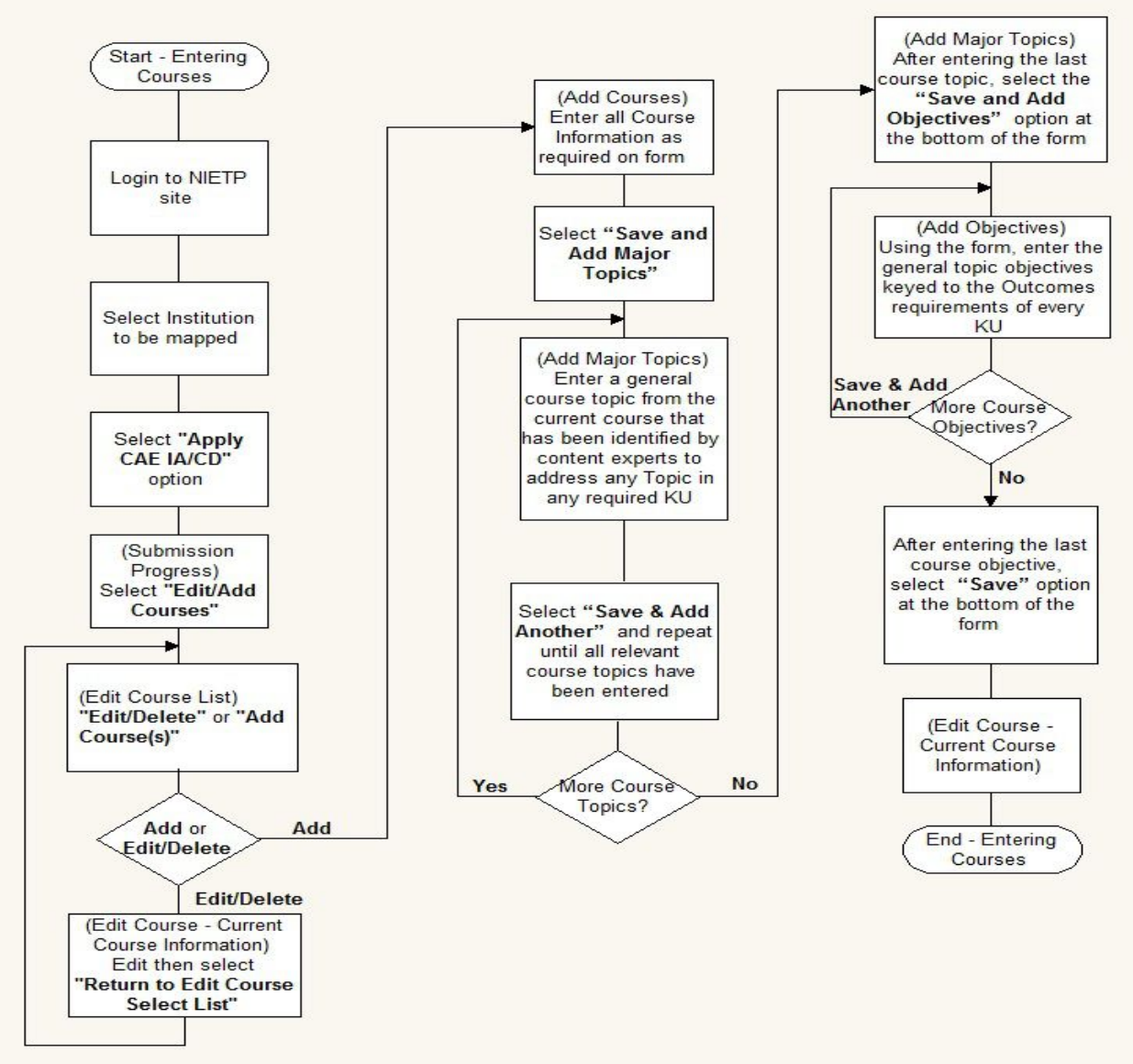


Fig. 10 Course Data Entry Flowchart

Phase 2 (Enter Courses, Topics, Objectives)		
Step	**Operation**	**Note**
1	Login	(**Welcome, Login/Join**)
2	Select Institution to be mapped	(**Institution List**)
3	Select "Apply CAE IA/CD" option	(**Welcome**)
4	In opening screen, select "Add New Courses"	(**CAE Submission xYr Submission**)
5	Enter all Course Information as required on form	(Add Course)
6	Select "Save and Add Major Topics"	
7	Using the form, enter a general course topic from the current course that has been identified by content experts to address any Topic in any required KU	(**Add Major Topics for xx**) Course topics come from textbook, syllabus, supplementals, etc.
8	Select "Save & Add Another" and repeat until all relevant course topics have been entered	
9	After entering the last course topic, select the "Save and Add Objectives" option at the bottom of the form	
10	Using the form, enter the general topic objectives keyed to the Outcomes requirements of every KU	(**Add Objectives for xx**) The terminology used in the Objectives should correlate closely with that in the KUs' required Outcomes
11	Select "Save & Add Another" and repeat until all relevant course objectives have been entered	
12	After entering the last course objective, select the "Save" option at the bottom of the form	
13	Once all courses have been identified with topics and objectives relevant to the KUs, the next phase starts.	This concludes identifying the courses, their topics, and objectives

Fig. 11 Course Data Entry Step-by-Step

Online Application Tool

The next three figures (Figs. 12, 13, and 14) show the first NIETP database screens that are encountered when initiating a mapping. Fig. 12 is the Login/Join screen of the NIETP CAE data entry system. It appears immediately after the Welcome screen at www.iad.gov/NIETP/. Note the optional selections for new registrations, forgotten password, and forgotten username.

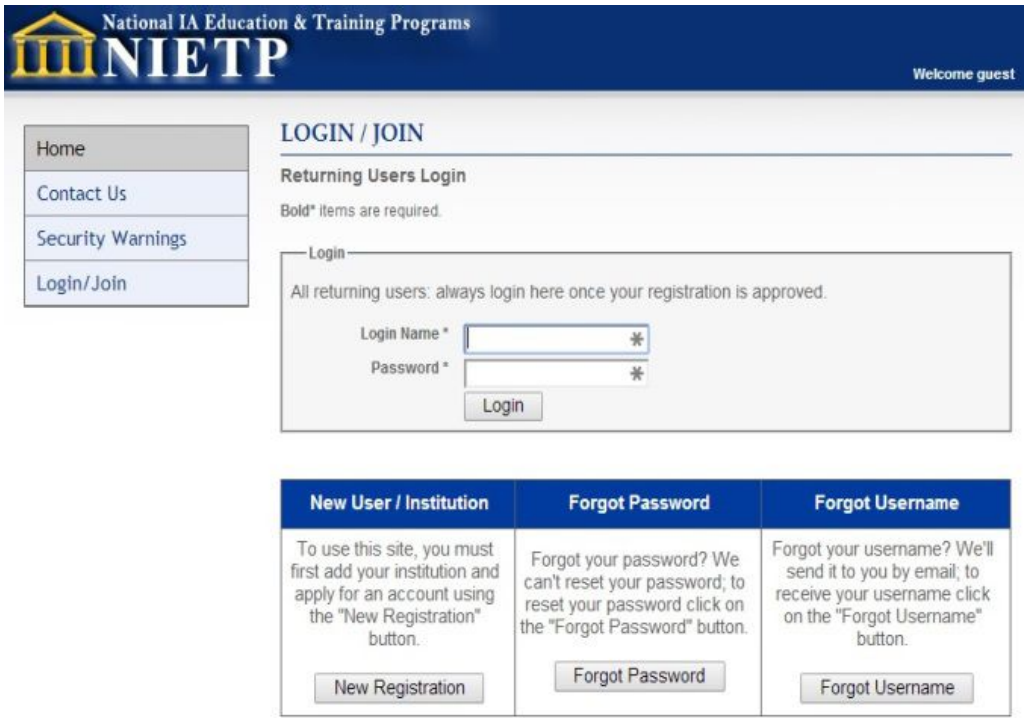


Fig. 12 Login Screen

Once logged into the system, users must identify the institution for which they are performing the data entry. This is achieved by picking the institution from the drop-down box and clicking on the **Select Institution** button (Fig. 13).

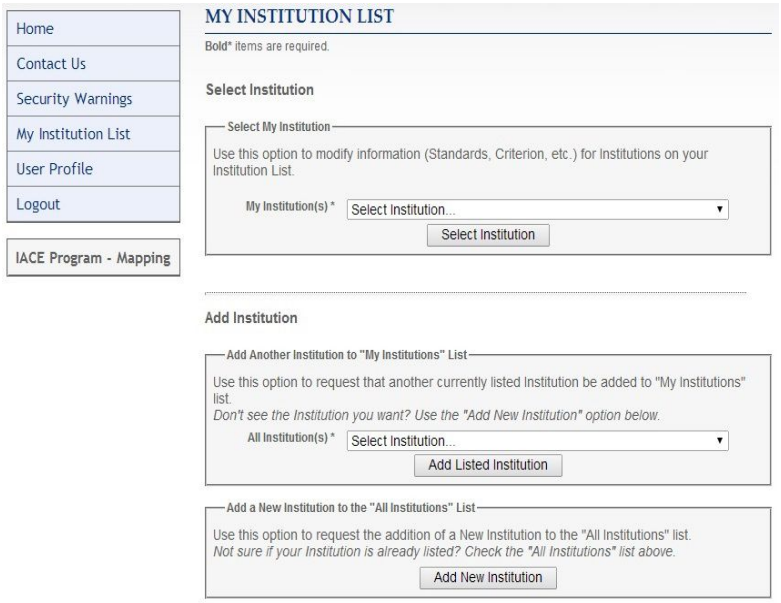


Fig 13 Institution List

Successful login and selection of an institution, results in a Welcome screen that provides notes and notices to the CAE mapping community, Fig. 14. The left panel of the screen serves as a switchboard for moving among many of the mapping operations. The panel appears on virtually all screens. The Apply CAE/CD button is used frequently to gain access to lower level mapping procedures. Selecting the button leads to Fig 15.

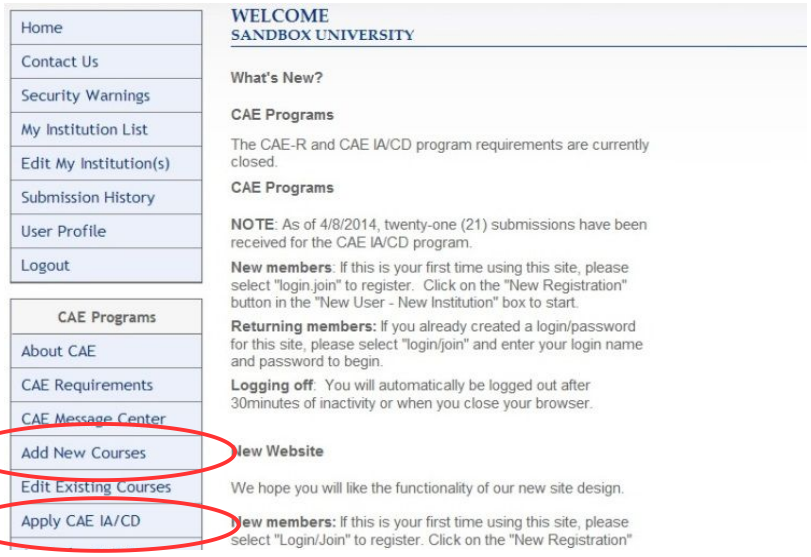


Fig. 14 Welcome

Add New Course

Adding courses to the database begins the mapping process. There are two ways to access the screen for entering a course. Selecting the **Add New Course** button from the left panel set of options opens the screen in Fig. 15. It is used only for entering new courses into the database. Alternatively, selecting the **Apply CAE IA/CD** button brings up the **Submission Progress** screen in Fig. 15 and allows entering new or editing existing courses. This multipurpose screen leads to a number of other operations which are covered later.

This phase involves entering a considerable amount of course information into the database. Considerable amounts of time and effort can be saved by employing **copy and paste** to transfer from the digital forms of information gathered in Phase 1 to fields in the database.

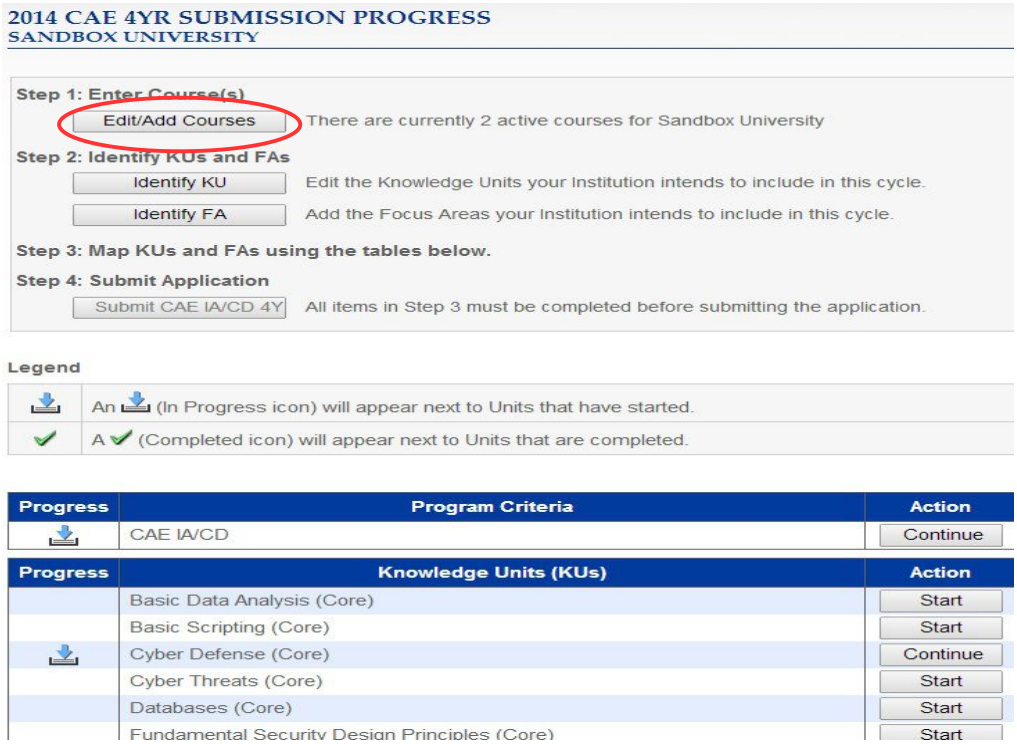


Fig. 15 Submission Progress

The **Add Course** screen is shown as two pieces in Figs. 16 and 17. It consists of mandatory data fields (marked with an asterisk). Use the form provided in Fig. 8 to complete this screen for each course that will be mapped to a KU.

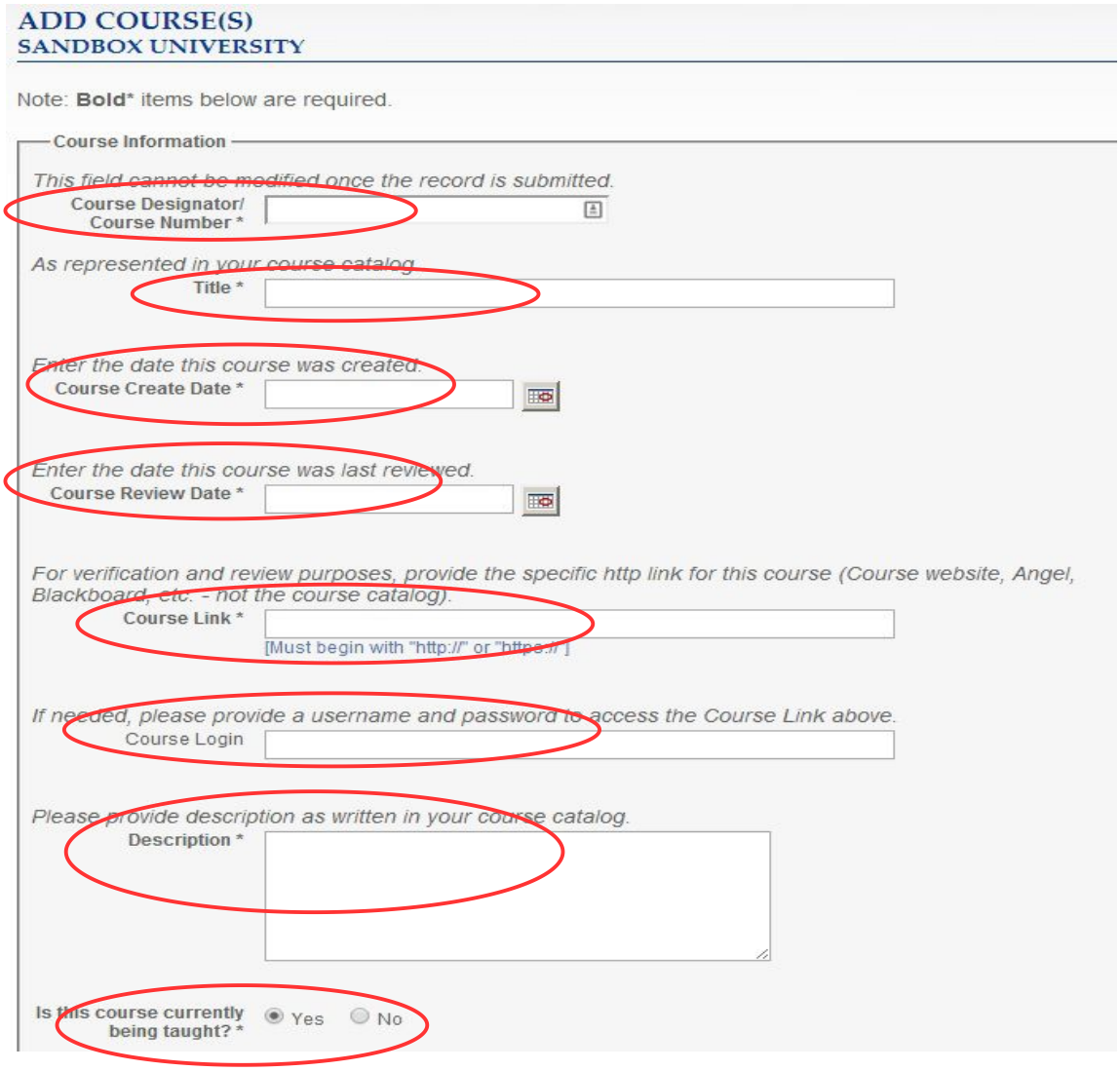


Fig. 16 Top Half of Add Course Screen

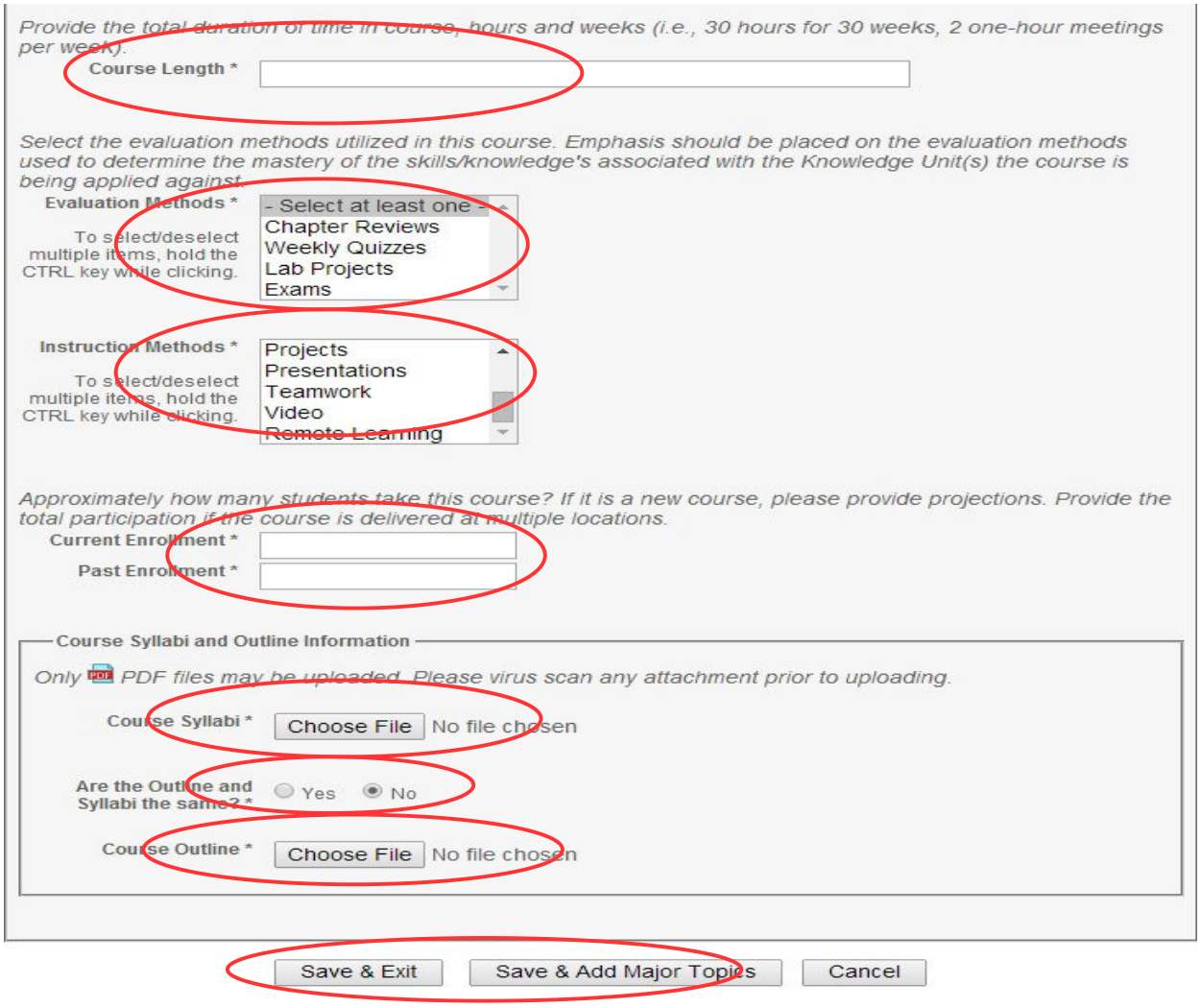


Fig. 17 Bottom Half of Add Course Screen

Once a course has been entered into the database (Figs. 16 and 17), its major topics and can be specified. This information comes from syllabi, detailed course outlines, textbooks, data incorporated in the mapping spreadsheets (Fig. 6) and/or other course/instructional specific elements (Figs. 7A and 7B).

Add Major Course Topics and Objectives

Fig. 18 shows the required fields for major course topics. Only one course topic is intended to be entered for each screen. Multiple topics are entered using additional screens – see the Save & Add Another button at the bottom of the screen (Fig. 18).

Fig. 18 Add Major Topics

Course objectives can also be added at this time by selecting the Save & Add Objectives button (Fig. 18). Data entry of Topics or Objectives may be interrupted by selecting the Save button. Additional Course Topics and Objectives can later be added in three steps as show in the Figs 19 through 21.

1. Select an existing course to open the Edit Course List page,
2. Select the pencil icon to open the course summary screen, and
3. Select Add a Major Topic for Course ... or Add an Objective for Course ... (Fig 20).

Step 1: Select Edit Existing Course

Once a course or portion of a course has been entered into the database, it can be added to, edited, or even deleted. For example, Major Course Topics or Objectives can be inserted into a course in this manner. Select Edit Existing Courses button from the left hand panel of any screen. This will open the Edit Course List screen shown in Fig 19.

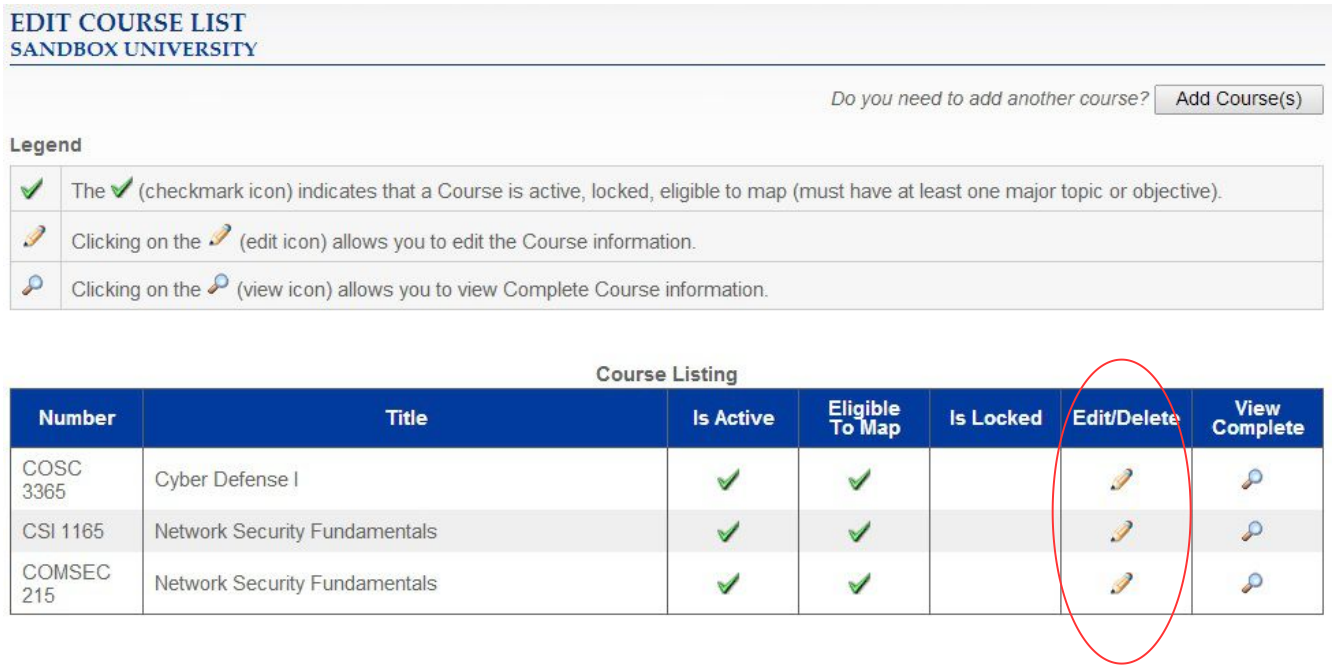


Fig. 19 Edit Course List

Step 2: Select Pencil Icon

Select the pencil icon under the Edit/Delete column for the course to be modified. This will open the Course Summary screen shown in Fig 20.

Step 3: Add a Major Course Topic or Objective

Course Number	COSC 3365
Title	Cyber Defense I
Course Created	01/15/2013
Course Last Reviewed	01/15/2014
Course Link	http://sandboxU.edu
Course Login	
Description	This course introduces the student to the identification of vulnerabilities, forms of attack, appropriate countermeasures, and the detection and defense of the same. Tools and techniques for the securing of hardware, software and data, including physical security are covered. The issues and facilities available to both the intruder and administrator will be examined and evaluated with appropriate exercises to illustrate their effect.
Is Currently Taught	Yes
Course Length	45 hours for 15 weeks; 2 one-and-a-half hour meetings per week
Current Enrollment	35
Past Enrollment	35
Instruction Methods	Lecture,Demonstrations,Labs,Projects
Evaluation Methods	Lab Projects,Exams
Syallabus	Sandbox Univ Syllabus-CyberDef I COSC 3365.pdf
Outline	Sandbox Univ Syllabus-CyberDef I COSC 3365.pdf
Is Active	Yes

Add a Major Topic for Course COSC 3365

	Major Topics for COSC 3365	Active	Edit/Delete
1	Potential Attack Methods	✓	✎

Add an Objective for Course COSC 3365

	Objectives for COSC 3365	Active	Edit/Delete
1	Student will identify various potential system attack methods including social engineering, denial of service, Trojans, logic bombs, database inference, man-in-the-middle, etc. Graded written exams will assess their understanding of ability to recognize attack methods.	✓	✎

Fig. 20 Course Summary

Finally, select Add or Edit/Delete a either a Major Topic or Objective. Fig 21 shows the screen that appears when the Add Objective for Course button is selected.

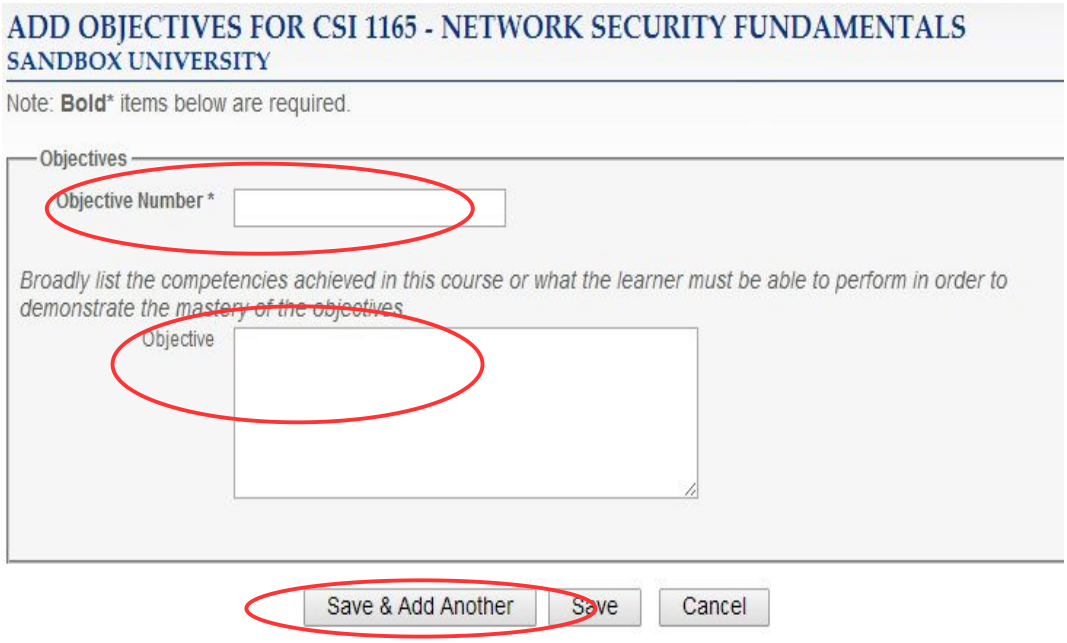


Fig. 21 Add Objectives

Entry of course objectives follows a simple format of an identifying number (Objective Number) and a description of the objective (Objective) as seen in Fig. 21. Multiple objectives are added by selecting the Save & Add Another button.

Once all courses, their topics, and objectives have been entered into the database, Phase 2 is complete.

End of Phase 2

Phase 3 - Formal Mapping

Phases 1 and 2 prepared the way for mapping to take place. With the conclusion of Phase 2, all courses reside in the database. Since all of the KUs are preloaded into the database, they require no effort on the part of the mapping institution. The final step maps (i.e., links) course topics and objectives to KU topics and outcomes.

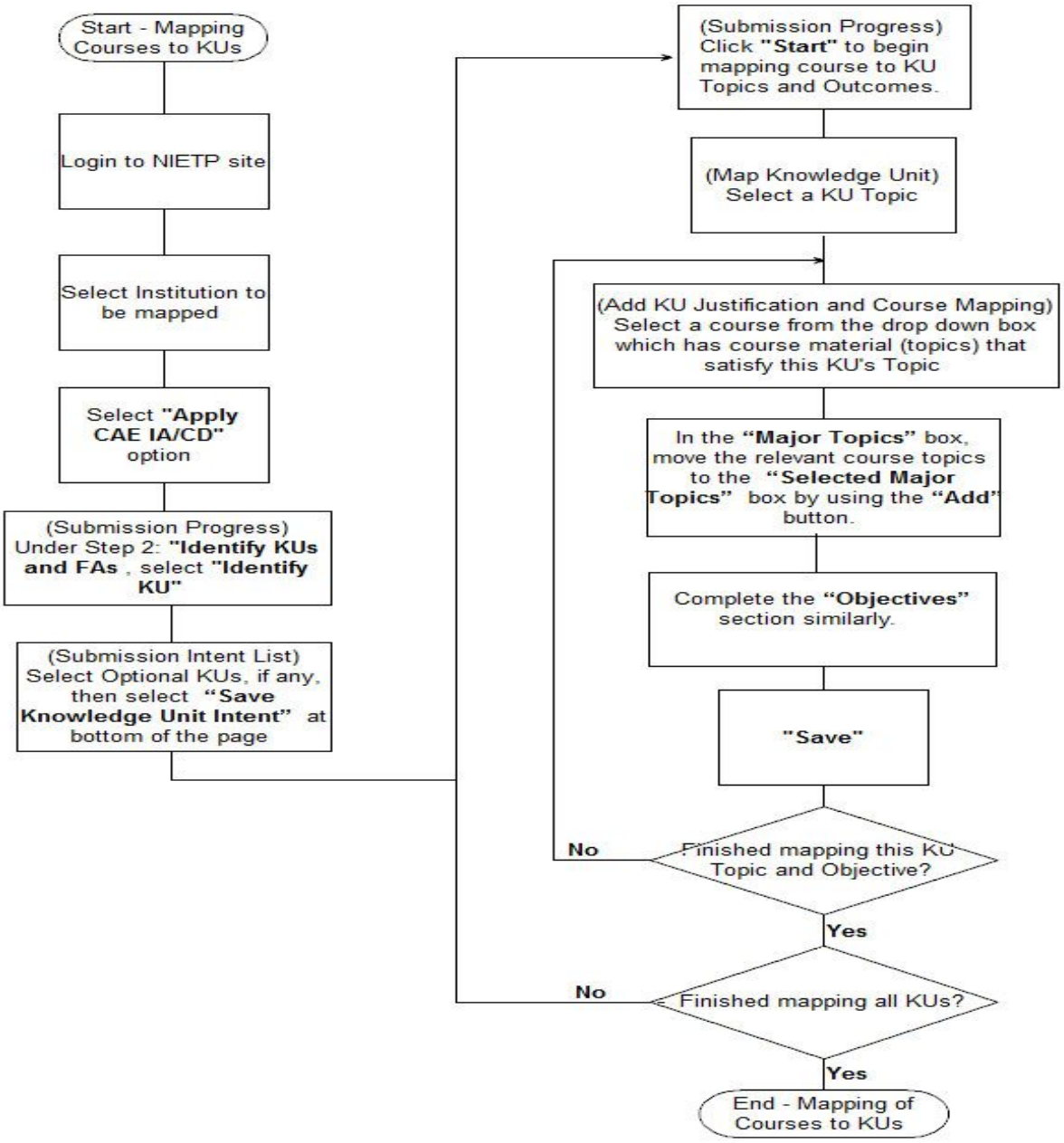


Fig. 22 Phase 3 Flowchart

Phase 3 (Enter Courses, Topics, Objectives)		
Step	**Operation**	**Note**
14	Repeat steps 1, 2, and 3 of Phase 2	
15	Under "Step 2: Identify KUs and FAs" of the opening form, select "Identify KU" box	**(Submission Progress)**
16	The next screen selects all mandatory KUs for the level of your institution. If institution is 4 yr, 5 additional KUs must be selected. Select "Save Knowledge Unit Intent" at bottom of the page	**(Submission Intent List)** At the conclusion of this step, all KUs that are intended to be mapped by this institution should have been identified
17	This screen returns to the Submission Progress screen lists all KUs that the institution plans to map. "Start" identifies a KU, none of whose Topics or Outcomes has yet been addressed. "Continue" identifies a KU whose mapping has been initiated.	**(Submission Progress)**
18	Click "Start" (or "Continue") on a KU to be mapped	
19	A screen appears with a list Topics and Outcomes defining that KU. Select a Topic or Outcome to map.	(**Map Knowledge Unit)**
20	On the next screen, select a course from the drop down box which has course material (topics) that satisfy this KU's Topic	**(Add KU Justification and Course Mapping)**
21*	In the "Major Topics" box, move the relevant course topics to the "Selected Major Topics" box by using the "Add" button.	
22*	Repeat the process for the "Objectives" section.	
*	*Alternative to steps 21 & 22, enter "Justification"	Use Justification when KU is satisfied by pre-req or means other than coursework.
23	"Save"	
24	Repeat the process from step 18 until every KU Topic and Outcome has been mapped by current course.	**(Map Knowledge Unit)**
25	Repeat the process from step 17 until all KUs have been mapped for all courses.	

Fig 23 Phase 3 Step-by-Step

Identify KU

The formal mapping process starts on the Submission Progress screen seen during Phase 2 (Fig. 15). The job now is to identify the KUs that have to be mapped by the institution. Selecting the Identify KU button on the Submission Progress screen (Fig. 24) starts the process by bringing up the Submission Intent List display, Fig. 25.

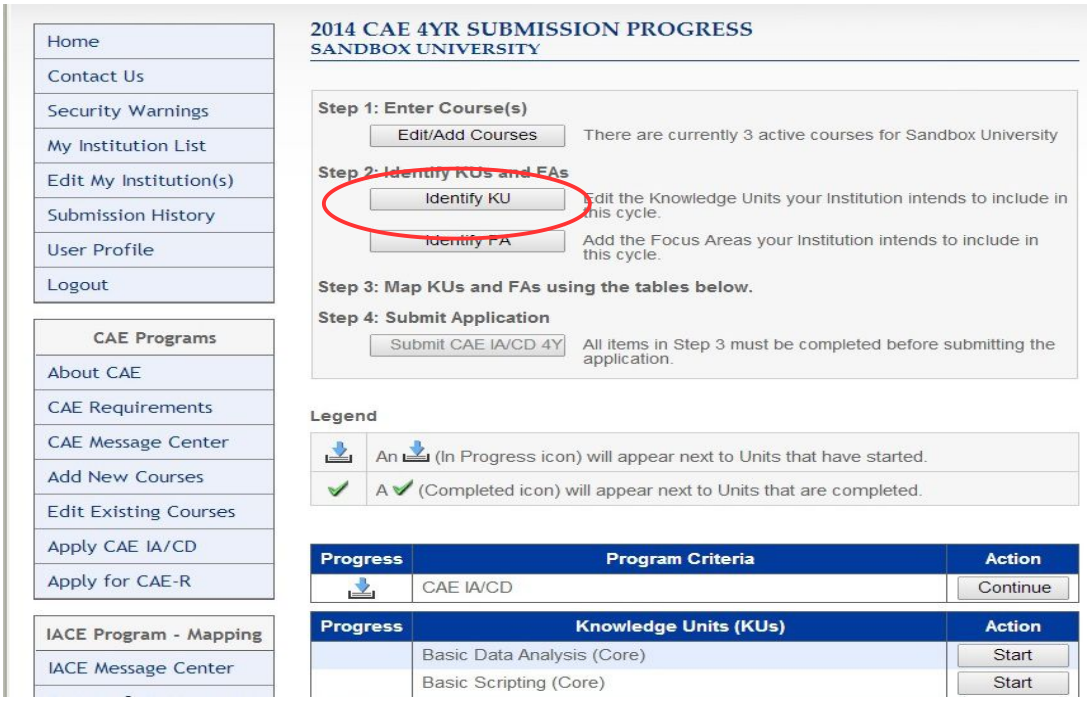


Fig. 24 Submission Progress

Select Intent to Map KU

An institution declares the KUs it plans to map via the Submission Intent List screen. The display will differ somewhat depending on whether the mapping institution is two year or four year. The number of Mandatory Knowledge Units for a two year institution is eleven, for a four year institution, seventeen. (Fig. 26 shows the screen for a four year school.) All of the Core KUs must be mapped for their respective types of institutions. Note that in the column headed "Intend to Map?," all required Core KUs are automatically marked as "Yes."

2014 CAE4Y KU SUBMISSION INTENT LIST
SANDBOX UNIVERSITY

1. Select the Knowledge Units (KUs) your Institution intends to submit.
2. Knowledge Units that have already been successfully accredited will be noted below.
3. All Knowledge Units listed in the Core section are required.
4. At a minimum, the required number of Optional Knowledge Units must be selected.
5. Click on any Knowledge Unit title to see its associated Focus Areas (FAs).

Core Knowledge Units (All are Required)

Knowledge Unit	Intend to Map?
+ Basic Data Analysis	Yes (Required)
+ Basic Scripting	Yes (Required)
+ Cyber Defense	Yes (Required)
+ Cyber Threats	Yes (Required)
+ Databases	Yes (Required)
+ Fundamental Security Design Principles	Yes (Required)
+ IA Fundamentals	Yes (Required)
+ Intro to Cryptography	Yes (Required)
+ IT System Components	Yes (Required)
+ Network Defense	Yes (Required)
+ Network Technology and Protocols	Yes (Required)
+ Networking Concepts	Yes (Required)
+ Operating Systems Concepts	Yes (Required)
+ Policy, Legal, Ethics and Compliance	Yes (Required)
+ Probability and Statistics	Yes (Required)
+ Programming	Yes (Required)
+ Systems Administration	Yes (Required)

Optional Knowledge Units (5 Required)

Knowledge Unit	Intend to Map?
+ Advanced Cryptography	Yes / No
+ Advanced Network Technology and Protocols	Yes / No
+ Algorithms	Yes / No
+ Analog Telecommunications Systems	Yes / No
+ Cloud Computing	Yes / No
+ Cybersecurity Planning and Management	Yes / No

Fig. 25 Submission Intent (top)

Also, four year institutions must select five optional KUs from the lower section. The intended optional KUs are selected by setting their radio buttons to Yes. When all KUs intended for mapping are identified, select “Save Knowledge Unit Intent” at the bottom of the screen (Fig. 26).

+ Penetration Testing	Yes / No
+ QA / Functional Testing	Yes / No
+ RF Principles	Yes / No
+ Secure Programming Practices	Yes / No
+ Security Program Management	Yes / No
+ Security Risk Analysis	Yes / No
+ Software Assurance	Yes / No
+ Software Reverse Engineering	Yes / No
+ Software Security Analysis	Yes / No
+ Supply Chain Security	Yes / No
+ Systems Certification and Accreditation	Yes / No
+ Systems Programming	Yes / No
+ Systems Security Engineering	Yes / No
+ Virtualization Technologies	Yes / No
+ Vulnerability Analysis	Yes / No
+ Wireless Sensor Networks	Yes / No

NOTE

Removing a Knowledge Unit "Intend to Map" will remove all Focus Area "Intend to Map" where the Knowledge Unit is required.

Save Knowledge Unit Intent | Cancel Changes

Fig. 26 Submission Intent (bottom)

In addition to mapping the minimum number of required KUs, some institutions may wish to distinguish their programs by offering additional IA/CD emphasis. NSA/DHS recognizes certain combinations of mandatory and optional KUs formally as Focus Areas. Selecting the "+" next to the name of any KU in Figs. 25 or 26 expands that KU to reveal the FAs in which they are a component. (The "Identify FA" button in the Submission Progress screen does the inverse, i.e., reveals the set of KUs that compose an FA.) Clicking "Save Knowledge Unit Intent" at the bottom of the screen returns to the Submission Progress screen which will be populated with all of the KUs selected in the previous step (Figs. 25 & 26).

Map Knowledge Unit

Initially, all KUs on the Submission Progress screen (Fig. 27) have "Start" buttons in the right column of the form. Clicking a "Start" brings up a Map Knowledge Unit screen which reveals that KU's defining topics and outcomes (Fig. 28). (Once a KU mapping has been started, the Action column on the screen marks it with a "Continue" button.)

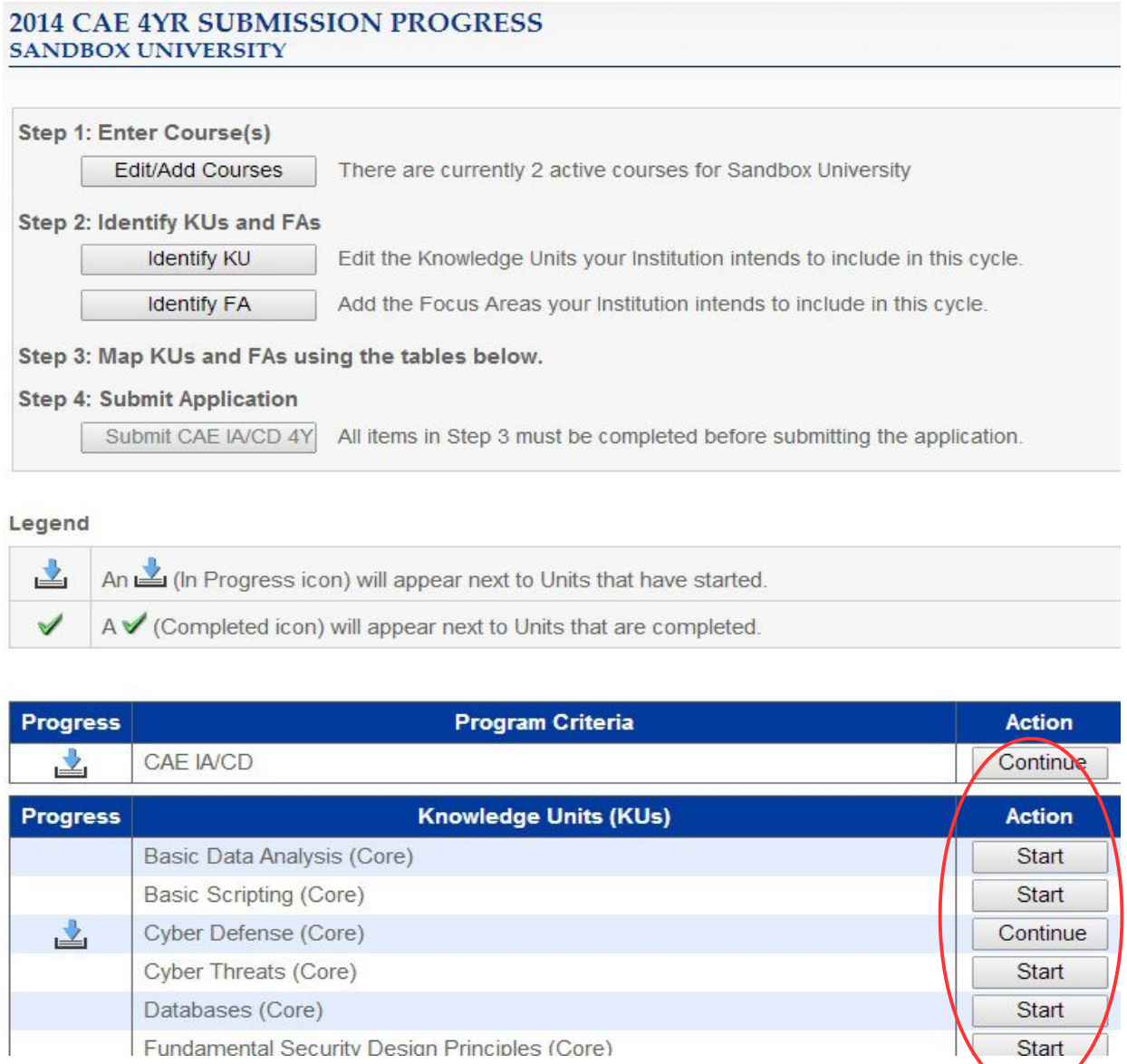


Fig. 27 Submission Progress

Linking Courses to KUs

The topics and outcomes are underlined hot buttons. Picking one of the topics say, Graphing/Charts, in Fig. 28, causes the Add Justification and Course Mapping screen to appear (see Figs. 29, 30 & 31). This is where the actual linkage between course and KU takes place.

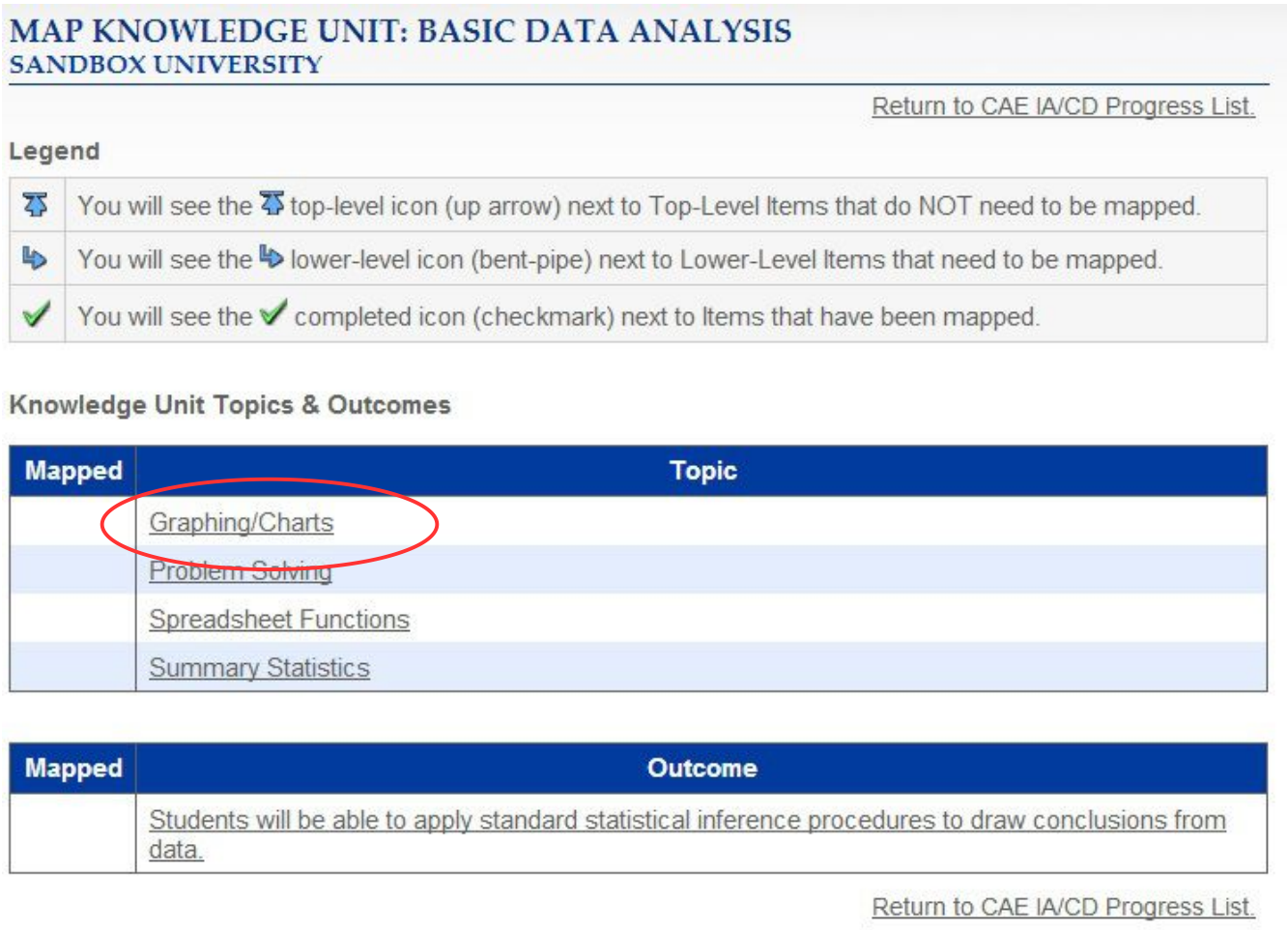


Fig. 28 Map Knowledge Unit Topic

Map Course Topics and Objectives to KU Topic

Next, choose “Select Course” box (Fig. 29) from the dropdown box on the “Add KU Justification and Course Mapping Screen

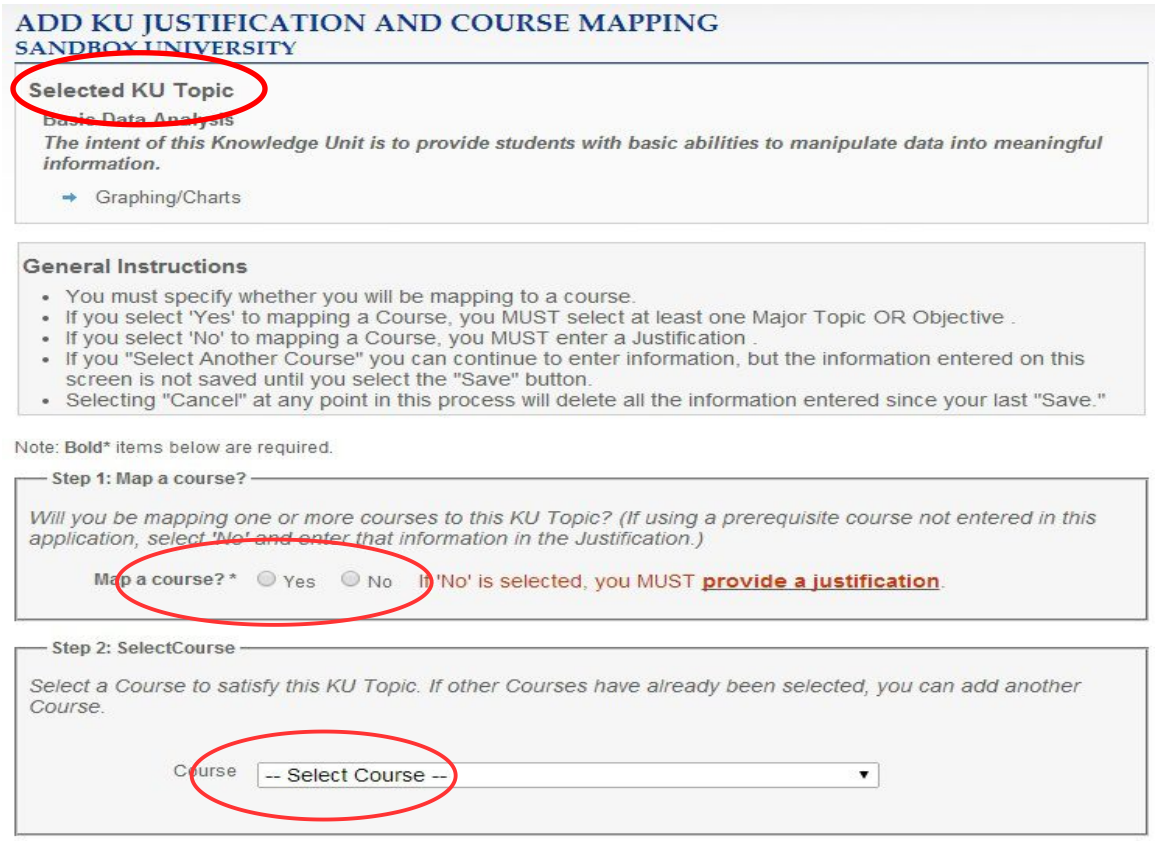


Fig. 29 Add Justification and Course Mapping – Topics (top third)

All of the topics previously entered for that course will populate “Major Topics” box (Fig. 30). The topic or topics that address the KU's current major topic are selected from the box and moved to the Selected Major Topics box with the Add button. Likewise, the objectives associated with the course appear in the “Objectives” box. The relevant ones, too, must be moved to the “Selected Objectives” box with the Add button.

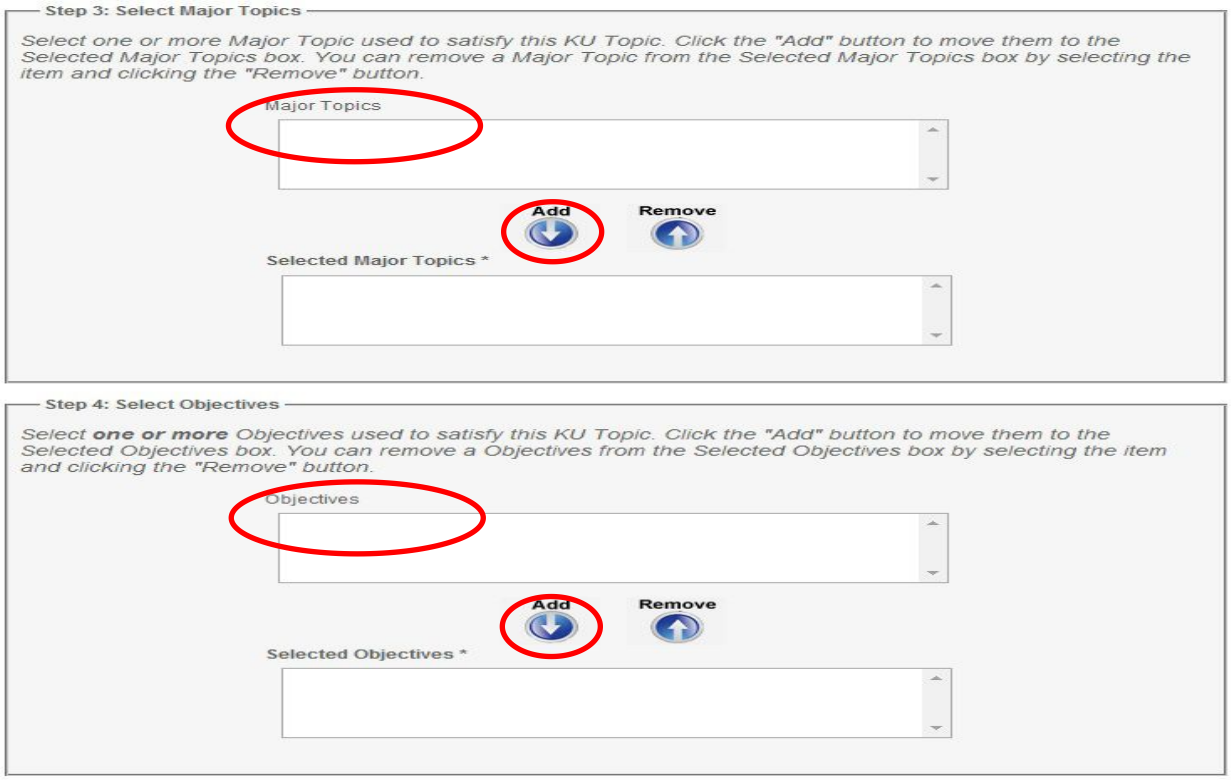


Fig. 30 Add Justification and Course Mapping – Topics (middle third)

The Justification Box

The "Justification" box (Fig. 30) is only required when a course topic matching the KU topic is not explicitly covered in the course material but is either required prerequisite knowledge for the course. (e.g., CCNA, CISSP, Network+, etc.) or will be achieved through an activity in the course.

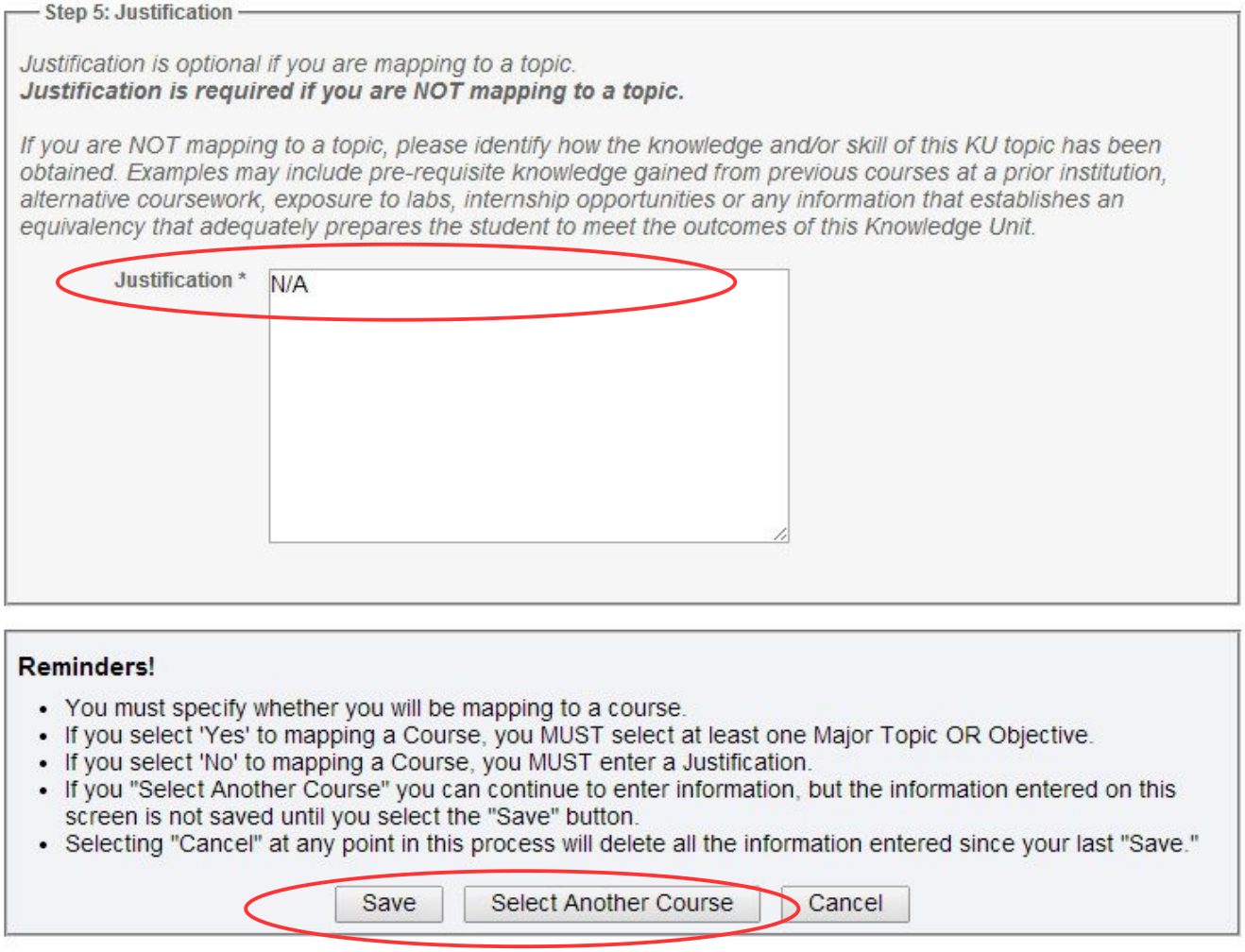


Fig. 31 Add Justification and Course Mapping – Topics (bottom third)

Repeat the process of matching course topics and objectives to KUs until all KU topics have been mapped.

Map Course Topics and Objectives to KU Outcomes

The lower portion of the Map Knowledge Unit screen shown in Fig. 32 provides the path to KU Outcomes. Selecting an outcome from the list opens the Outcome screen shown in Figs. 33, 34, and 35.

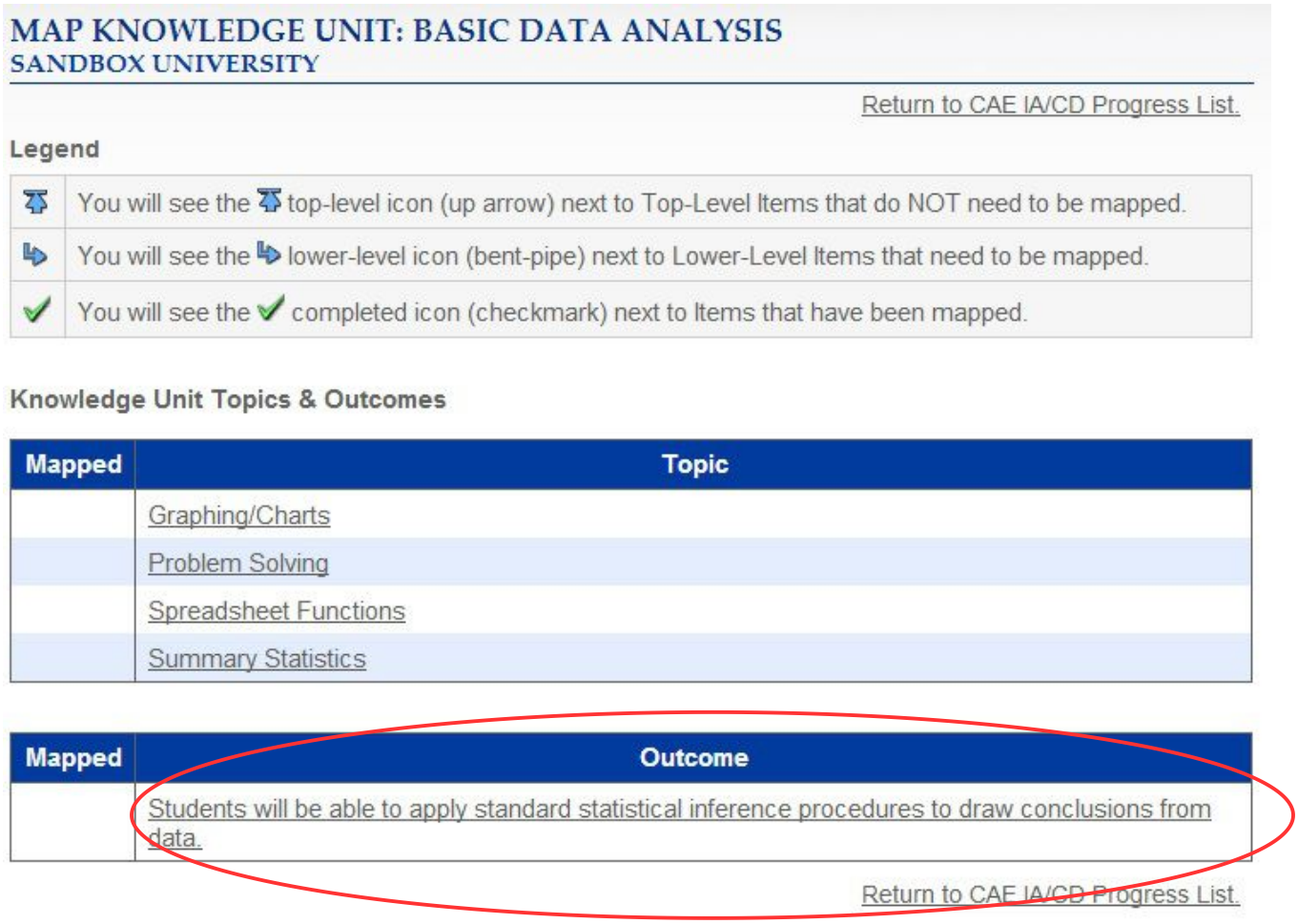


Fig. 32 Map Knowledge Unit - Outcomes

Mapping courses to KU Outcomes follows the same procedure as mapping courses to KU Topics above. Even the screen layouts are nearly identical. As was the case for mapping KU topics, when a course is selected from the drop-down box (Fig. 33), all of the topics and objectives previously entered for that course will populate the Major Topics and Objectives boxes (Fig. 34). The topic(s) and objective(s) that satisfy the KU's currently selected outcome must be picked from the boxes and moved to their respective Major Topics or Objectives boxes with the Add button.

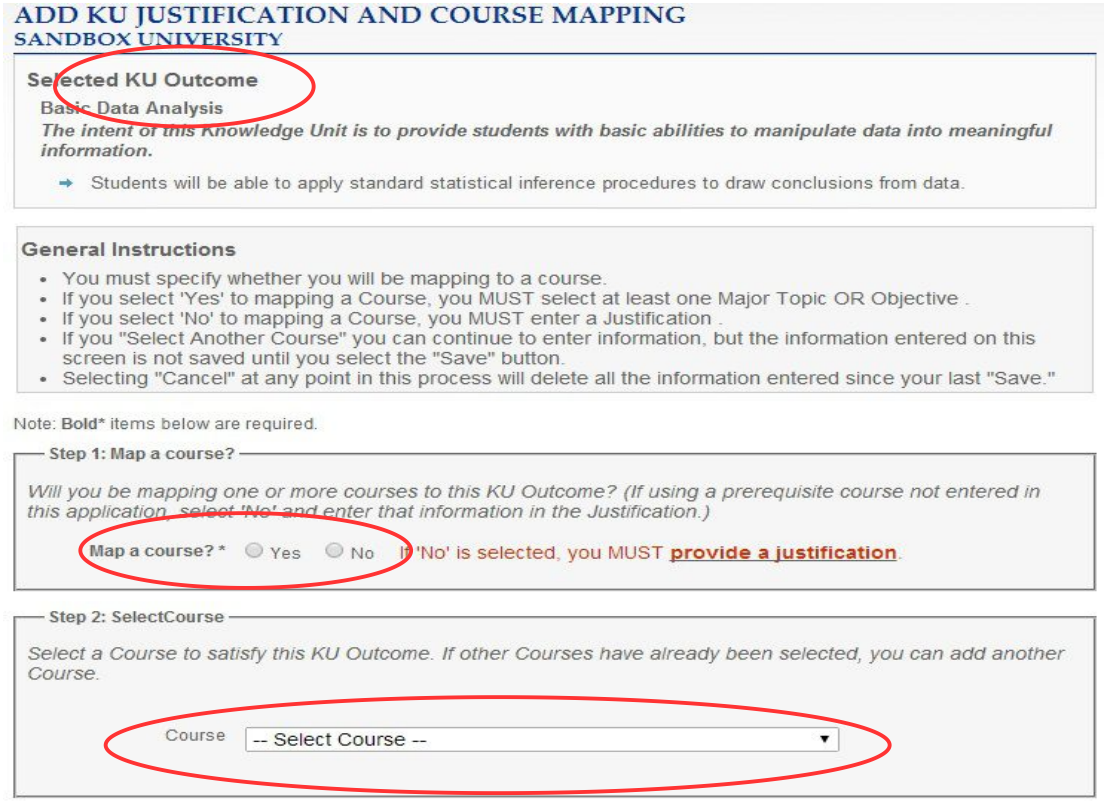


Fig. 33 Add Justification and Course Mapping – Outcomes

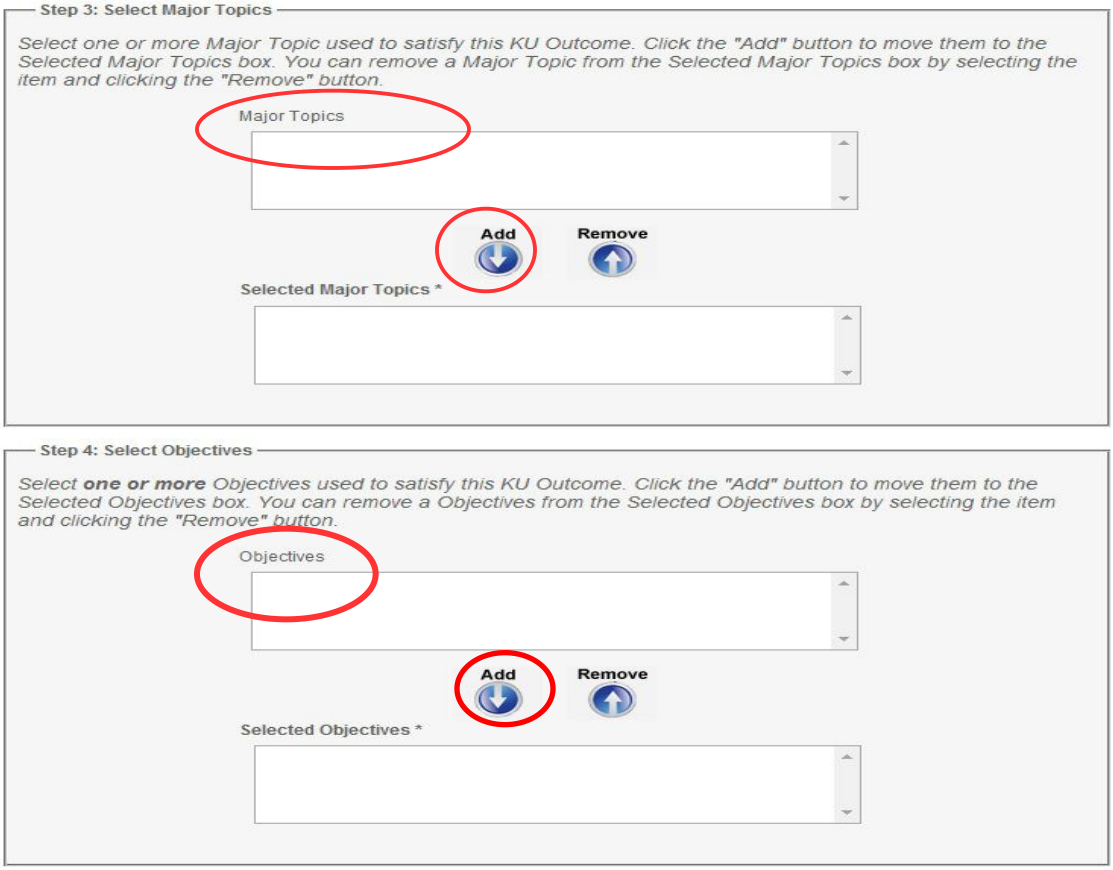


Fig. 34 Add Justification and Course Mapping – Outcomes

A Justification (Fig. 35) is required for an Outcome only if the Outcome is not mapped by a topic or objective of one or more courses. It must describe what means will be used to determine that the outcome is achieved. The form states: *"Examples may include any projects, exercises and/or labs that support this outcome. Outcomes may also be met by pre-requisite knowledge gained from previous courses at a prior institution, alternative coursework, exposure to labs, internship opportunities or any information that establishes an equivalency that adequately prepares the student to meet the outcomes of this Knowledge Unit."*

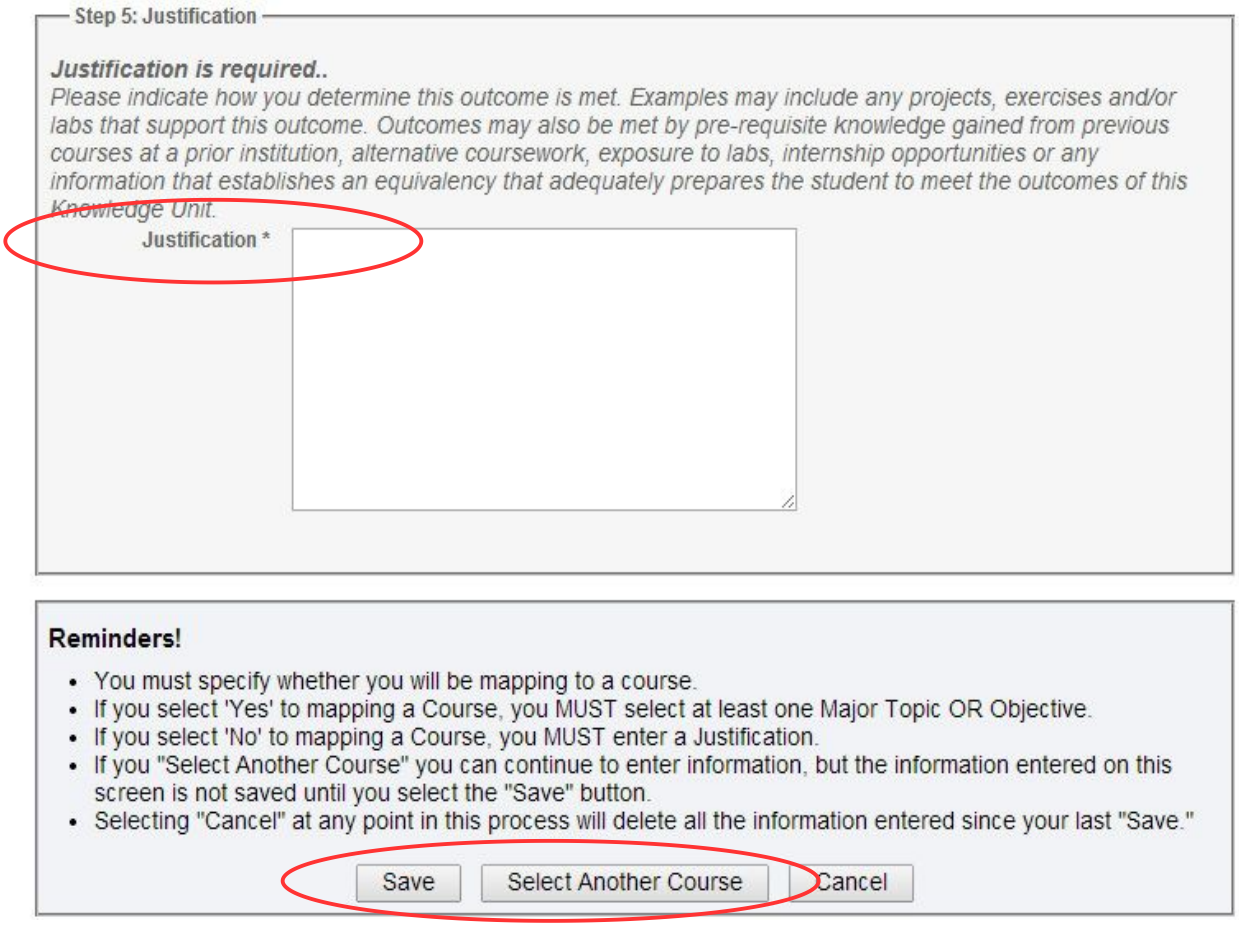


Fig. 35 Add Justification and Course Mapping – Outcomes

This process is repeated until all KUs' Outcomes have been satisfied.

After KU Topics and Outcomes have been linked to course instructional materials, the mapping portion of the CAE application is complete.

End of Phase 3

Eight Measurement Criteria

Besides mapping courses to KUs, institutions must submit a Letter of Intent and also show that it meets eight Measurement Criteria. These submissions are also performed through the NIET site interface. Fig. 36 shows the process.

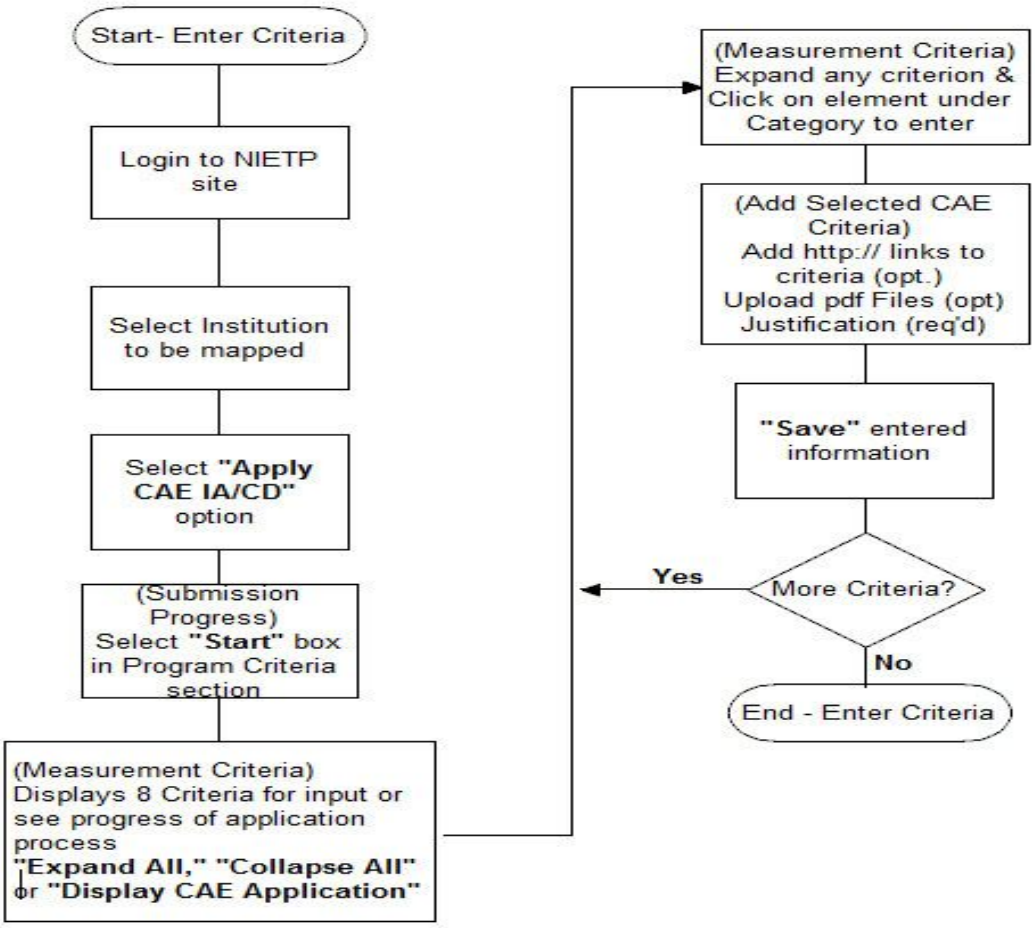


Fig. 36 Criteria Flow-chart

Two year institutions must complete seven criteria (0 thru 6) and four year institutions, nine (0 thru 8). To get to the criteria entry screen, select the “Apply for CAE IA/CD” in the left hand panel of any screen. This opens the Submission Progress form. The section titled “Program Criteria” appears midway down the form (see Fig. 24). Clicking on the single Criteria entry's “Start” (or “Continue”’if previously used) button leads to the screen showing all Measurement Criteria as in Fig. 37. Clicking on a “+” next to any criterion expands it to reveal its components. Each of those underlined components is a hotlink to a screen form that facilitates user input for that criterion (see Fig. 38).

Alternatively, all criteria can be expanded simultaneously by selecting the “Expand All” button. The “Collapse All” button returns all expanded criteria to the minimum state and “Display CAE Application” shows the current data entry status of all criteria.

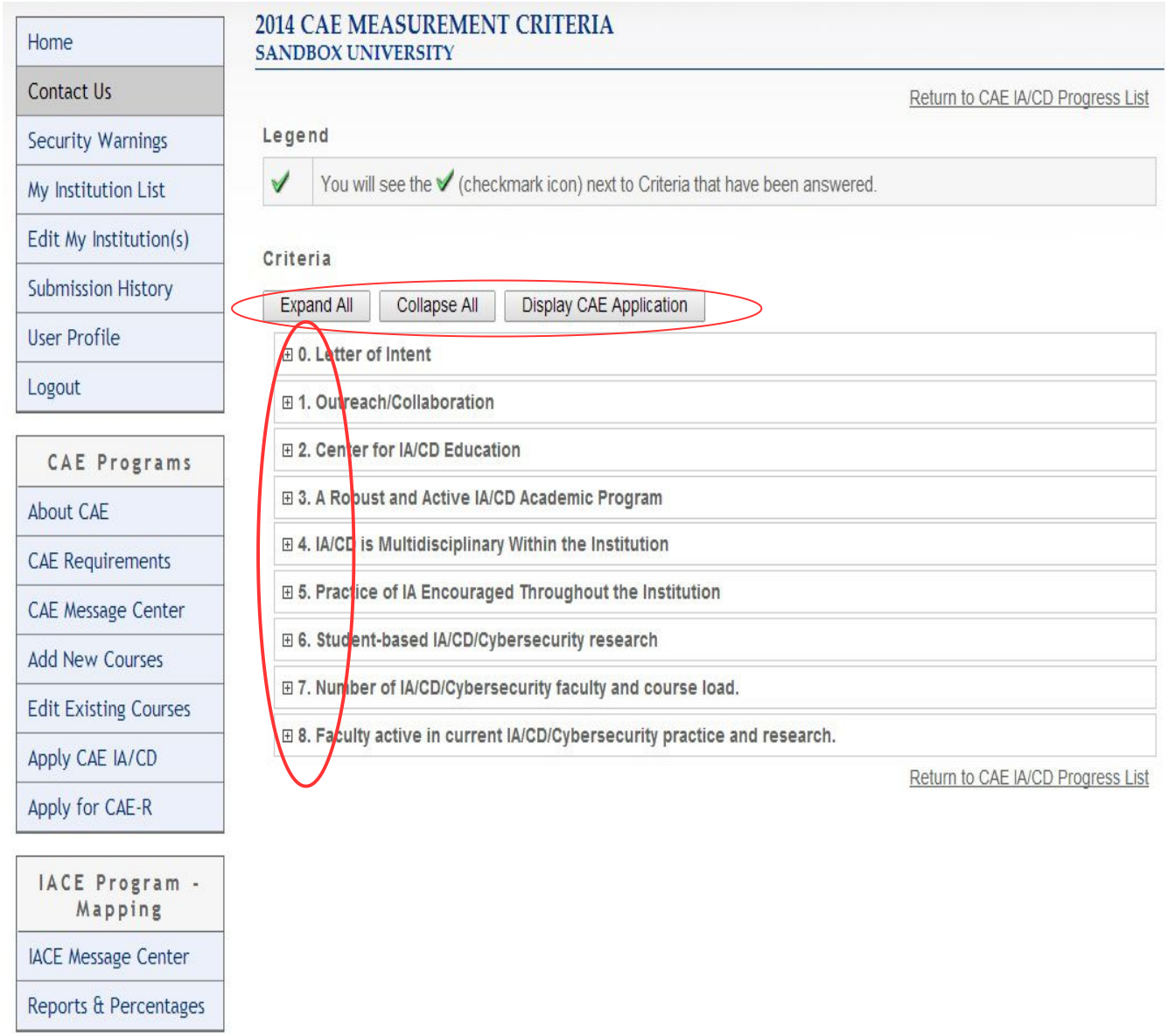


Fig. 37 CAE Measurement Criteria

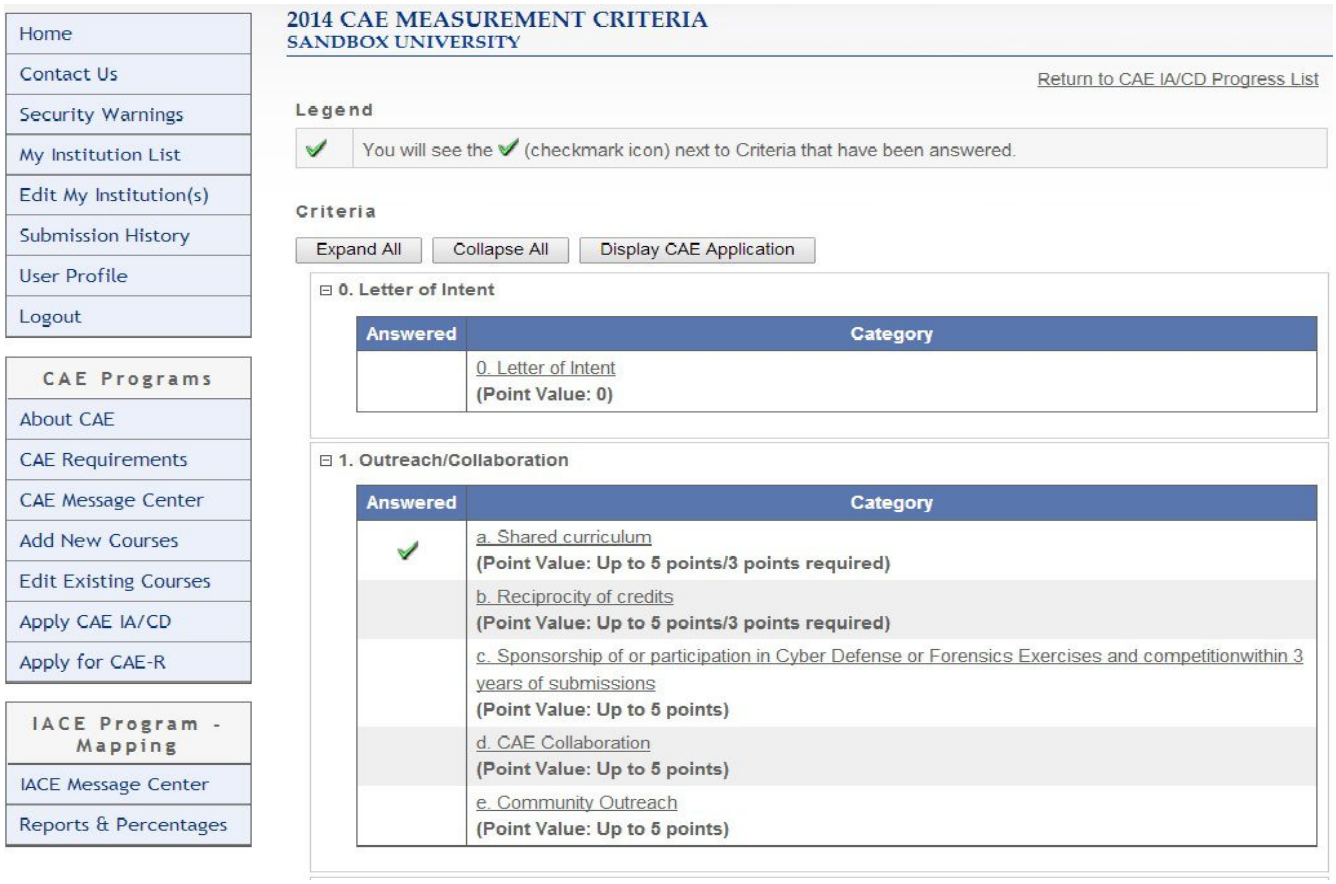


Fig. 38 Measurement Criteria – Criteria 0 and 1 Expanded
(Check mark in *Answered* column indicates an item has been completed.)

For example, the hotlink for a component of "1. Outreach/Collaboration" brings up the screen shown in Figs. 39, 40, and 41. This is the standard format for all criteria. It provides fields for http links, uploads of pdf attachments, and a justification statement to support the fulfillment of the respective criterion.

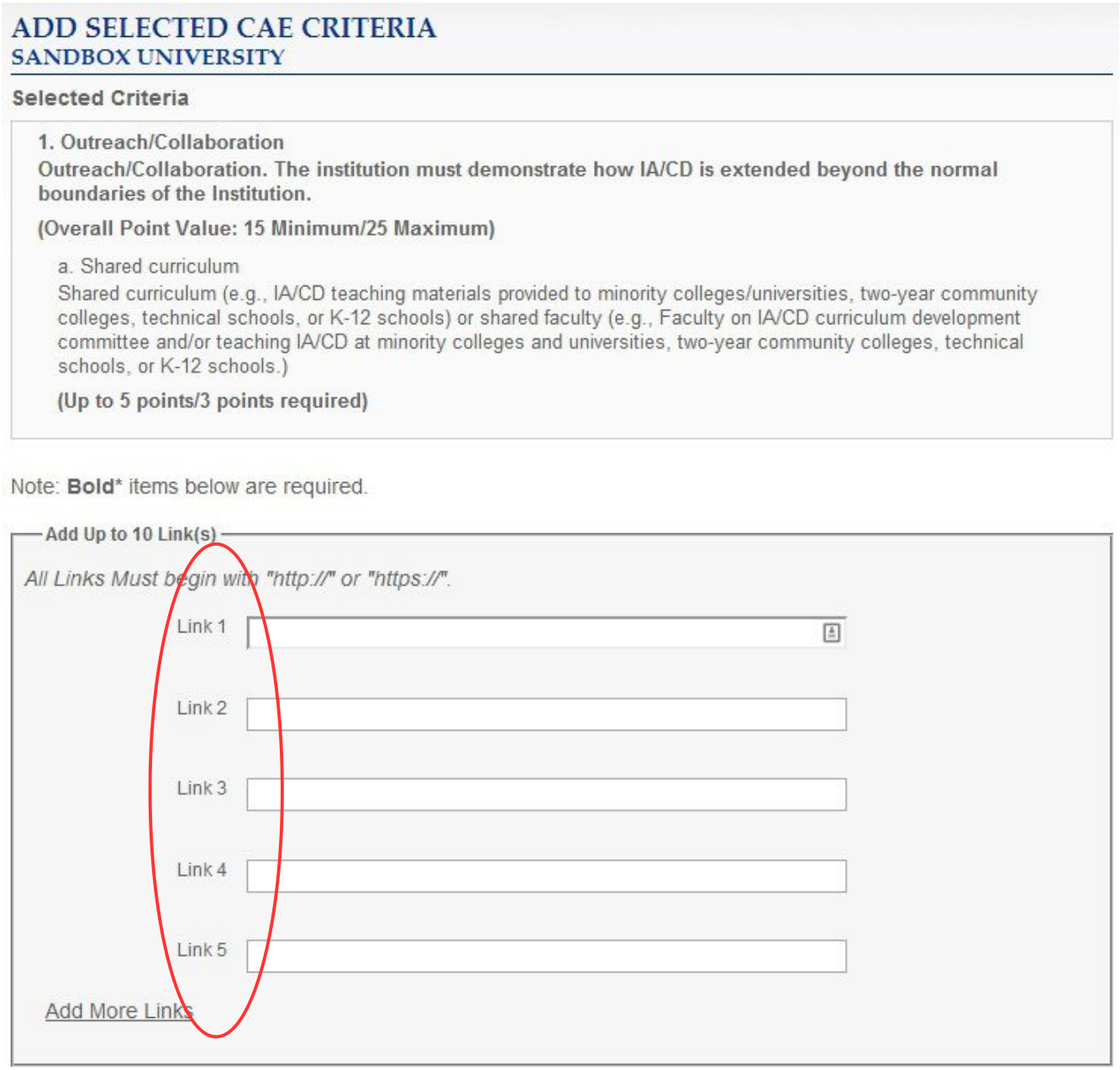


Fig. 39 **Add Selected CAE Criteria** – Criterion 1
(Top Third of Screen)

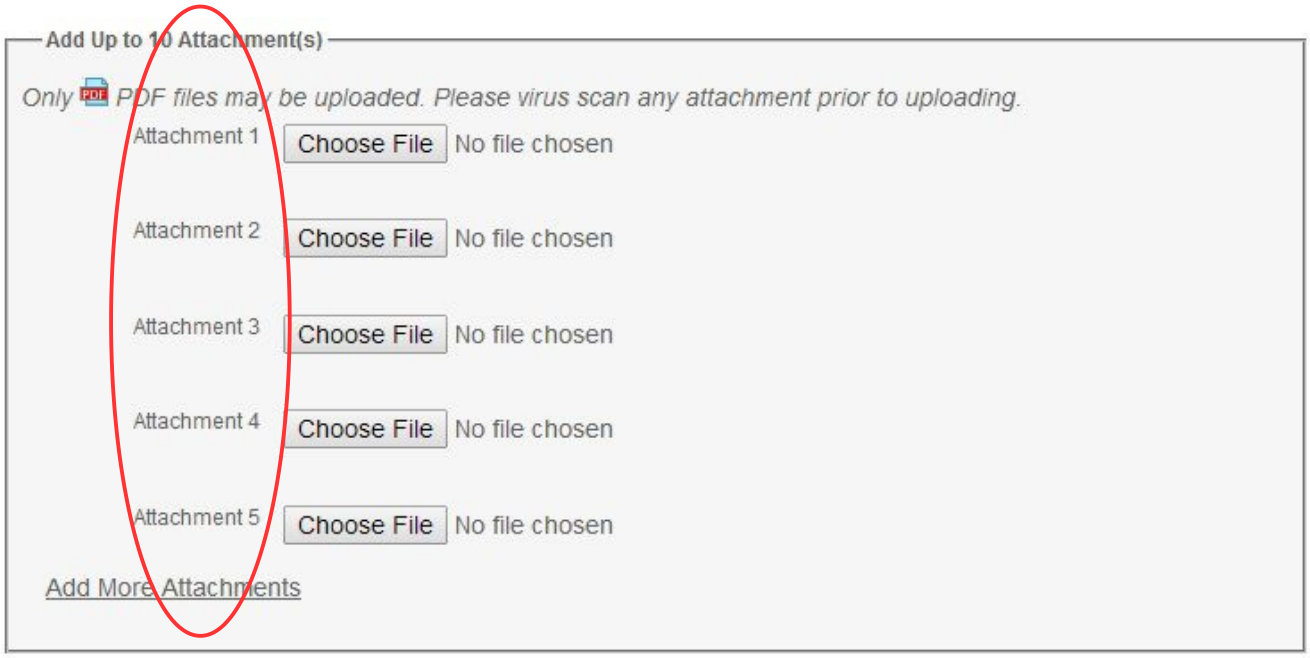


Fig. 40 Add Selected CAE Criteria - Criterion 1
(Middle Third of Screen)

Fig 41 Add Selected CAE Criteria - Criterion 1
(Bottom Third of Screen)

The “Display CAE Application” button seen in Figs. 37 and 38 produces a summary of the Application Criteria status (Fig. 42).

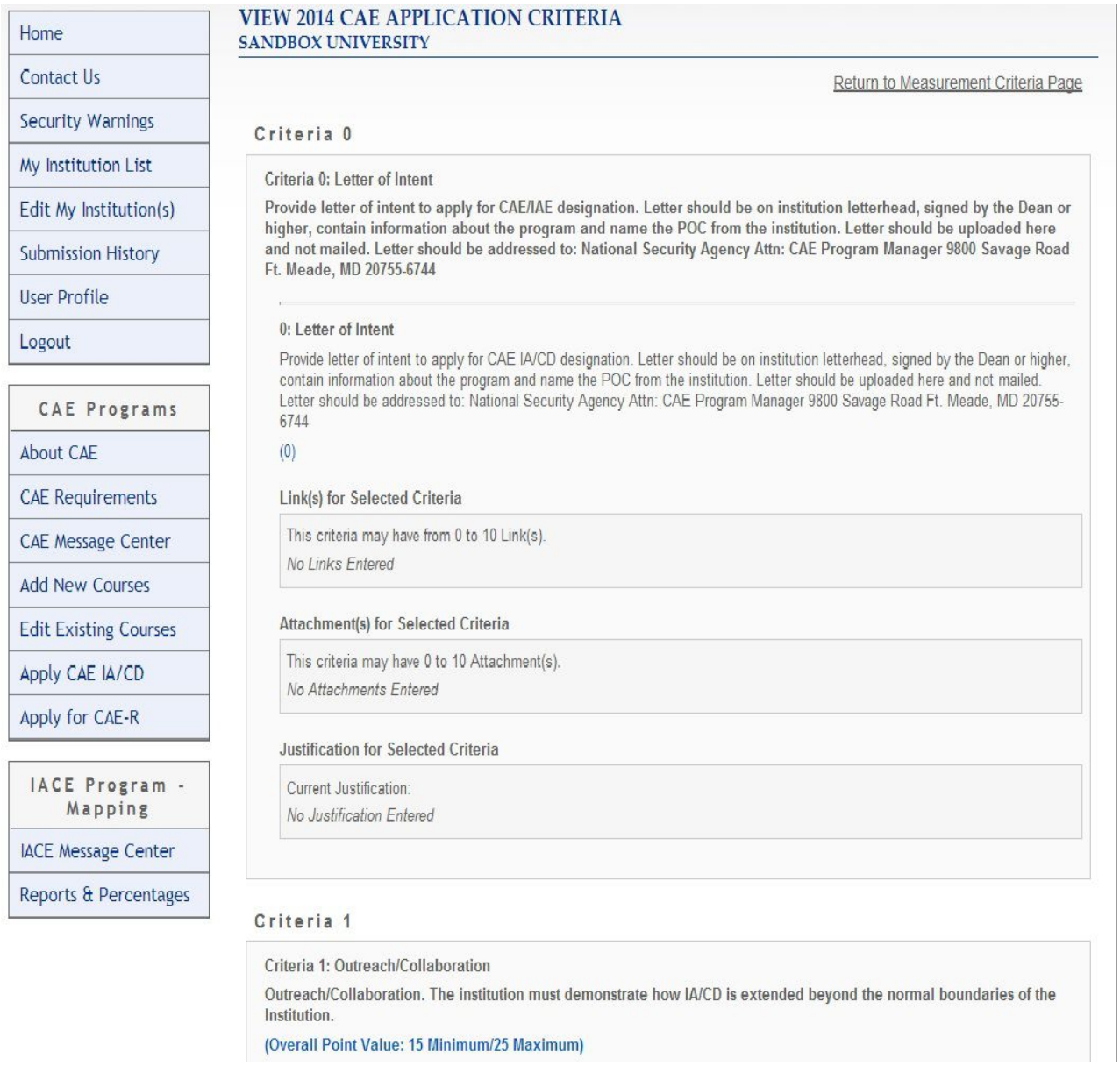


Fig. 42 View Application Criteria – Summary Status

(First segment of continuous page ...)

End of Application Criteria Data Entry

Conclusion

Without suitable organization and preparation, the mapping process can (will) be time and labor intensive. Following the processes and procedures discussed in this manual can greatly facilitate a successful mapping. This manual presents the major elements involved in matching course elements to KUs. The best way to learn the system is to "jump in" by selecting a single course that maps to one or more KUs and follow the methods and flowcharts in the manual.

Happy mapping!

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