

Standards in Education: An IEEE Perspective

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SET Professional

ABET Engineering Criteria

Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate **engineering standards** and multiple realistic constraints.



SET Professional

ABET Engineering Technology Criteria

Capstone or other integrating experiences must draw together diverse elements of the curriculum and develop student competence in focusing both technical and non-technical skills in solving problems.

SET Professional

ABET Computing Criteria

are silent on the matter of a culminating integrative experience for computer science, information systems, and information technology professionals.

SET Professional

ABET Applied Science Criteria

Students must be prepared for applied science practice through the curriculum culminating in comprehensive projects or experiences based on the cumulative knowledge and skills acquired in earlier course work.

What are the impediments? What do the programs need?

Impediments

- knowledge
- availability
- cost



Needs

- learning modules
 - tutorials
 - illustrative cases
- glossaries
- reference guides

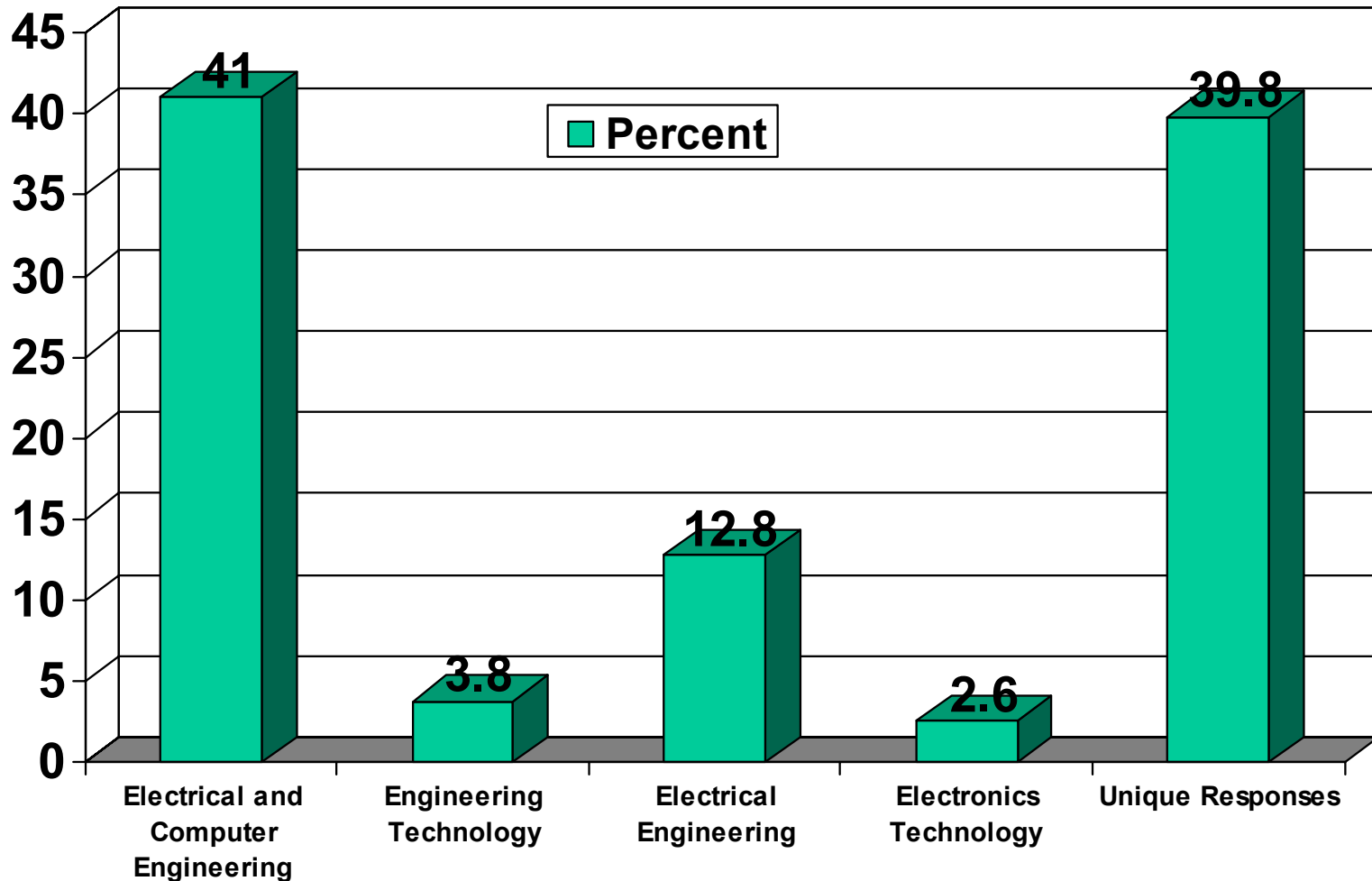
Needs Survey Participants

- **410 heads of electrical and computer engineering and engineering technology departments received the request to participate in the online (final and pilot) surveys**
- **78 responses were received in total from both surveys**
- **19% total response rate**

Summary of Key Findings

- **Most respondents recognize a need for more standards education in their programs;** however, fewer than half suggested ideas for meeting this need. On the contrary, several respondents are looking to the IEEE Standards in Education Task Force (SETF) to provide them with strategies in this area.
- For the respondents that answered that **standards are “Very or Somewhat Available,”** the standards are largely available to faculty members and students via the Internet or institutional libraries, rather than through coursework or textbooks.
- For the respondents that answered that **standards are less than “Very or Somewhat Available,”** the major limiting factor was cost – too expensive.
- **Communications-related, interface, and network-related standards are considered to be the most important** in teaching design and development. Furthermore, nearly one-third of respondents feel that the design process is the best place for incorporating standards education into the curricula.
- **Nearly one-third of respondents want to see tutorials containing both summaries of standards and case studies** illustrating the practical application of standards. Case studies were also singled out as crucial to capstone courses by several respondents.

Please indicate the name of the Department you are in. (Please select one.)

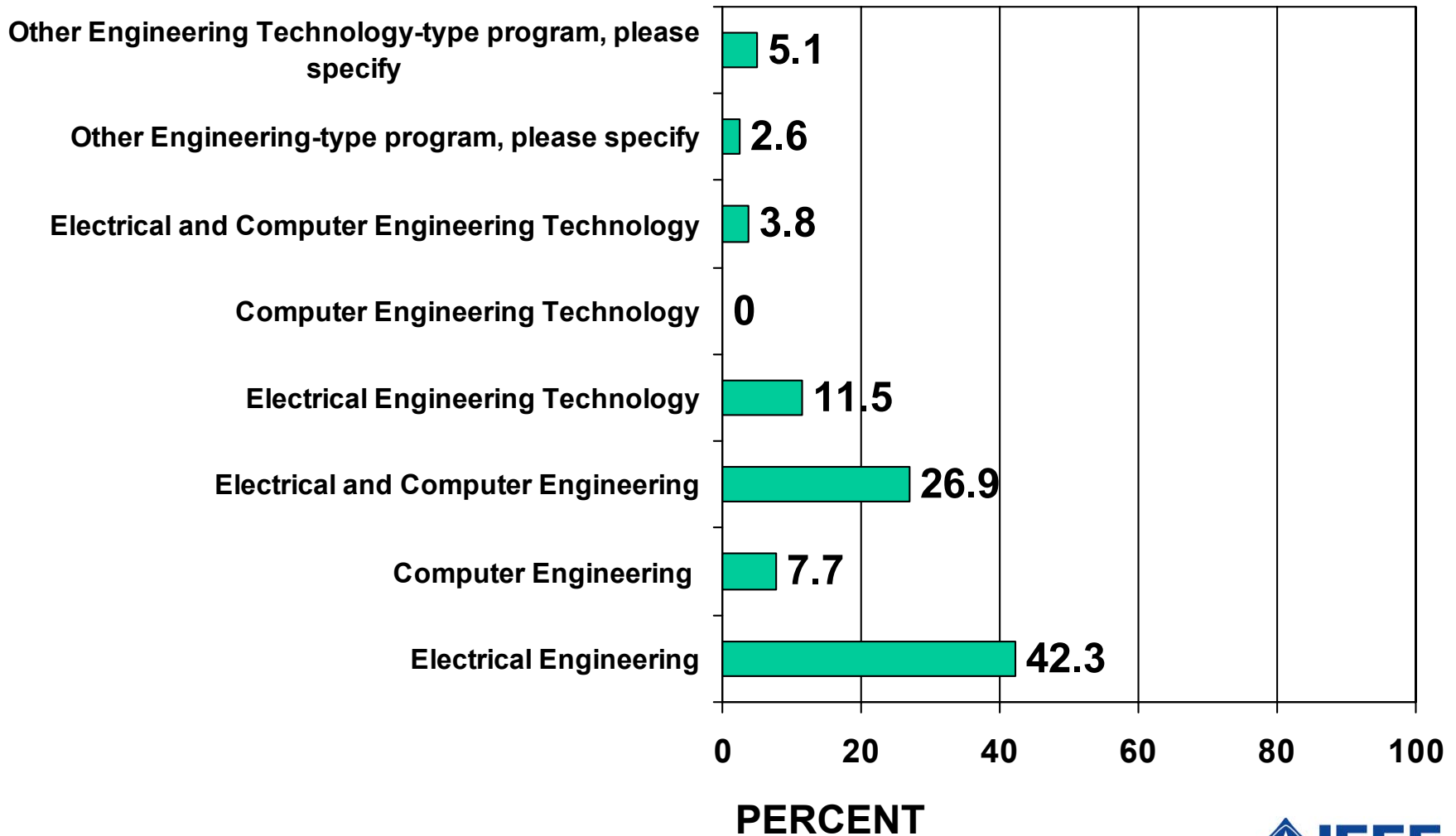


Q.1a Your department

Item	Frequency	Percent
Electrical and Computer Engineering	32	41.0%
Engineering Technology	3	3.8%
Electrical Engineering	10	12.8%
Electronics Technology	2	2.6%
(Unique responses)	31	39.8%
(Total)	78	100.0%

Sample Answering: 78 responses

Please indicate the name of the degree program you are responding about. (Please select one.)



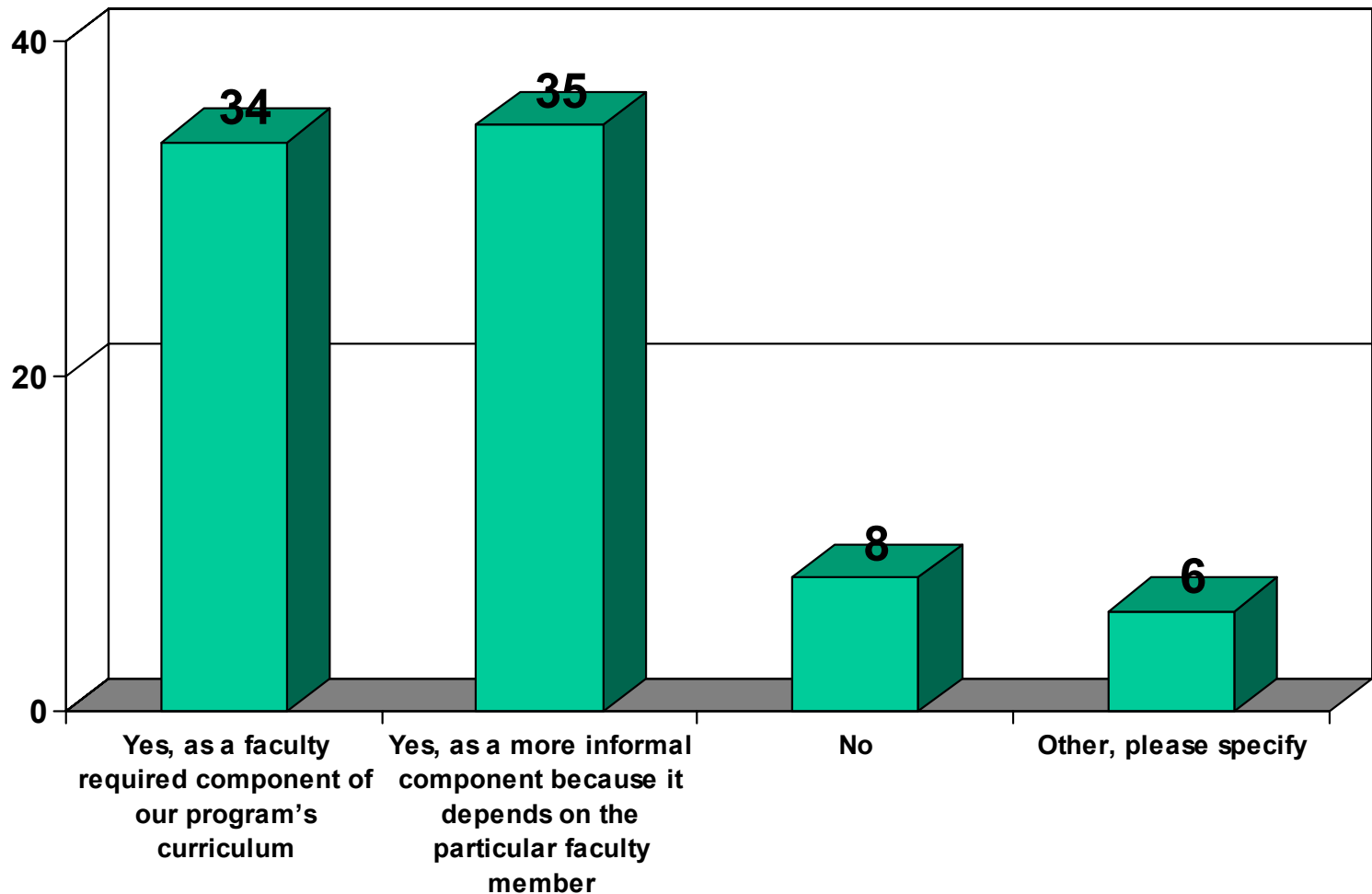
Please indicate the name of the degree program you are responding about. (Please select one.)

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Electrical Engineering	33	42.3%	42.3%	42.3%
Computer Engineering	6	7.7%	7.7%	7.7%
Electrical and Computer Engineering	21	26.9%	26.9%	26.9%
Electrical Engineering Technology	9	11.5%	11.5%	11.5%
Computer Engineering Technology	0	0.0%	0.0%	0.0%
Electrical and Computer Engineering Technology	3	3.8%	3.8%	3.8%
Other Engineering-type program, please specify	2	2.6%	2.6%	2.6%
Other Engineering Technology-type program, please specify	4	5.1%	5.1%	5.1%

Please indicate the name of the degree program you are responding about. (Please select one.) - Other Engineering-type program, please specify

- **Software Engineering**
- **Electronics**
- **Telecommunications Engineering Technology**
- **Electronics and Computer Engineering Technology**
- **Computer Networks and Systems (B.S. in Engineering Technology); responses apply also to Electrical Engineering Technology**
- **Electronics Engineering Technology**

Does at least one course that includes product and process design or development content address standards and their applications? (Check all the apply.)



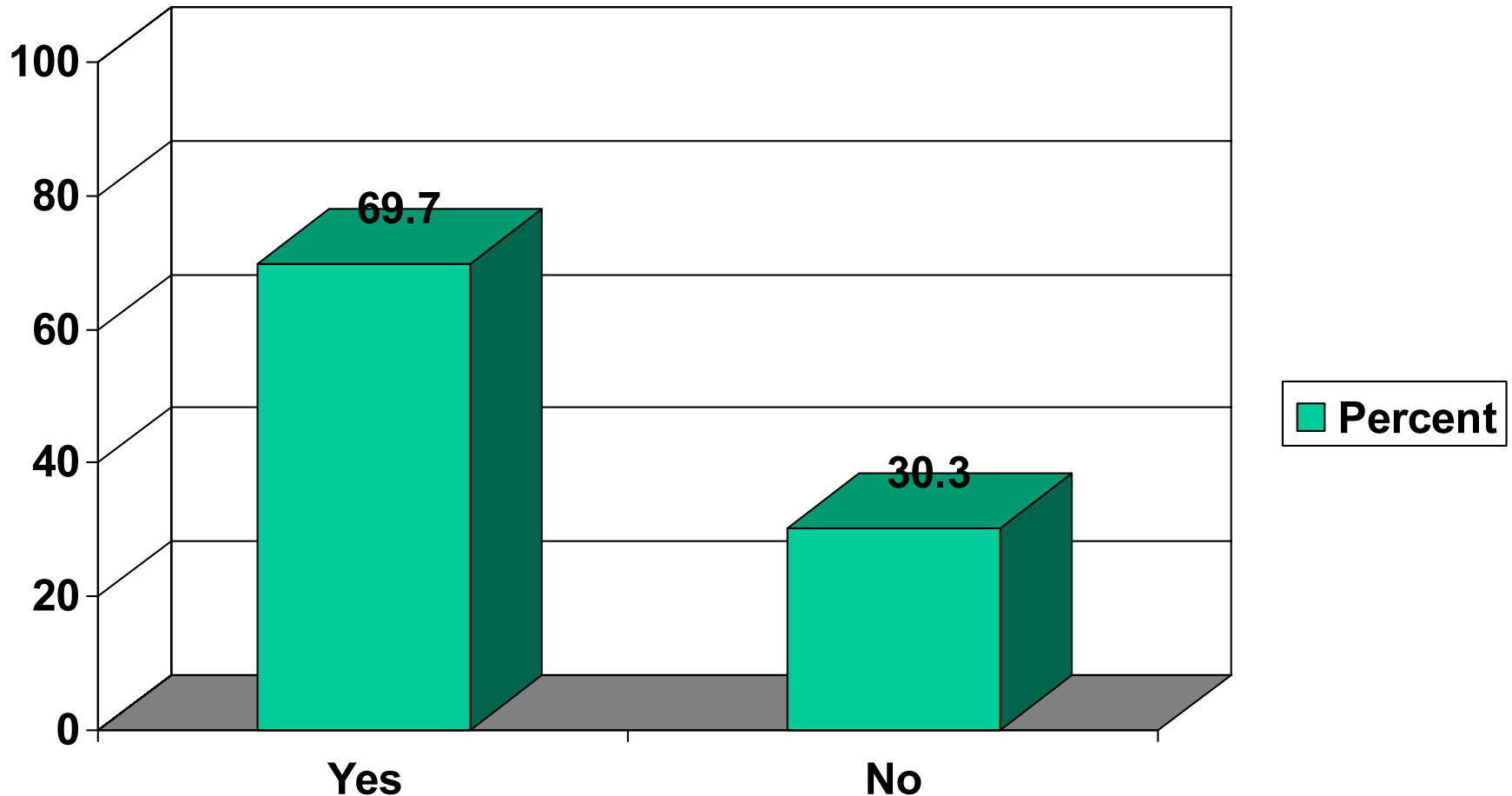
Does at least one course that includes product and process design or development content address standards and their applications? (Check all the apply.)

Choice	Count	Percent of Sample Asked	Percent of Total Sample
Yes, as a faculty required component of our program's curriculum	34	41.0%	41.0%
Yes, as a more informal component because it depends on the particular faculty member	35	42.2%	42.2%
No	8	9.6%	9.6%
Other, please specify	6	7.2%	7.2%

Does at least one course that includes product and process design or development content address standards and their applications? (Check all the apply.) - Other, please specify

- Senior Design course also discusses
- The content of some elective courses address standards.
- The capstone project involves specifications and application of standards
- Some required classes and electives discuss standards such as IEEE 802.11 and IEEE 488
- It is a part of the course syllabus, so it does not depend upon the faculty teaching the course
- Within the 4th year design course - generally covered in a tutorial

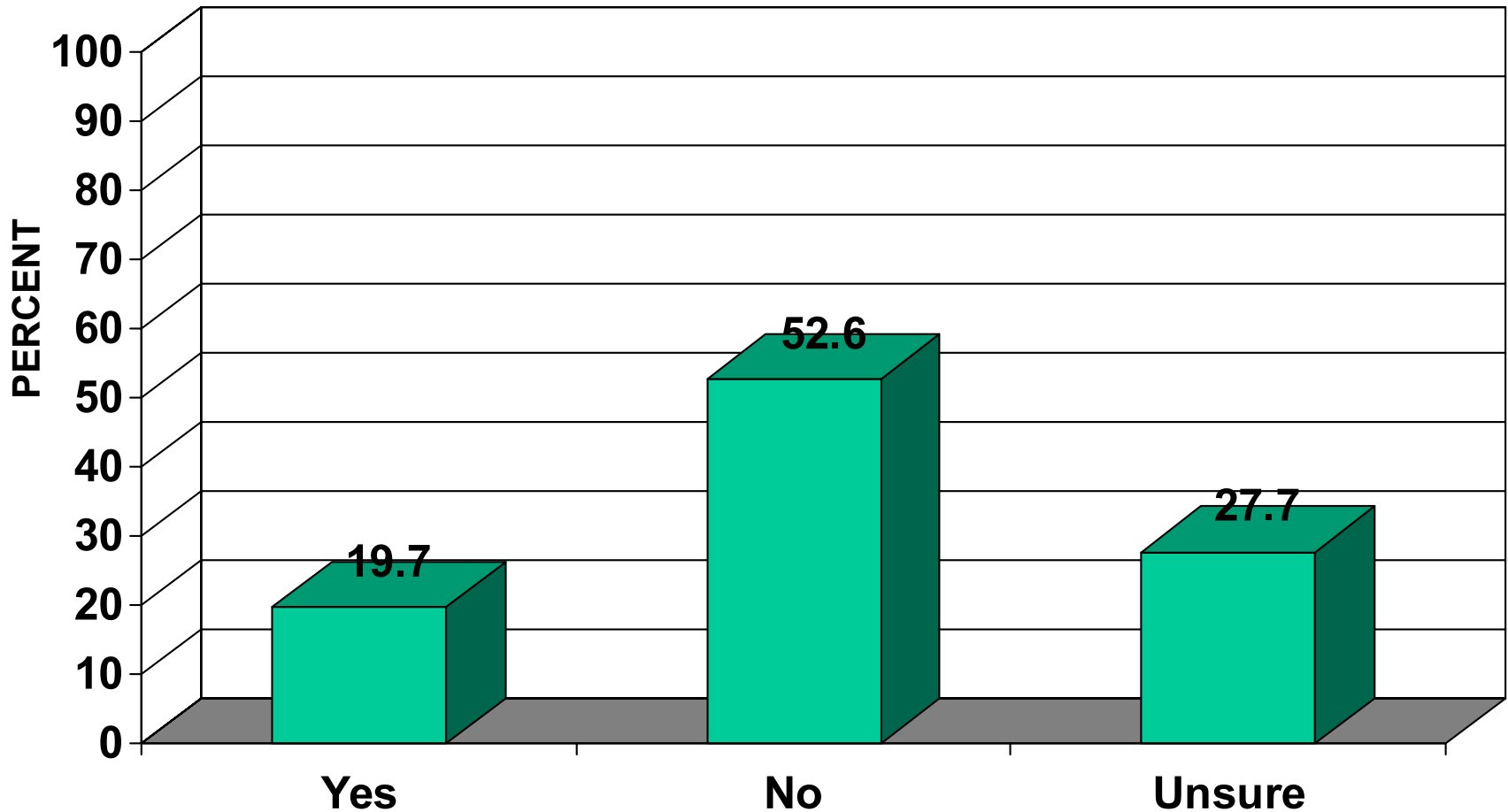
Do you think some courses, not just a capstone course, in your program would be enhanced by teaching more about standards?



Do you think some courses, not just a capstone course, in your program would be enhanced by teaching more about standards?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	53	69.7%	67.9%	67.9%
No	23	30.3%	29.5%	29.5%

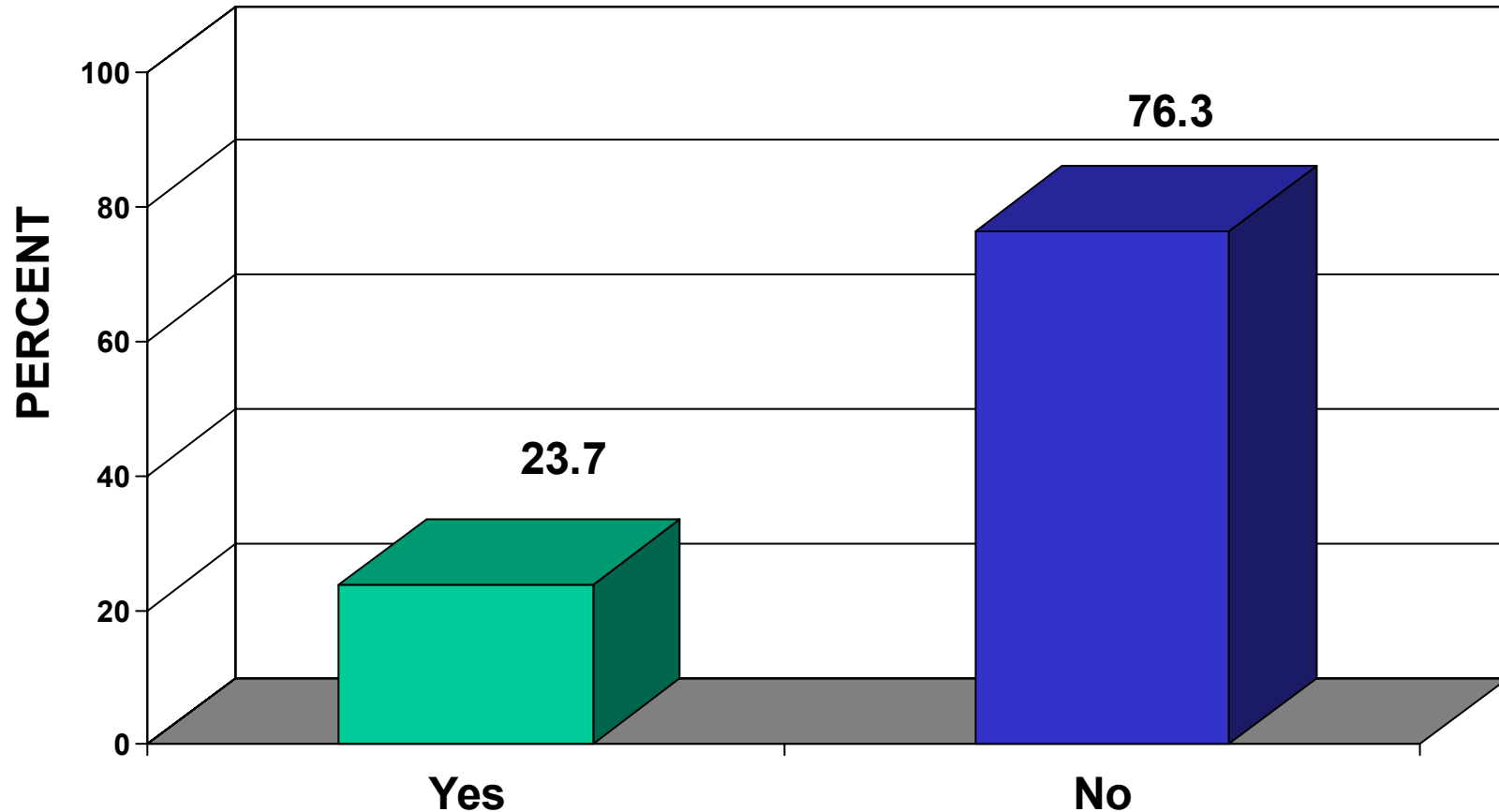
Do you think current textbooks incorporate adequate consideration of standards when relevant?



Do you think current textbooks incorporate adequate consideration of standards when relevant?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	15	19.7%	19.2%	19.2%
No	40	52.6%	51.3%	51.3%
Unsure	21	27.7%	26.9%	26.9%

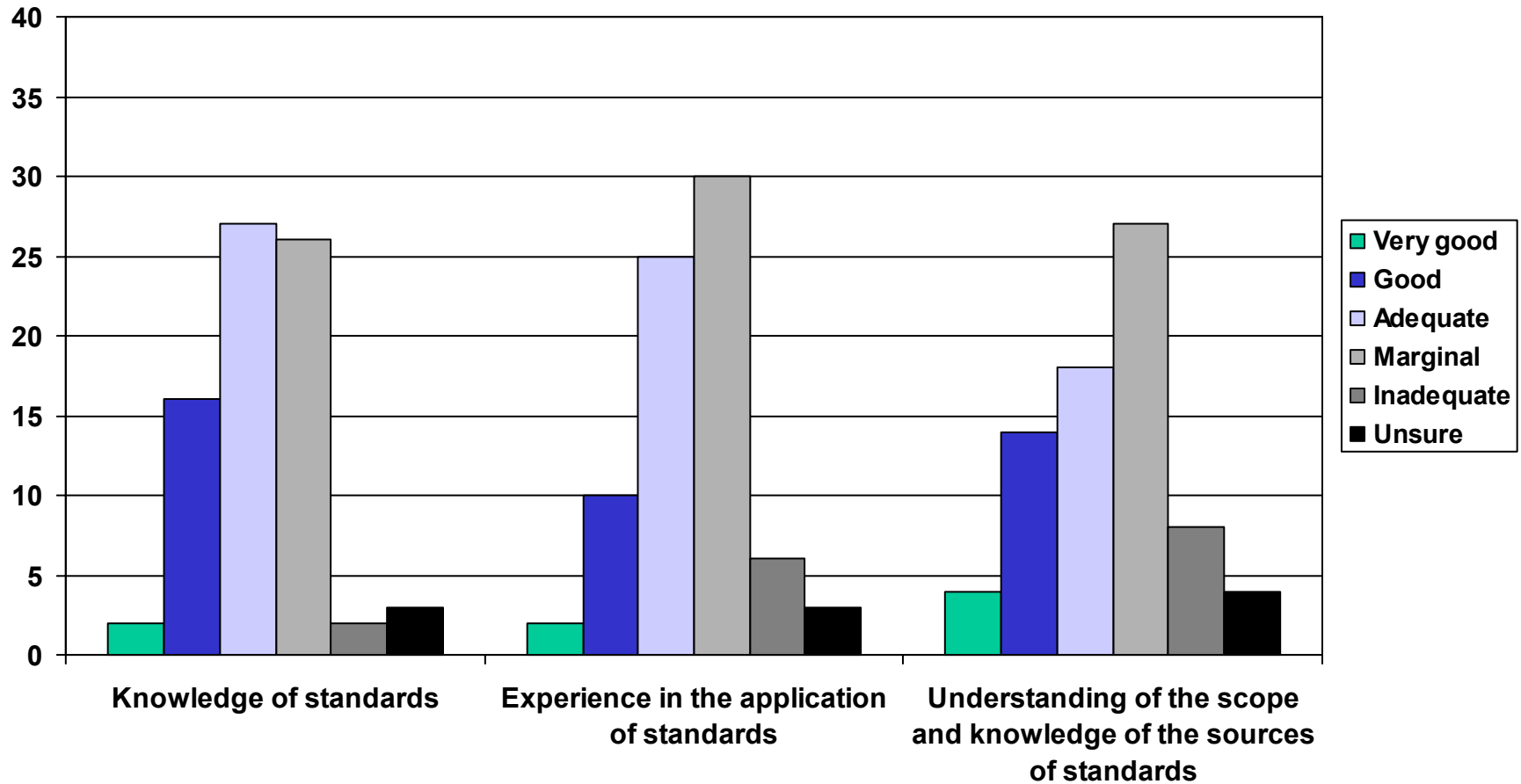
Is the identification of relevant standards by students a requirement in all design and/or development activities?



Is the identification of relevant standards by students a requirement in all design and/or development activities?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	18	23.7%	23.1%	23.1%
No	58	76.3%	74.4%	74.4%

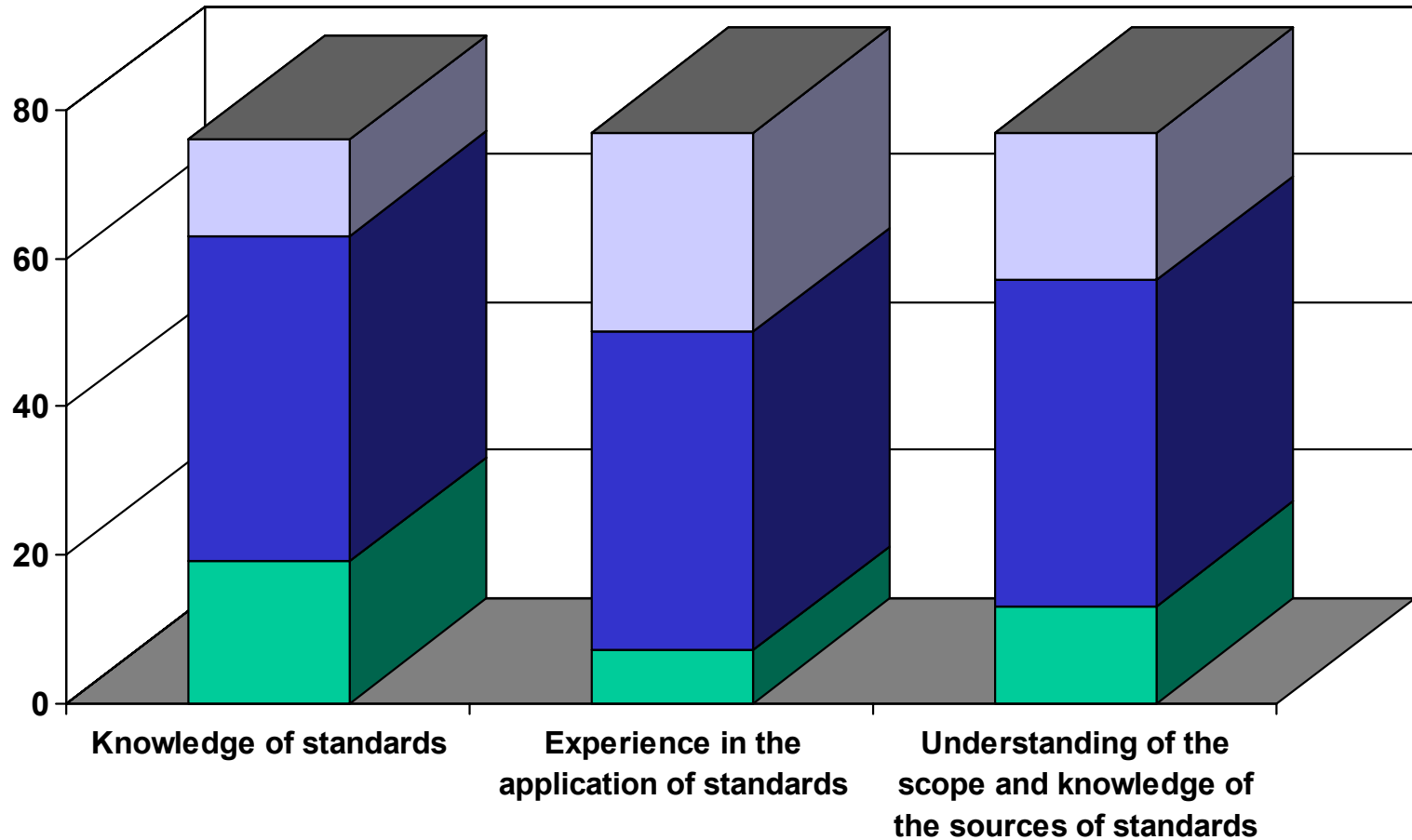
At the time of graduation from your program, please indicate how well students have the following. (Check one for each item.)



At the time of graduation from your program, please indicate how well students have the following. (Check one for each item.)

Topic	Very good	Good	Adequate	Marginal	Inadequate	Unsure	Not Answered	Not Asked
Knowledge of standards	2	16	27	26	2	3	2	0
Experience in the application of standards	2	10	25	30	6	3	2	0
Understanding of the scope and knowledge of the sources of standards	4	14	18	27	8	4	3	0

Please indicate how important you think each of the following are in undergraduate education.
(Check one for each item.)

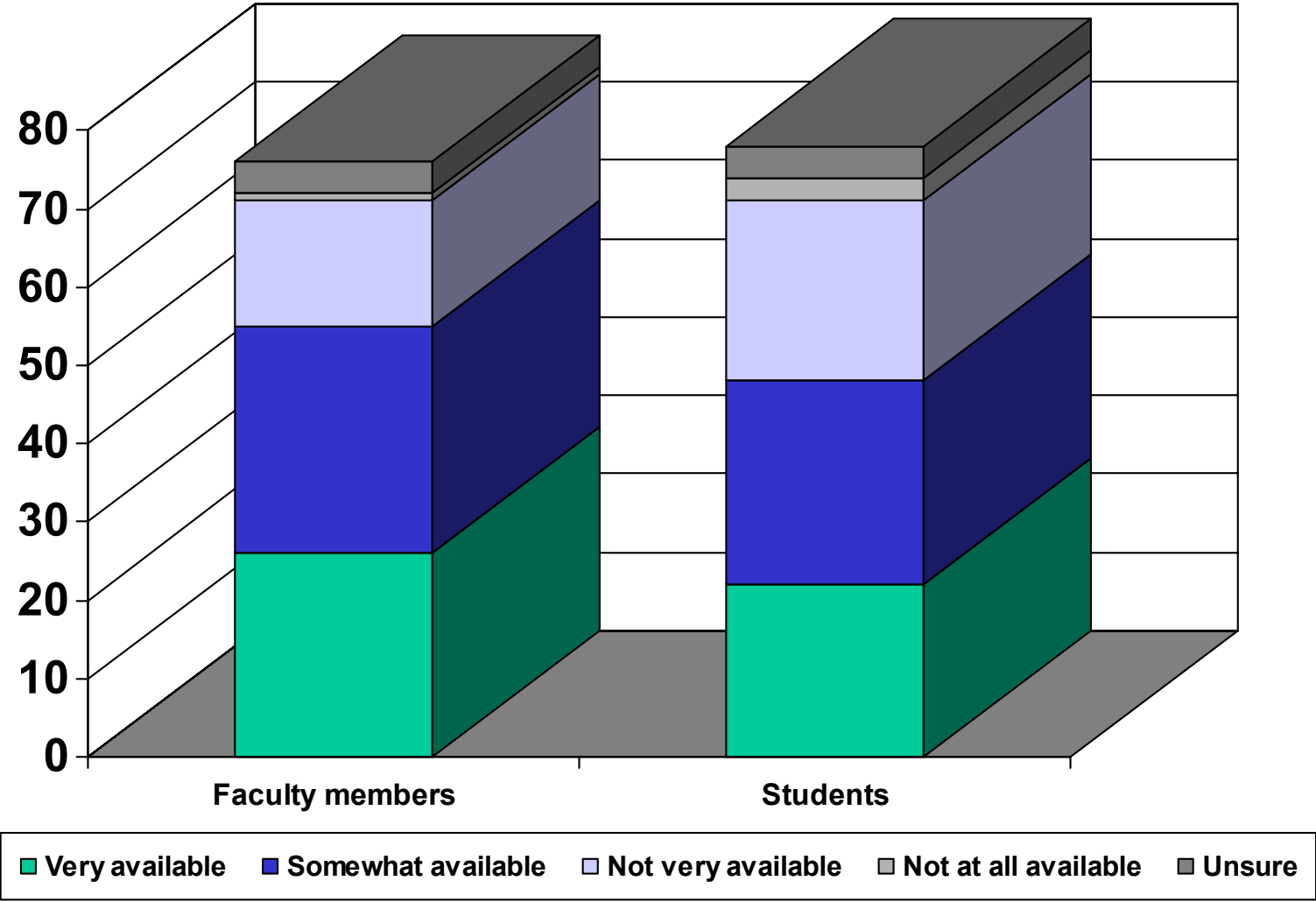


Very important Moderately important A little bit important Not at all important Unsure

Please indicate how important you think each of the following are in undergraduate education. (Check one for each item.) - A

Topic	Very important	Moderately important	A little bit important	Not at all important	Unsure	Not Answered	Not Asked
Knowledge of standards	19	44	13	0	0	0	0
Experience in the application of standards	7	43	27	0	0	0	0
Understanding of the scope and knowledge of the sources of standards	13	44	20	0	0	0	0

How available are standards to students and faculty members at your institution?



How available are standards to students and faculty members at your institution? - A

Topic	Very available	Somewhat available	Not very available	Not at all available	Unsure	Not Answered	Not Asked
Faculty members	26	29	16	1	4	2	0
Students	22	26	23	3	4	0	0

Limiting Factors in Standards Being “Less Than Somewhat / Very Available”

Question: “If availability is less than adequate, indicate the limiting factor(s) in making standards available to the students and faculty members at your institution.”

- Main reasons for limited access to standards included (in order of significance):
 - Cost – too expensive
 - Lack of library resources
 - Lack of interest

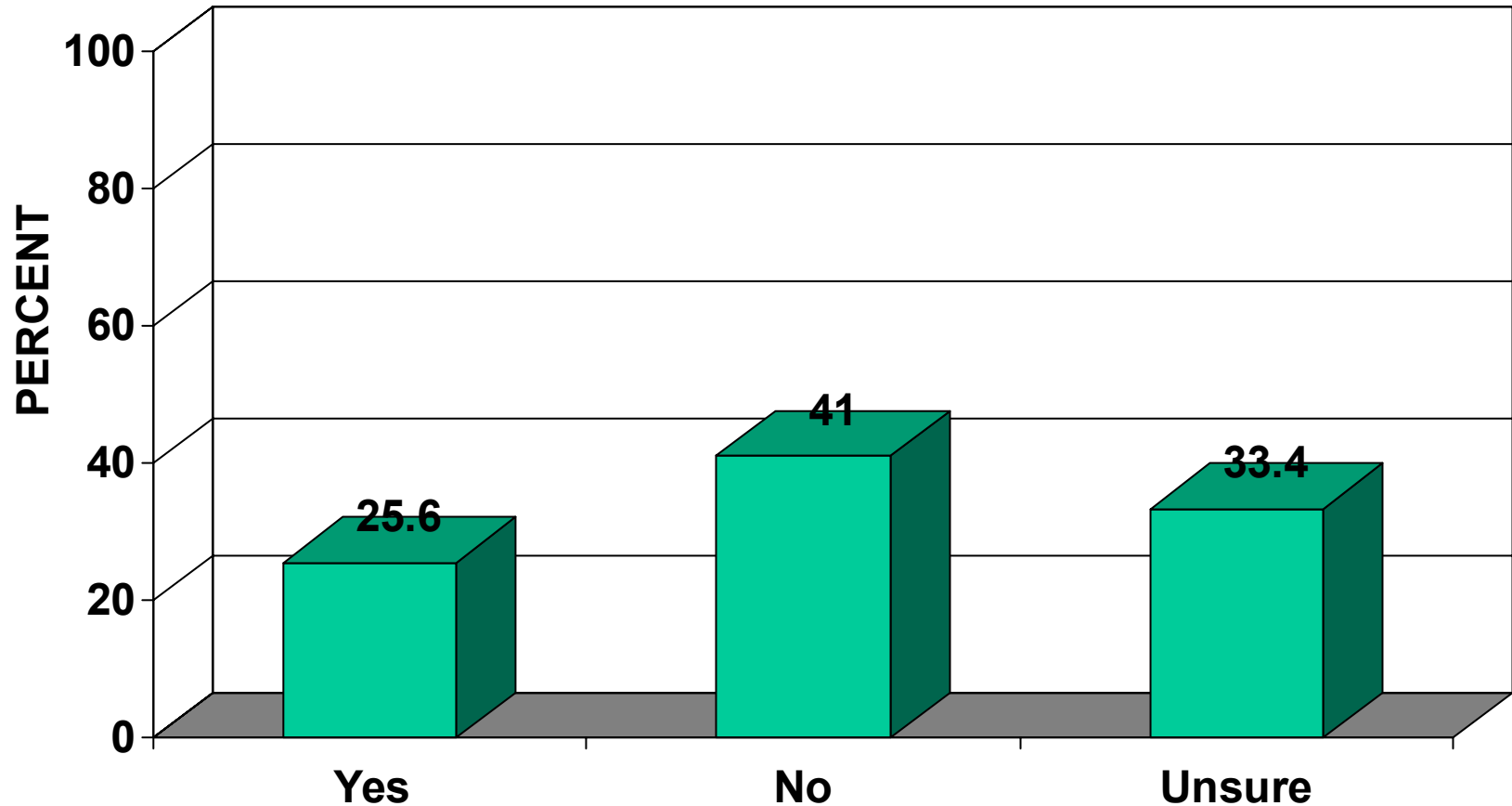
Scope of Available Standards

Question: “If you indicated above that standards are somewhat or very available [at your institution] to either faculty members or students, please indicate the scope of the standards available.”

- Among respondents who described the scope of standards available to either faculty members or students at their institutions, half (50% of total respondents) reported that all or most standards are accessible online, and 35% indicated that paper copies of standards can be found in their libraries.
- Some respondents (18%) reported that some specific standards are discussed in certain courses, and a few respondents (9%) stated that some standards are summarized or partially described in textbooks in use at their institutions.
- Several respondents (12%) noted that their institutions did not specifically teach or encourage students regarding the general use of standards.

Note: 34 respondents (out of the at least 48 who indicated that standards are somewhat or very available to either faculty members or students) provided usable written responses. Because these respondents provided multiple responses to this question, the percentages add to more than 100 percent.

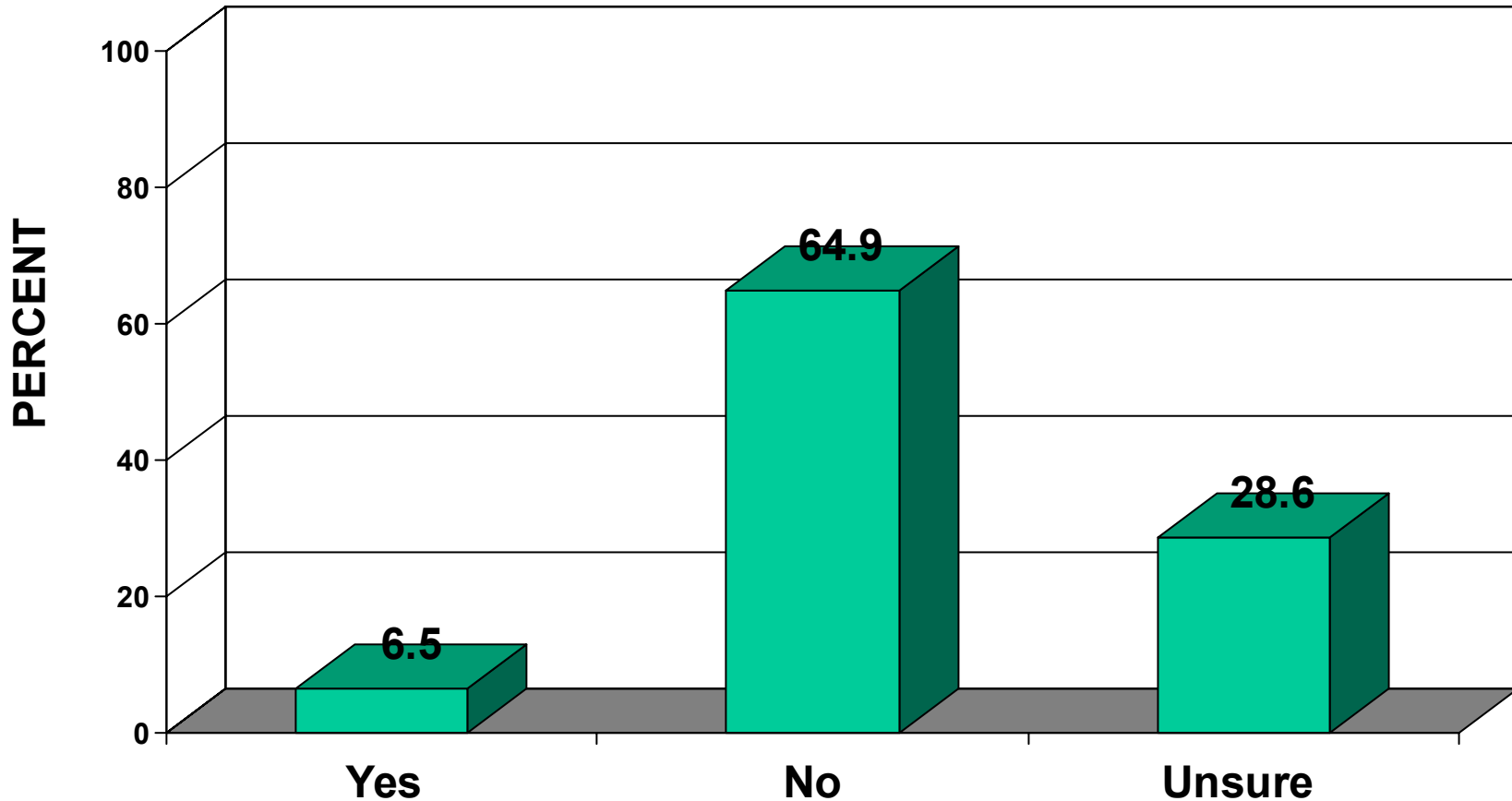
Is there a standards section in your institution's library?



Is there a standards section in your institution's library?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	20	25.6%	25.6%	25.6%
No	32	41.0%	41.0%	41.0%
Unsure	26	33.4%	33.4%	33.4%

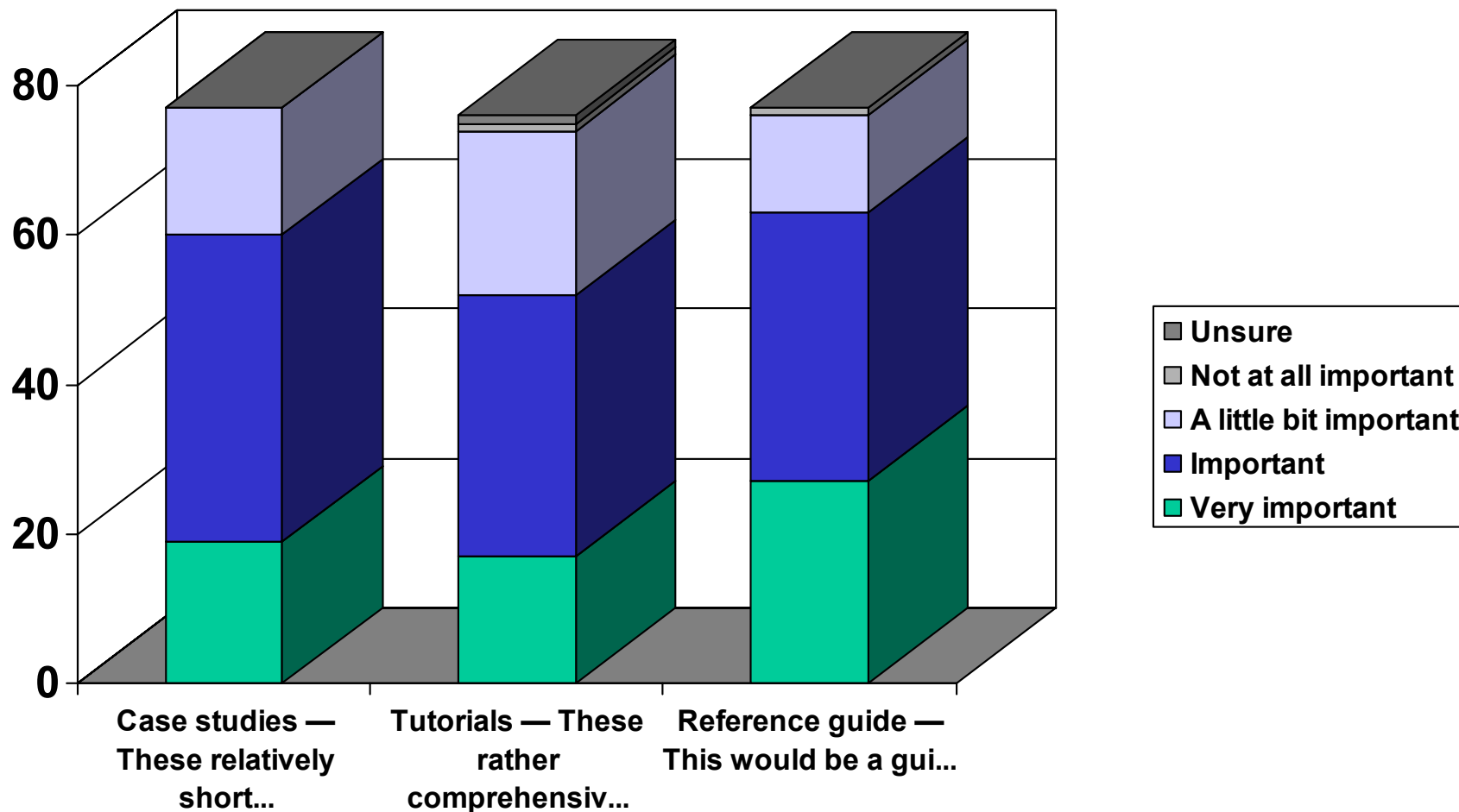
Does your institution have a standards librarian?



Does your institution have a standards librarian?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	5	6.5%	6.4%	6.4%
No	50	64.9%	64.1%	64.1%
Unsure	22	28.6%	28.2%	28.2%

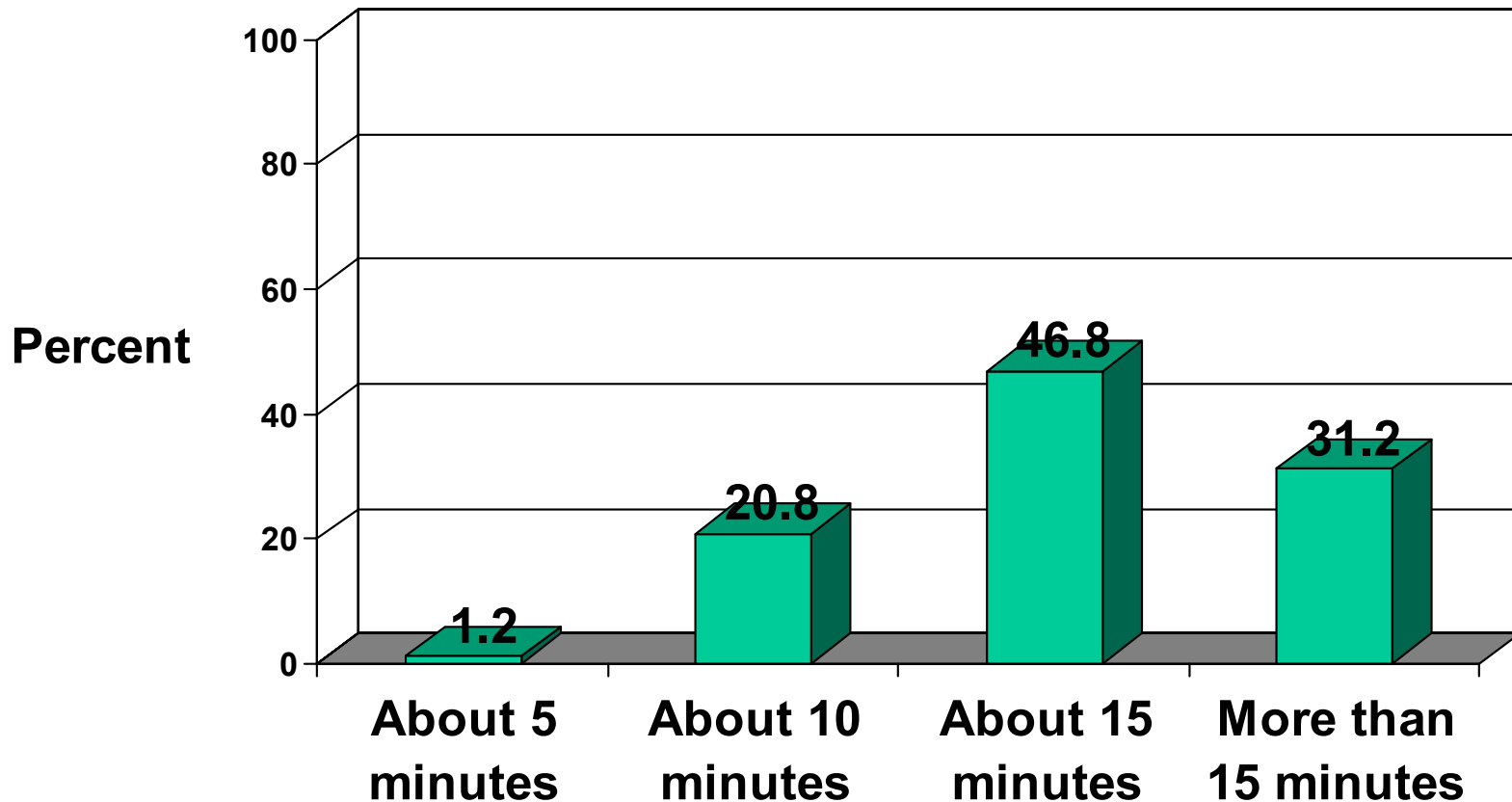
Please indicate how important you feel it is that students have access to the following types of teaching tools.



Please indicate how important you feel it is that students have access to the following types of teaching tools.

Topic	Very important	Important	A little bit important	Not at all important	Unsure	Not Answered	Not Asked
Case studies — These relatively short learning modules would illustrate the need for and application of standards in the development of a product or process.	19	41	17	0	0	0	0
Tutorials — These rather comprehensive learning modules would provide guidance in how to assemble and apply standards appropriate to the development of a product or process, most likely from a domain(or class) of products or processes.	17	35	22	1	1	1	0
Reference guide — This would be a guide to standards including title, brief description of content of standard, and URL to the standard's full text.	27	36	13	1	0	0	0

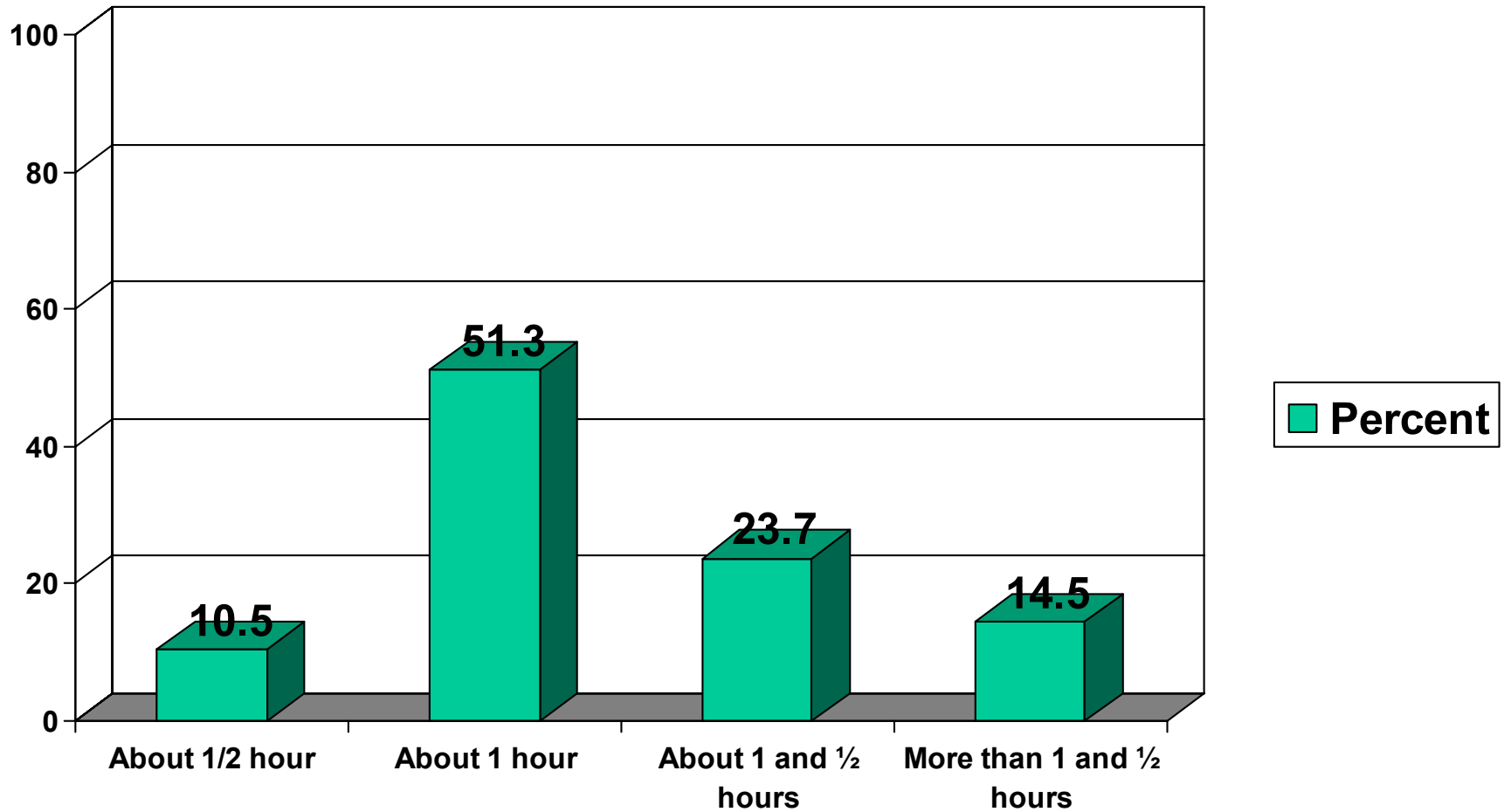
How long do you think a well-designed case study should take a student to review?



How long do you think a well-designed case study should take a student to review?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
About 5 minutes	1	1.2%	1.3%	1.3%
About 10 minutes	16	20.8%	20.5%	20.5 %
About 15 minutes	36	46.8%	46.2%	46.2%
More than 15 minutes	24	31.2%	30.8%	30.8%

How long do you think a well-designed tutorial should take a student to review?



How long do you think a well-designed tutorial should take a student to review?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
About 1/2 hour	8	10.5%	10.3%	10.3%
About 1 hour	39	51.3%	50.0 %	50.0%
About 1 and ½ hours	18	23.7%	23.1%	23.1%
More than 1 and ½ hours	11	14.5%	14.1%	14.1%

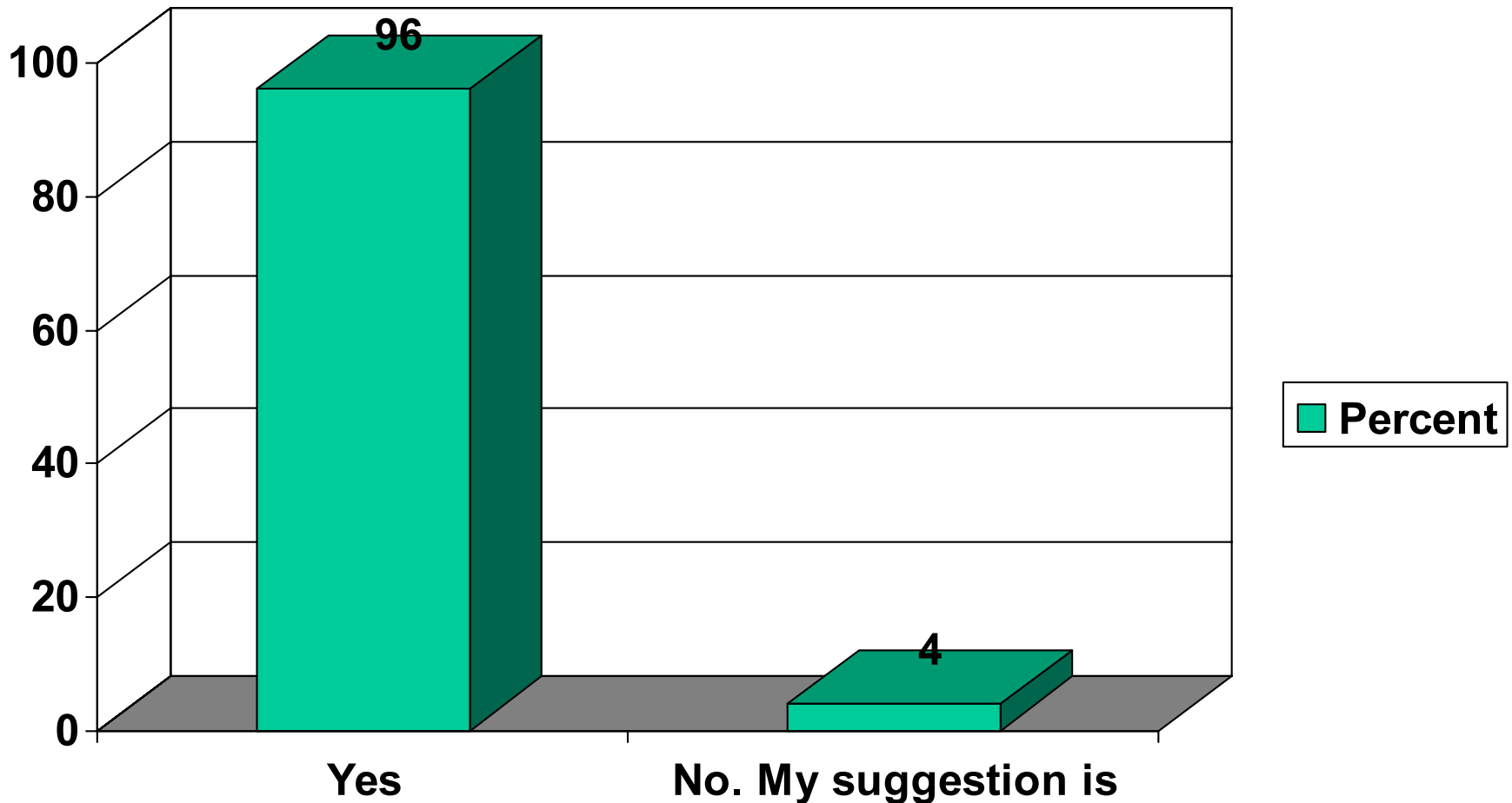
Tutorial Domains, Factors and Issues

Question: “Please specify the technical domains, factors, and issues that you believe should be illustrated in a tutorial.”

- Respondents listed the following technical domains, factors, and issues as proper subjects for tutorials:
 - Practical application/case studies of specific standards or of standards in general (36% of total respondents)
 - Summary/Outline of each standard and its uses (21%)
 - History of each standard (21%)
 - Networking and communications standards (18%)
 - Importance of specific standards or of standards in general through examples of absence or misuse of standards (14%)
 - Overview of full range of standards available (11%)
- Furthermore, summaries of standards and practical application examples were considered integral parts of the same standard-specific tutorials for 29% of respondents.

Notes: 28 respondents provided usable written responses. Because these respondents provided multiple responses to this question, the percentages add to more than 100 percent.

Reference guides are typically annotated with the following: title, brief description of content, and URL to full text standards. Would a format like this be useful in a reference guide to standards?



Reference guides are typically annotated with the following: title, brief description of content, and URL to full text standards. Would a format like this be useful in a reference guide to standards?

Choice	Count	Percentage of Sample Answering	Percentage of Sample Asked	Percentage of Total Sample
Yes	72	96.0%	92.3%	92.3%
No. My suggestion is	3	4.0%	3.8%	3.8%

Reference guides are typically annotated with the following: title, brief description of content, and URL to full text standards. Would a format like this be useful in a reference guide to standards? - No. My suggestion is

- For a given problem, what should they consider in choosing a set of standards.
- A short description of application will enhance let the user appreciate its use.
- Full text standards are written for those in the know. Brief description of contents should be followed by tutorial which should be followed by application example. Full text standards can be used as a reference, not an end point.

Standards and Categories of Standards Important to Teaching Design/Development

Question: “What are the most important standards and categories of standards to the teaching of design and/or development in your program? Please be as specific as possible.”

- Respondents listed the following standards and categories of standards as important to the teaching of design and/or development in their programs:
 - All types of communications-related standards (e.g., wireless, computer, data; 36% of total respondents)
 - All types of interface standards (e.g., physical, electrical, digital; 22%)
 - Network-related standards (20%)
 - All or some specific IEEE standards (10%)
 - Safety standards (10%)
 - Electronic components (8%)
 - Power system standards (8%)
 - Computer bus standards (8%)
 - ISO (8%)
- In addition, a few respondents (6%) focused on the significance of imparting a general understanding of standards and their proper use to students, rather than covering a variety of specific standards.

Note: 50 respondents provided usable written responses. Because these respondents provided multiple responses to this question, the percentages add to more than 100 percent.

Use of Standards in Capstone Course

Question: “Please share any (best) practices on how you or your colleagues use, or imagine you could use, standards within the time constraints of a capstone course.”

- Among respondents who commented upon the best use of standards in a capstone course, nearly one-third (31% of total respondents) indicated that standards should be, or are currently, incorporated into the design process.
- One-fifth of respondents (21%) reported that standards would be discussed in their courses only if particular standards were applicable to a student’s project. Conversely, 14% of respondents stated that their programs require students to have a comprehensive understanding of the importance and use of standards.
- Some respondents (21%) suggested ways to improve their courses by requiring broader exposure to standards. A few respondents (10%) admitted that their programs are currently suffering from a lack of standards inclusion.
- Additionally, several respondents (14%) noted that presenting case studies as practical examples of standards usage is crucial to students’ comprehension of standards.

Notes: 29 respondents provided usable written responses. Because these respondents provided multiple responses to this question, the percentages add to more than 100 percent.

General Suggestions for the IEEE Task Force

Question: Please indicate any suggestions you may have related to the IEEE task force.

- More than one-fifth (22%) of respondents who commented on the IEEE Task Force generally are eager for suggestions from the Task Force on how to integrate standards education into their programs.
- Several respondents also listed suggestions of their own:
 - Develop a textbook and/or reference materials devoted to standards usage across disciplines (17% of total respondents)
 - Develop a set of standards for each field and publish them as a series of booklets (11%)
 - Provide continuous updates on standards development that can be included in the curricula (11%)
 - Develop case studies of specific standards (11%)
- Finally, a few respondents (11%) reiterated the importance of conveying a general awareness of standards and their proper usage, rather than teaching a variety of specific standards.

Notes: 18 respondents provided usable written responses. Because these respondents provided multiple responses to this question, the percentages add to more than 100 percent.

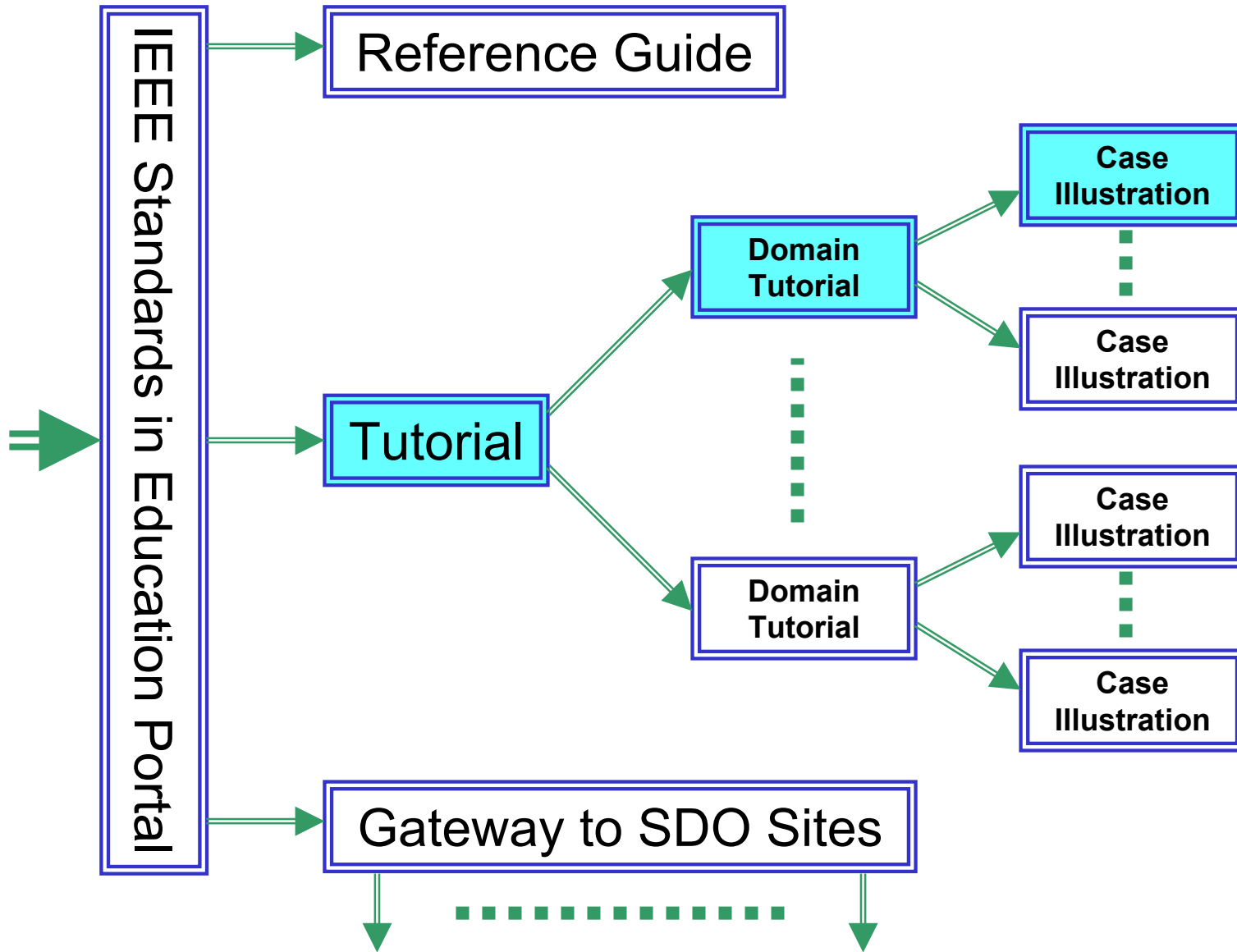
Conclusions

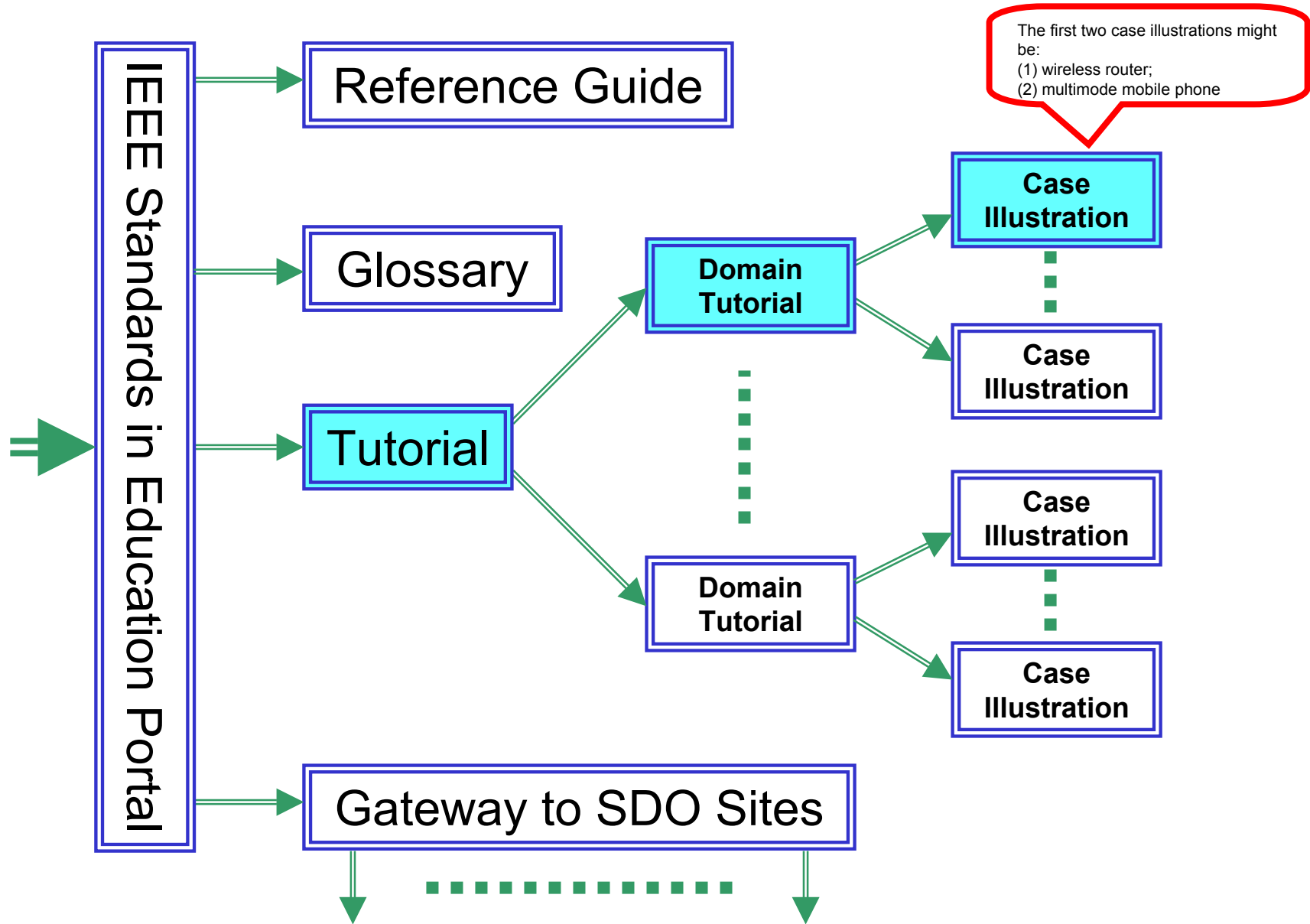
- Most respondents recognize a need for more standards education in their programs; in addition to their written comments, **70% of respondents agreed that their programs would be enhanced by increased teaching of standards.** However, fewer than half suggested ideas for meeting this need. On the contrary, **several respondents are looking to the IEEE Task Force to provide them with strategies for improving their standards education levels.** This latter finding is supported by the fact that when respondents were asked if they would like to receive a copy of the Task Force conclusions, fully 87% answered in the affirmative.
- For those that responded that **standards are “Very or Somewhat Available,” the standards are largely available** to the faculty members and students **via the Internet or institutional libraries**, rather than through coursework or textbooks.
- For the respondents that answered that **standards are less than “Very or Somewhat Available,” the major limiting factor was cost – too expensive.**
- **Communications-related, interface, and network-related standards are considered by respondents to be the most important** in teaching design and development. Furthermore, nearly one-third of respondents feel that the design process is the best place for incorporating standards education into the curricula.
- **Nearly one-third of respondents want to see tutorials containing both summaries of standards and case studies illustrating the practical application of standards;** both tutorials focusing on specific standards as well as those addressing standards usage more broadly were requested. Case studies were also singled out as crucial to capstone courses by several respondents.

Standards in Education: An IEEE Solution



**Tutorials, Case Illustrations,
and Reference Guides**





Tutorial

This comprehensive learning module provides information about standards:

- **How they come about.**
- **How they are classified.**
- **How they impact the development of a product, process, or service.**
- **How they benefit the economy.**

It will include a glossary of words and phrases in common use by standards developers and users.

Domain Tutorial

This learning module provides information about standards in a technological domain:

- **What is their history.**
- **What are the issues that they address.**
- **What is their impact on the design and development of products, processes, and services.**
- **What is the potential impact on the economy.**

Case Illustration

This learning module describes the application of standards from the antecedent domain to a realistic problem:

- **Product, process, or service expectations.**
- **Identification of relevant standards.**
- **Determination of design and development constraints imposed by the standards.**
- **Statement of design or development task.**

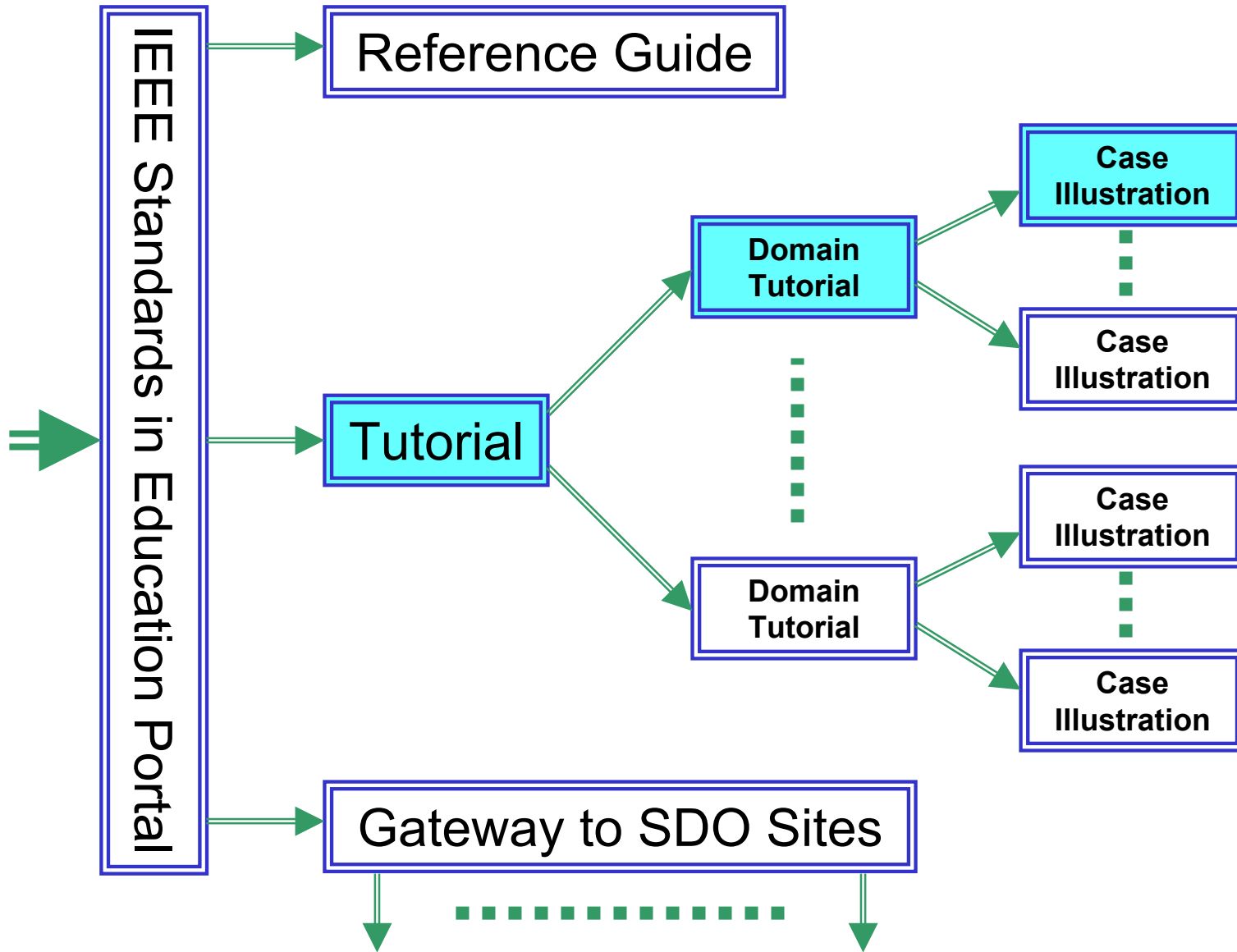
Reference Guide

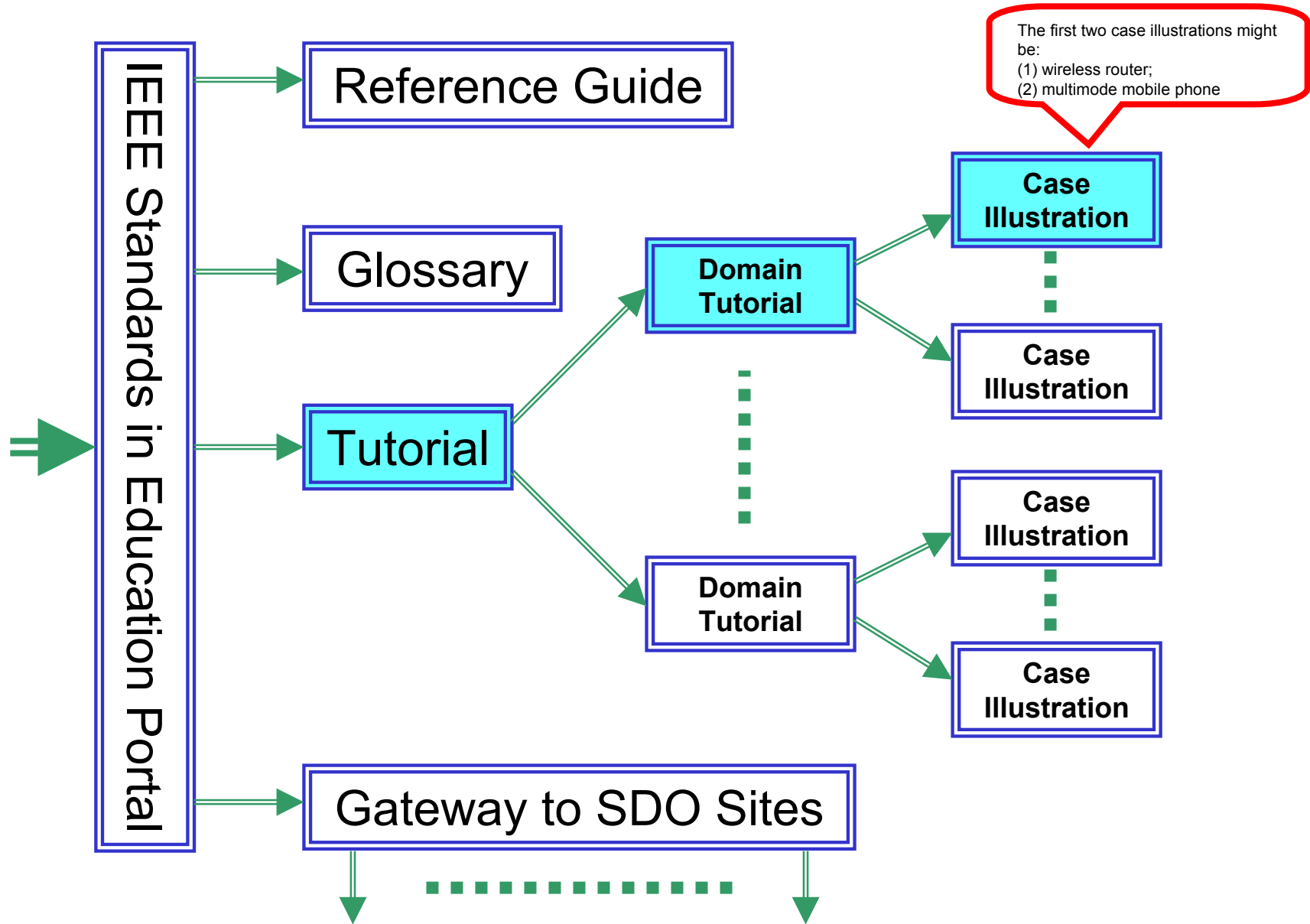
This resource will be a reference guide to standards, grouped in categories, with each reference including:

- **the title of the standard,**
- **a brief description of the content of the standard, and**
- **the URL to the standard's full text.**

Gateway to SDO Sites

This resource will be an annotated index of Standards Development Organizations (SDOs) with URLs linked to their web-sites.





THE ROLE OF STANDARDS

in engineering and technology



This tutorial addresses the subject of technical standards. These are standards that deal with the physical and electrical properties and dimensions of a product or service. In the body of this tutorial the term "standards" is to be taken as "technical standards," as opposed to standard, such as ethical and business, which are also important but are not covered by this tutorial.

This first publication of 'The Role of Standards in Engineering and Technology' presents introductory material that is applicable to most classes of standards. It then makes use of existing standards from the telecommunications and information technology fields to provide direct examples on how standards and technical developments interact.

Each section in this module is navigated by a toolbar at the top of the page. This toolbar has five choices:

TABLE OF CONTENTS	TOPICS IN THIS SECTION	GLOSSARY	FURTHER READING	INDEX
The Table of Contents listing all the sections in the module.	A list of all topics in the section you are currently viewing.	A list of all terms in the module with their definitions and links to further material, as appropriate.	A reading list for the module, linked to additional material as appropriate.	A full index of content in the module, linked as appropriate.

BEGIN MODULE

A project of the IEEE Educational Activities Board and the IEEE Standards Association through the work of the joint Standards in Education Task Force produced by Unreal Productions

This tutorial is provided as a tool to practicing technologists and for engineering faculty and students in the fulfillment of the accreditation requirement set by ABET that: "Students must be prepared for engineering practice through the curriculum culminating in a major design experience...incorporating engineering standards and [other] realistic constraints..."

Table Of Contents

Please select a section from the list below.

The first time you review this material, we suggest you do so in sequence.



What are Standards?



The Application of Standards



Standards and Markets



Product Design and Manufacture



Summary and Next Step

THE ROLE OF STANDARDS

in engineering and technology



TABLE OF CONTENTS	TOPICS IN THIS SECTION	GLOSSARY	FURTHER READING	INDEX
What are Standards?	Section Learning Objectives			
The Application of Standards	Standards Defined			
Standards and Markets	How Standards are Codified			
Product Design and Manufacture	Consensus vs. Proprietary Standards			
Summary and Next Step	Proprietary and De Facto Standards			
	Key Elements of the Standards Development Process			
	Accredited Standards Development Processes			
	Forums, Consortia and De Facto Standards Development Processes			
	National, Regional, and International Standards			
	Voluntary vs. Mandatory Standards			
	Conclusion: Mastery Exercise			

What are Standards?

LEARNING OBJECTIVES

At the completion of this section, the student will understand:

- The definition of standards
- The different types of standards
- How standards are developed and codified
- The relationship between voluntary and mandatory standards



What are Standards?



STANDARDS DEFINED

In the practice of engineering and technology, the development of technical standards is fundamental to the delivery of products and services to meet design, manufacturing, market, application and other needs and requirements.

All products and services available in the marketplace are assembled/offered based on documented designs and/or processes. This is the only way that the supplier and their customers can be sure that each unit will be a replica of the prototype and other units sold or to be sold. One way to describe this supply is to say that all products and services are created according to one or more standards. Informally, any agreement on how something is done, made, or used can be considered a standard. This definition is explored further in subsequent pages of this section.

The different types of standards we will discuss in this section are:

- Proprietary standards vs. consensus voluntary standards
- Accredited standards vs. forum and consortia standards
- De facto standards
- National, Regional, and International standards

PRACTICE

practice tips

Whenever one makes a local, long distance or international telephone call, many standards are exercised to accomplish the desired interconnection. Next time you make a telephone call, listen to the tones on the hand set: the dial tones (Multi-Frequency signaling, MF signals) and the ring-back signals. These are all realized in compliance with existing standards, and in fact the MF signals are in agreement with international standards, allowing one to send signals from a city in the USA to a city in Europe, for example.



EXAMPLE

In the United States, standards carrying the accreditation of the American National Standards Institute (ANSI) cover many familiar products ranging from safety glasses and shoes to how cellular telephones interconnect with wireless base stations, and hence to other telephones. Similar situations exist in other countries of the world, and, in some cases, common standards certified in a 'region' that includes two or more sovereign nations (e.g., in North America both the USA and Canada use many common electrical power and telephony standards.) When many nations/regions of the world agree on a common standard, it is referred to as an international standard. Many examples of the latter type exist for telephony and other subjects.



What are Standards?



MASTERY EXERCISE

Click the box to check the best response to each question.

1. Non-proprietary voluntary standards are codified by _____.
 - a. applying learned skills on work assignments
 - b. individual product suppliers internal processes
 - c. governmental regulatory agencies
 - d. developing a consensus agreement in an open process
 - e. developing product specifications for a new product

2. Proprietary standards are codified by _____.
 - a. not-for-profit oversight organizations
 - b. obtaining a formal agreement among individual companies
 - c. individual companies in a closed process
 - d. developing a consensus standard
 - e. governmental regulatory agencies

3. Regional standards are _____.
 - a. global standards
 - b. standards agreed to by most or all nations
 - c. specific to one national entity
 - d. standards agreed to by more than one national entity

SUBMIT ANSWERS FOR FEEDBACK



The content for the Mastery Exercise is broader in scope than the sample page indicates.

Glossary