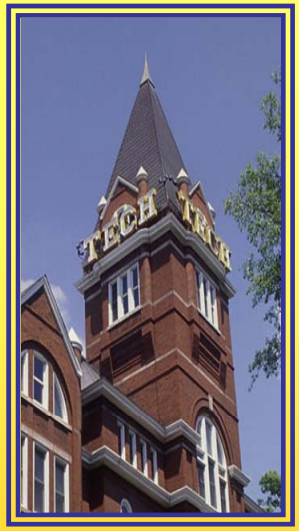
BENCHMARKING SAFEGUARDS & NONPROLIFERATION EDUCATION: A HEURISTIC APPROACH



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Nuclear Security Education: The Intersection of Policy, Science, and Technology

July 19-23, 2010

Overview

- **Program Overview**
- **Curricula in Safeguards**
- **Insider's Perspective**
- **Supply and Demand**
- **Preliminary Findings**

Preamble

- Georgia Tech's Nuclear Engineering Program is growing rapidly given increased domestic interest in nuclear power
- Seek to establish a **strong academic curriculum in nuclear safeguards and security** with particular emphasis on the **technical and policy challenges**
- Future activity address need for students to have an **interdisciplinary** understanding of the role of nonproliferation, safeguards and security in nuclear power expansion globally

Sampling of Courses as Basis for Safeguards Education

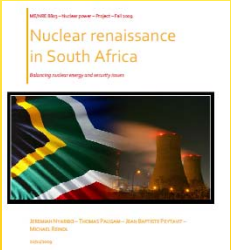
- ***NRE 3112/6757***
  Radiation Detection
- ***NRE 4204/6201***
  Reactor Physics
- ***NRE 4328***
  Radiation Sources & Applications
- ***NRE 4404/6755***
  Radiological Assessment & Waste Management
- ***NRE 4430***
  Nuclear Regulatory Requirements
- ***NRE 6501***
  Nuclear Fuel Cycle
- ***NRE 6502***
  Nuclear Materials

http://www.nre.gatech.edu

Newest Developments in Safeguards Education

- ***NRE 8803 – Fall 2009***

  NUCLEAR TECHNOLOGY, ENERGY & POLICY
  - **Georgia Tech – Lorraine Campus, Metz, France**
  - **Nuclear technology & policy for (non-nuclear) engineering students**
  - **Policy-relevant topics**
    - **EDF Cattenom Reactor Field Trip**
    - **Proliferation of Nuclear Weapons, Evolution of Safeguards & NPT**
    - **"Global Zero"**
    - **Nuclear Renaissance: Balancing Nuclear Energy and Security**



Newest Developments in Safeguards Education

- ***NRE 4803 – Spring 2010***

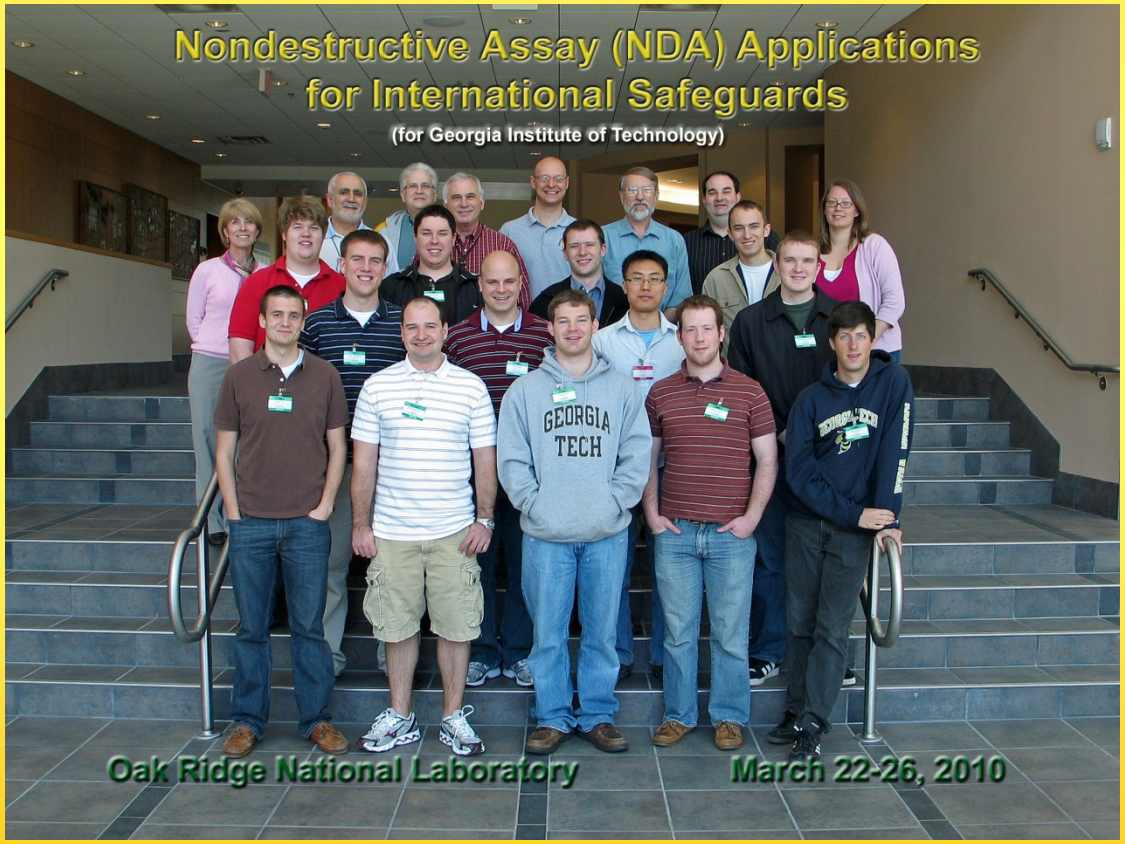
NUCLEAR SAFEGUARDS & SECURITY IN THE 21ST CENTURY

- 1. Fuel Cycle (with emphasis on material flow and quantities)
- 2. Future Directions for Nuclear Power
- 3. The Evolution of International Safeguards
- 4. Highly Enriched Uranium Fuel
- 5. Nuclear Proliferation (including some history)
- 6. Nuclear Energy: The International Dimension
- 7. Nuclear Power and the Weapons Threat – Links, Potential
- 8. Nuclear Weapons Basics (Brief Review of atomic bombs – very
  9. Nuclear Material Measurement Technologies
- 10. International Safeguards Inspection
- 11. Nuclear Weapons and Strategy
- 12. Safeguards for Plutonium Processing

Newest Developments in Safeguards Education

- ***NRE 4803 – Spring 2010***

ORNL Safeguards Laboratory Course



Next Step: Insider's Perspective

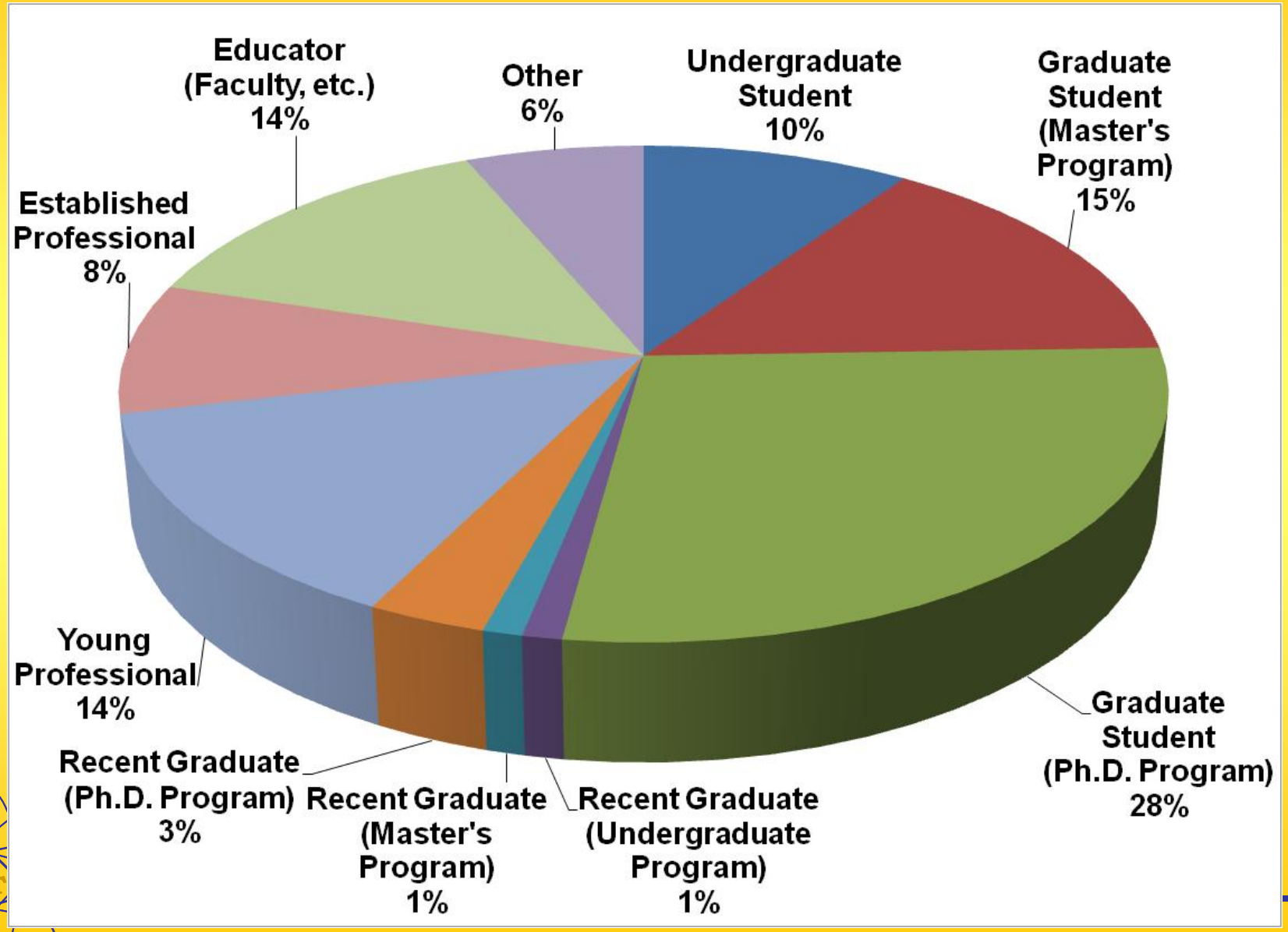
- Grand tour
  - **Sam Nunn Security Program**
  - **Public Policy & Nuclear Threats Program (PPNT)**
  - **Nuclear Nonproliferation, Safeguards & Security (NNSS)**
  - **Summer Intensive Course on Nuclear Safeguards Policy (MIIS)**
  - **University of Georgia**
  - **International Summer Symposium on Science and World Affairs (Carnegie)**

- **Top-down vs. bottom-up**

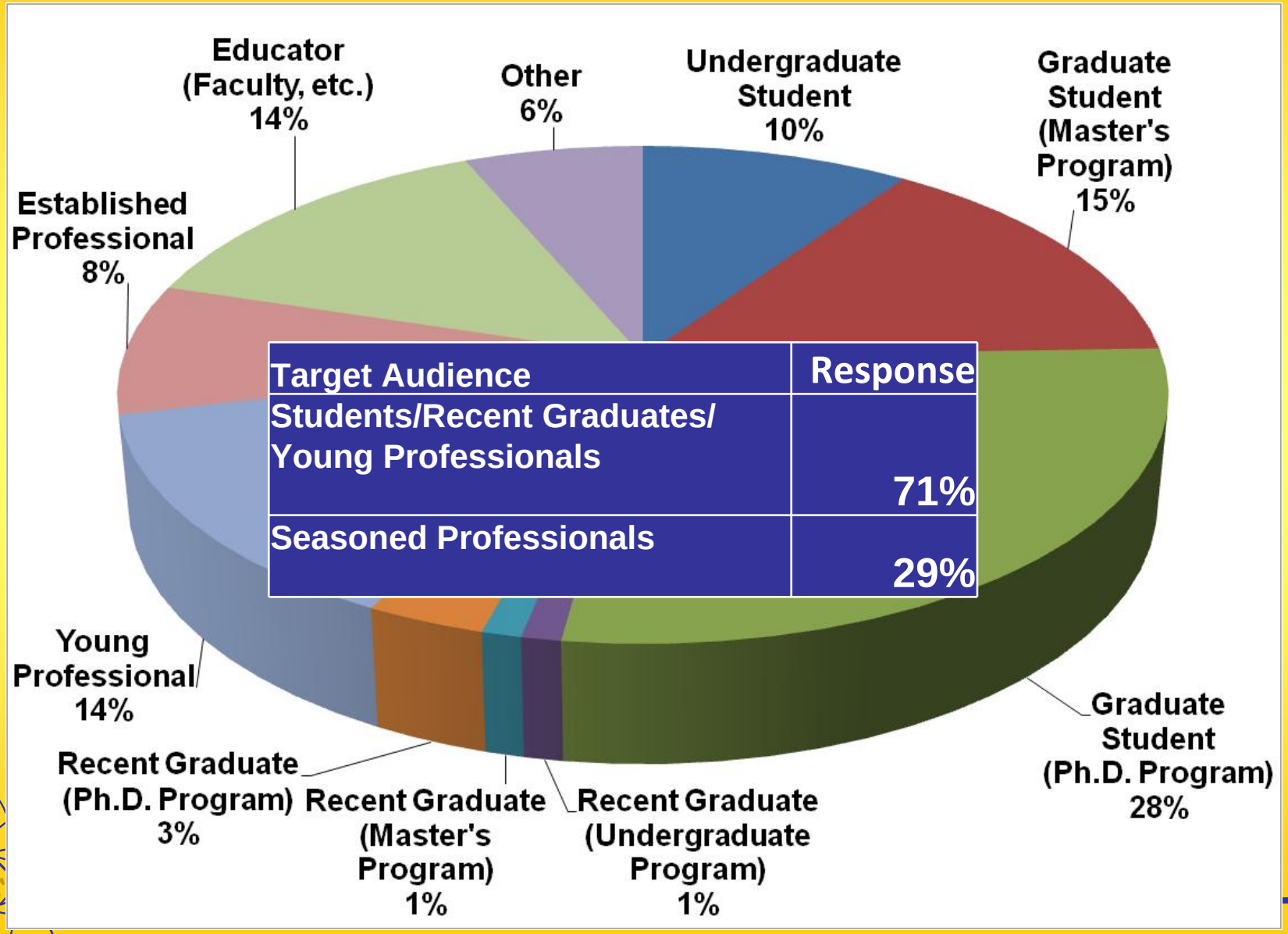
Supply & Demand: Safeguards & Nonproliferation Education Survey

- Target: *Students/Recent Graduates/Young Professionals*
- Running tally: *95 (94)*
- 32 Questions
  1) **Respondent Background**
  2) **Safeguards & Nonproliferation Background**
  3) **Assessing Safeguards/Nonproliferation Program Structures**
  4) **Program Technical Curricula**
  5) **Instruction and Audience**
  6) **Pedagogical Approaches**
  7) **Demographics**

Part 1: Respondent Background

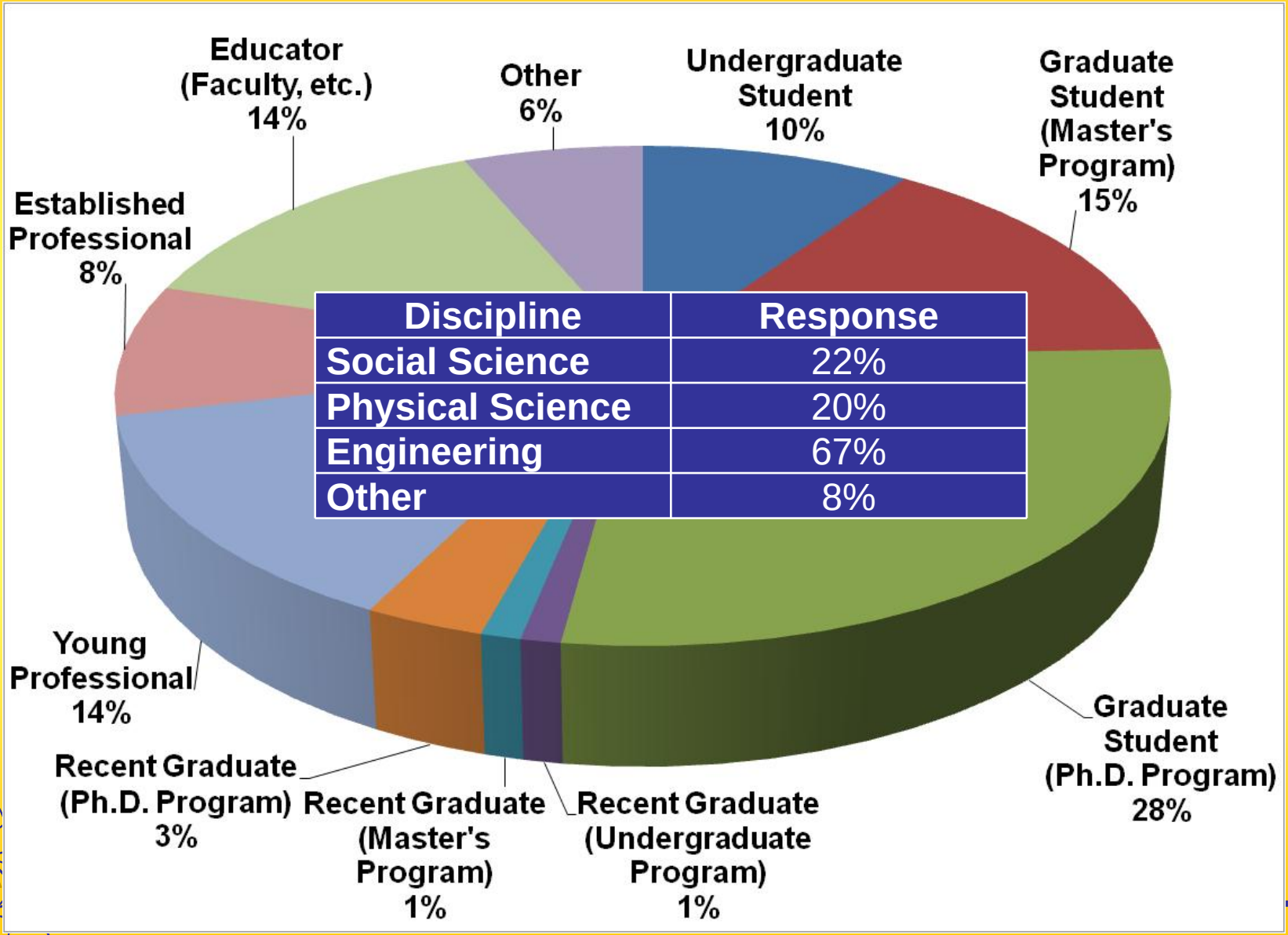


Part 1: Respondent Background



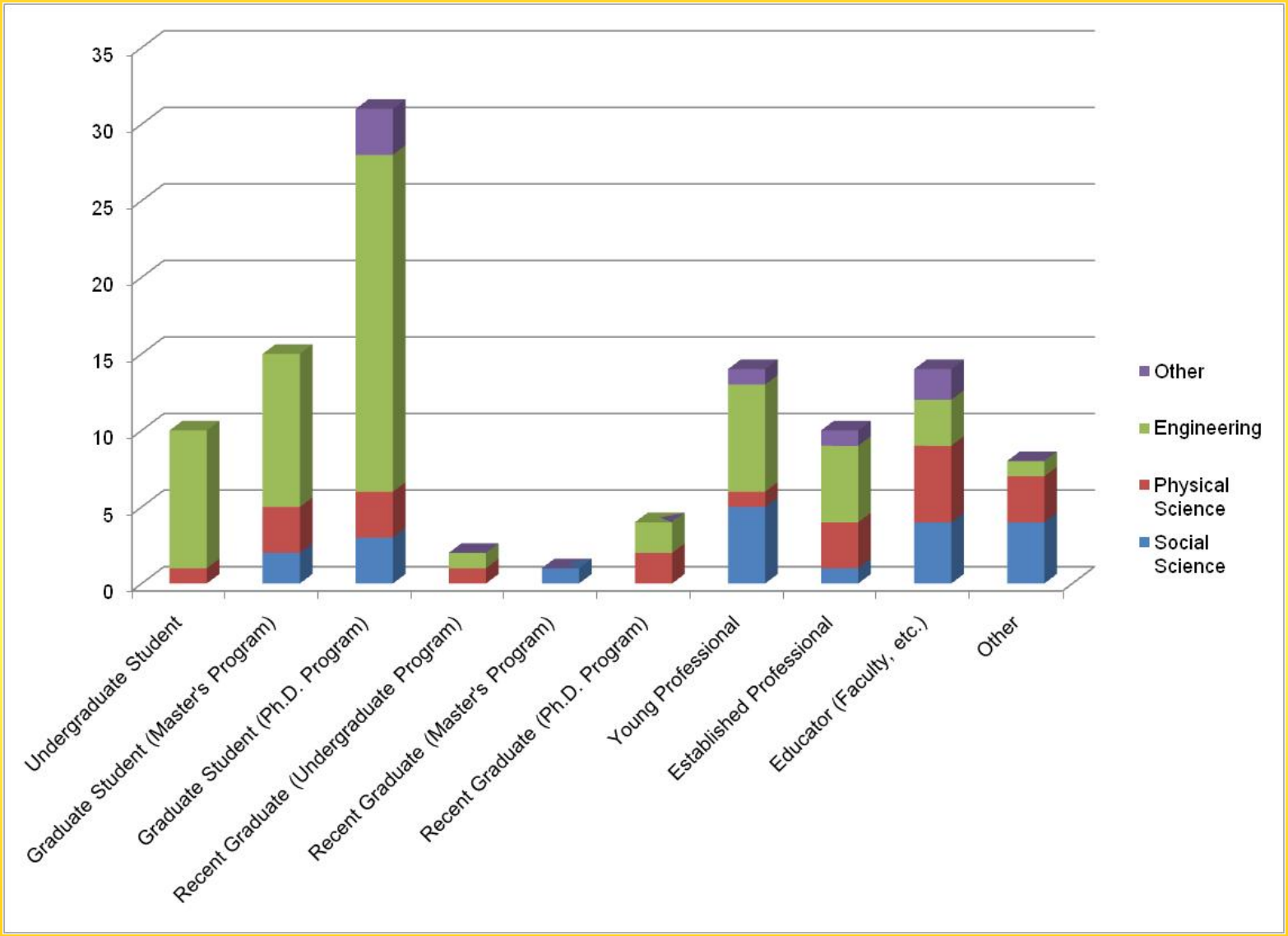
Target Audience	Response
Students/Recent Graduates/ Young Professionals	71%
Seasoned Professionals	29%

Part 1: Respondent Background



Discipline	Response
Social Science	22%
Physical Science	20%
Engineering	67%
Other	8%

Part 1: Respondent Background (2)



Part 1: Respondent Background (3)

Part 2: Safeguards & Nonproliferation Background

Which option(s) best describe your exposure to education in nuclear safeguards/ nonproliferation?

Check all that apply.

Exposure	Response
Minimal interest	7%
Personal interest/informal investigation	33%
Formal short course(s) (< 1 week)	16%
Formal intense course(s) ~ 1 month	12%
Semester-long university course	24%
More than one semester-long course	21%
Internship/Short-term Employment	34%
Career/Employment	34%
Other	5%

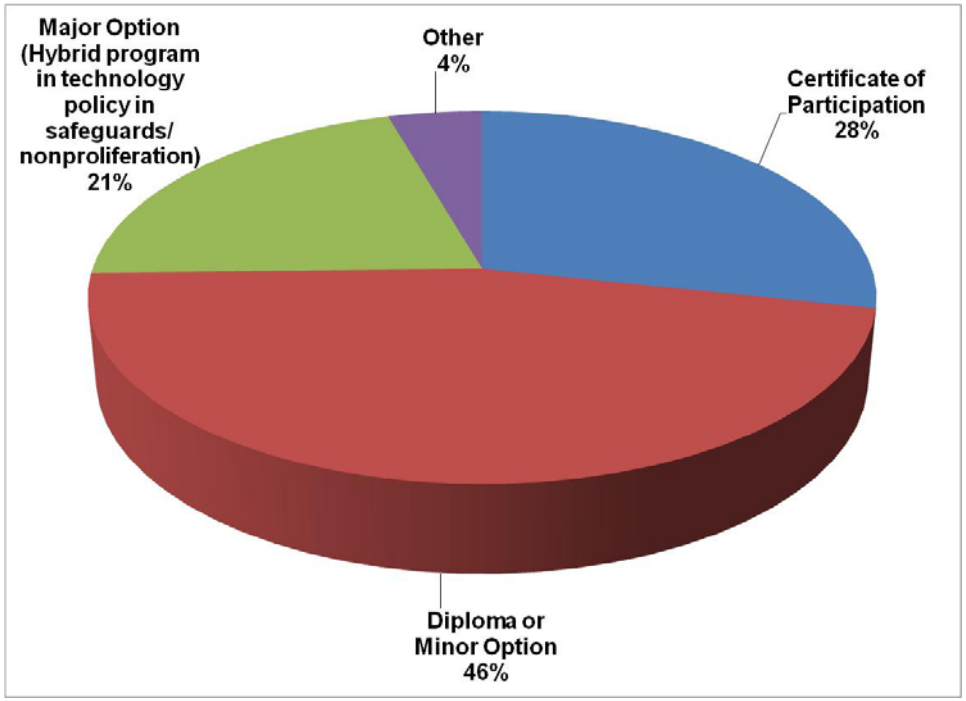
Part 2: Safeguards & Nonproliferation Background (2)

Source of safeguards/non-proliferation education.

	Response
University (normal course)	44%
National Laboratory	42%
Other	16%
University-sponsored program	14%
Non-Governmental Organization	7%
International Organization (Specify)	5%
N/A	12%

Part 3: Assessing Program Structures

Desirable goal for a safeguards/ nonproliferation university/ education program.

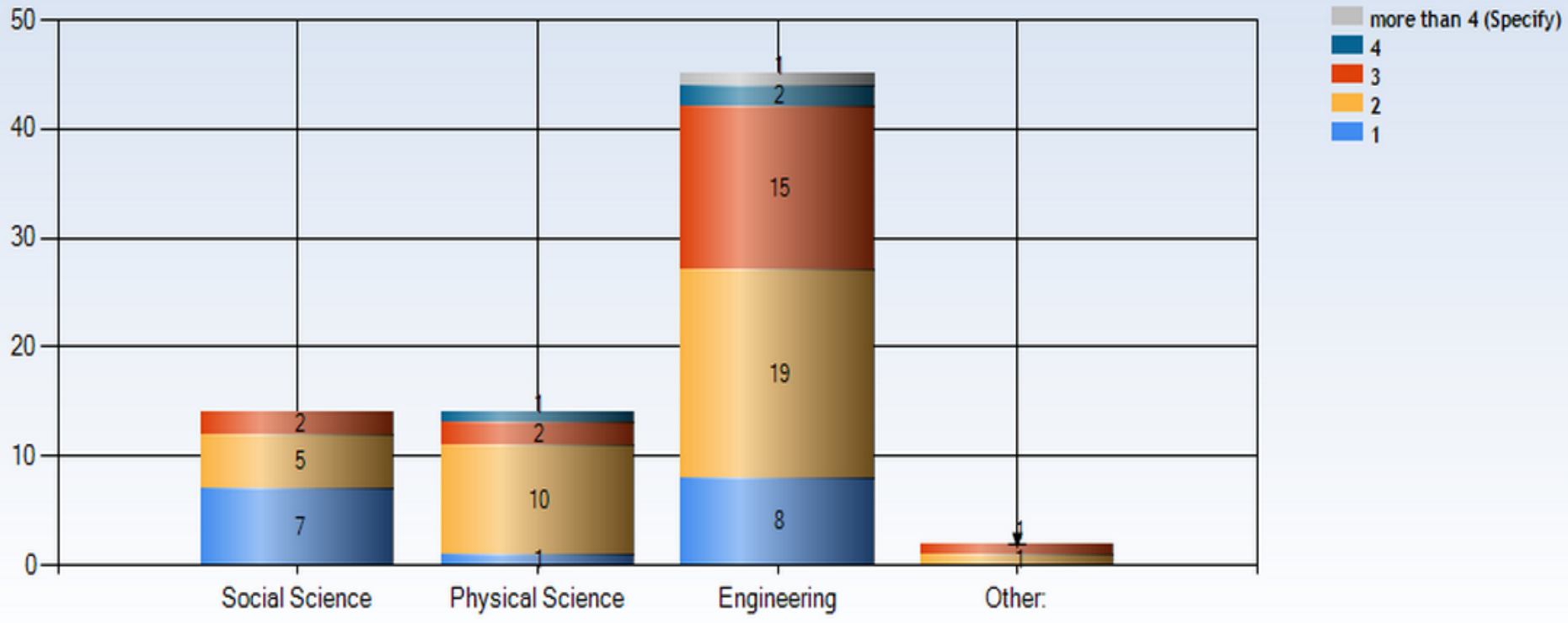


Number of courses that should constitute a cohesive "minor" or "diploma" in the field of safeguards and nonproliferation.

Number of Courses	Response
1	0%
2	1%
3	30%
4	54%
More than 4	15%

Part 3: Assessing Program Structures (2)

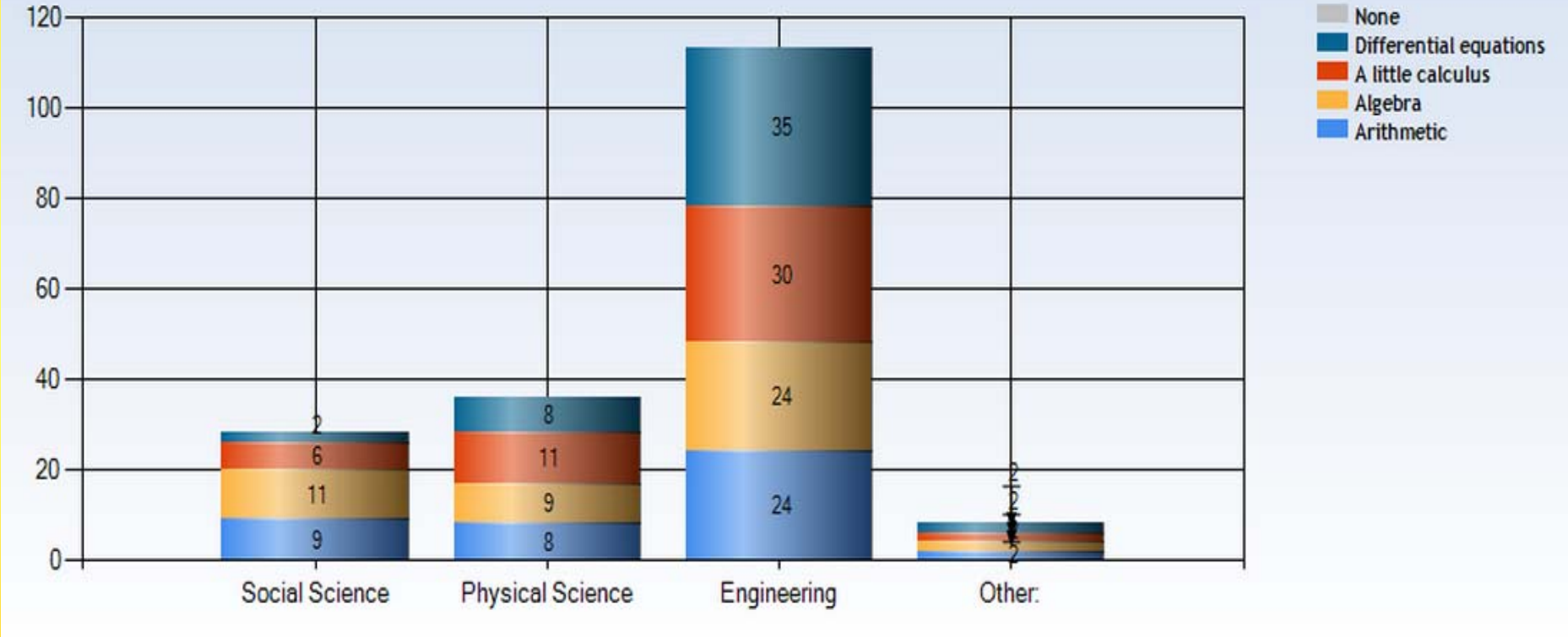
How many of these courses should have a technical/mathematical basis?



Part 3: Assessing Program Structures (3)

What level of mathematics would you feel comfortable with in a safeguards/nonproliferation course?

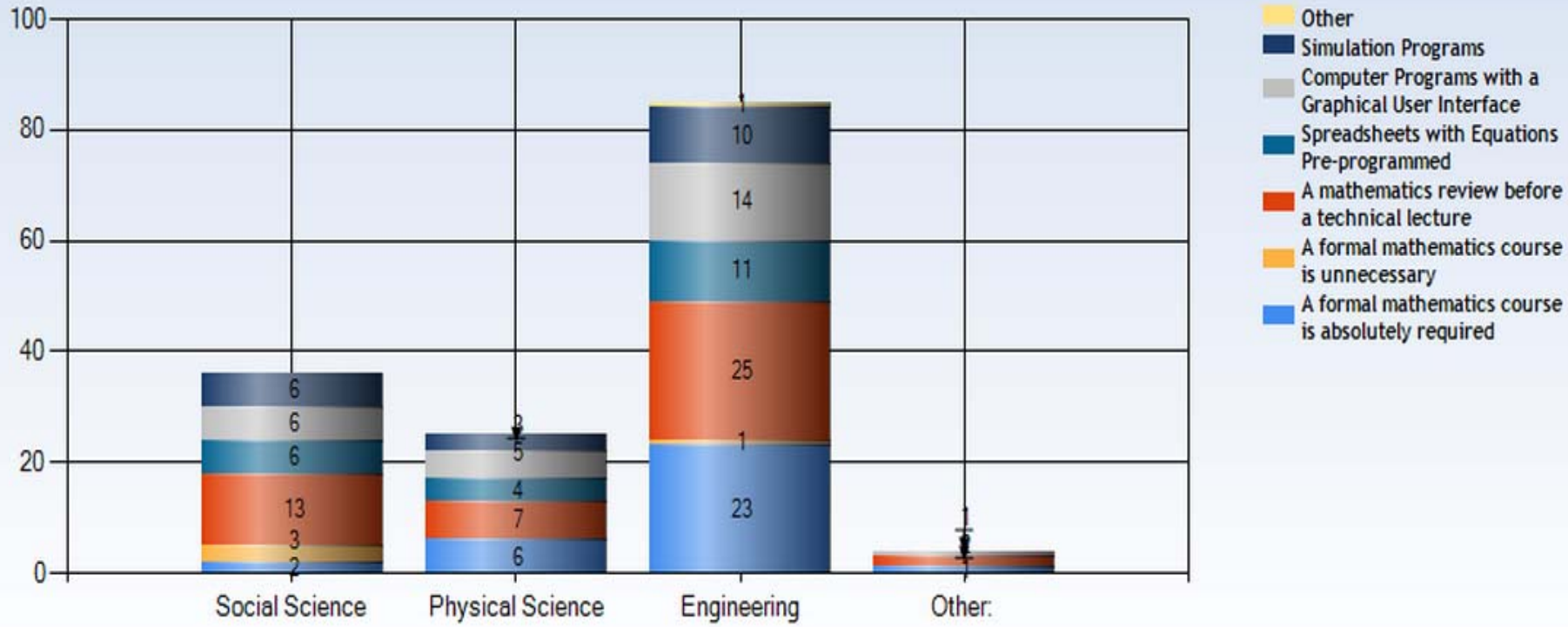
Check all that apply.



Part 3: Assessing Program Structures (4)

Based on your experience, what tools do you think would remedy a lack of a mathematical/technical background?

***Check all that apply*.**



Part 4: Program Technical Curricula

14. Which courses do you believe should be offered in a safeguards/nonproliferation education program as part of this certificate/diploma program? Please assess which you feel are most important in such a program.

RowChoice	Not Important	Less Important	Neither Important nor Unimportant	Somewhat Important	Very Important	N/A
1. Introduction to Nuclear Engineering	4	9	11	16	25	1
2. Technical Aspects of Safeguards	0	0	4	20	41	1
3. Material Protection, Control & Accounting	0	0	2	26	36	2
4. Statistics & Probabilistic Risk Assessment	1	5	12	31	15	2
5. Reactor Physics	3	14	16	27	5	1
6. Fuel Cycle	0	1	4	26	34	1
7. Economics of Nuclear Energy	3	19	18	19	6	1
8. History of Nuclear Weapons and Arms Control	0	5	10	26	24	1
9. Non-State Issues in Nuclear Security and	2	2	13	24	24	1
10. Proliferation (Terrorism, Trafficking)	1	1	4	23	36	1
11. State-based Issues in Nuclear Proliferation (Regional, Disarmament)	1	1	5	25	33	1
12. Special Topics Project/Directed Studies	2	8	18	17	19	2
13. Other (Specify)	9	0	8	1	0	48

21. How important do you believe each of the following technical topics in a nucle safeguards/nonproliferation course?

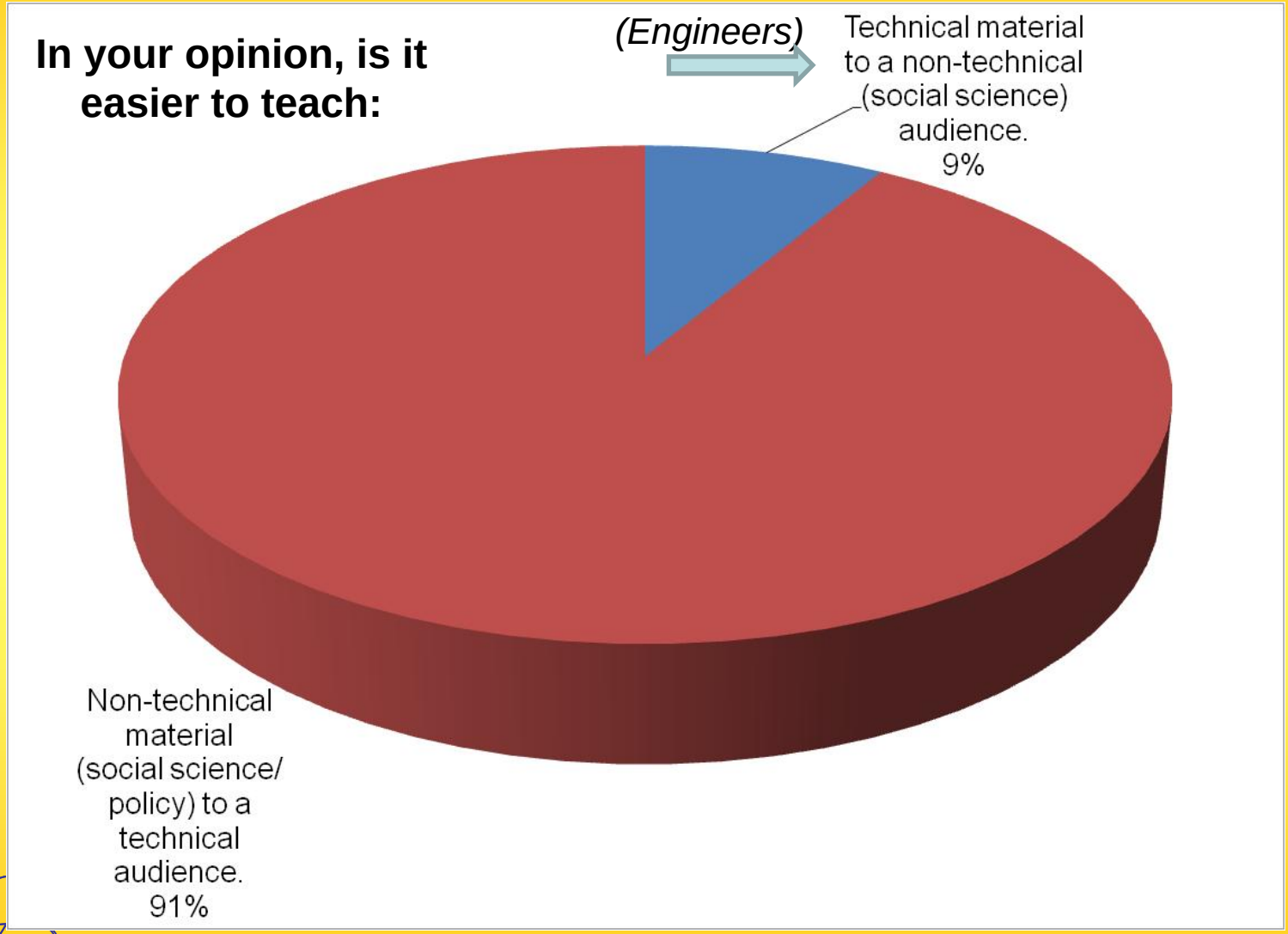
Row Choice	Not Important At All	Less Importan	Neither Important Nor Unimportant	Somewhat Important	Very Importan
1. Radioactive Decay	0	4	6	22	24
2. Nuclear Fission	0	2	2	19	33
3. Nuclear Fusion	8	12	15	16	5
4. Radiation Exposure Effects	0	5	5	28	18
5. Chain Reactions	0	1	8	28	19
6. Nuclear Weapons Basics	0	2	2	24	28
7. Types of Nuclear Reactors	0	7	6	17	26
8. New Reactor Design	2	8	13	22	11
9. Proliferation-Resistant Reactors	0	4	9	23	20
10. Fuel Cycle (General)	0	1	3	20	32
11. Fuel Cycle (esp. Enrichment/Reprocessing)	0	0	3	12	41
12. Nuclear Waste	0	4	3	31	18
13. Nuclear Reactor Safety/Accidents	1	8	15	24	8
14. Material Accountancy	0	1	2	21	32
15. Containment and Surveillance	0	1	9	21	25
16. Physical Protection	0	2	5	29	20
17. Safeguards Instrumentation (Radiation Detectors)	0	0	2	26	28
18. Safeguards in Enrichment/Reprocessing Facilities	0	1	2	17	36
19. Design Information Verification (DIV)	0	4	13	24	15

Part 4: Program Technical Curricula (2)

22. What were the modes of instruction for each of the topics in safeguards/nonproliferation courses or programs you have already taken? Check all that apply.

RowChoice	Traditional Lecture	Power Point	Problem Solving (Numerical)	Demo	Simulation	Field Trip	Hands On Training	Interactive Discussion	Group Project	Role Play	Other	N/A
1. Radioactive Decay	31	27	22	7	8	6	13	4	6	0	1	15
2. Nuclear Fission	36	31	21	5	10	6	9	5	4	0	1	8
3. Nuclear Fusion	28	25	9	1	4	2	0	2	1	1	1	15
4. Radiation Exposure Effects	33	28	15	0	2	2	6	5	4	0	1	12
5. Chain Reactions	33	26	14	4	7	1	6	6	4	0	1	11
6. Nuclear Weapons Basics	29	29	9	1	5	2	1	10	3	0	2	14
7. Types of Nuclear Reactors	30	31	9	3	6	10	3	7	5	0	2	12
8. New Reactor Design	24	27	8	0	4	1	0	5	5	0	2	18
9. Proliferation-Resistant Reactors	27	26	6	0	4	1	1	7	4	0	2	16
10. Fuel Cycle (General)	33	33	15	2	6	10	2	5	7	1	1	9
11. Fuel Cycle (esp. Enrichment/Reprocessing)	32	33	15	2	5	9	3	9	6	1	1	10
12. Nuclear Waste	32	33	10	0	2	10	1	6	3	1	1	11
13. Nuclear Reactor Safety/Accidents	30	29	9	3	4	1	0	5	2	1	2	16
14. Material Accountancy	25	28	12	4	5	8	13	8	5	2	1	17
15. Containment and Surveillance	26	28	5	2	5	11	13	9	6	3	1	14
16. Physical Protection	26	25	8	3	6	9	11	8	7	2	2	13
17. Safeguards Instrumentation (Radiation Detectors)	29	29	16	15	14	20	23	8	9	1	1	12
18. Safeguards in Enrichment/Reprocessing Facilities	30	29	10	0	3	10	8	9	8	2	1	15
19. Design Information Verification (DIV)	22	23	5	2	5	4	10	7	8	4	1	21

Part 6: Pedagogical Approaches



Preliminary Findings

- **Sentiments**
  - **Social Science:**
    - Technical material is still a challenge
  - **Technical:**
    - Strategic posture of nuclear weapons
  - **Both:**
    - Development of standard reference material
      - Text
      - Simulations
    - Hands-on experience
    - Interdisciplinary problem-based learning (deliverable)

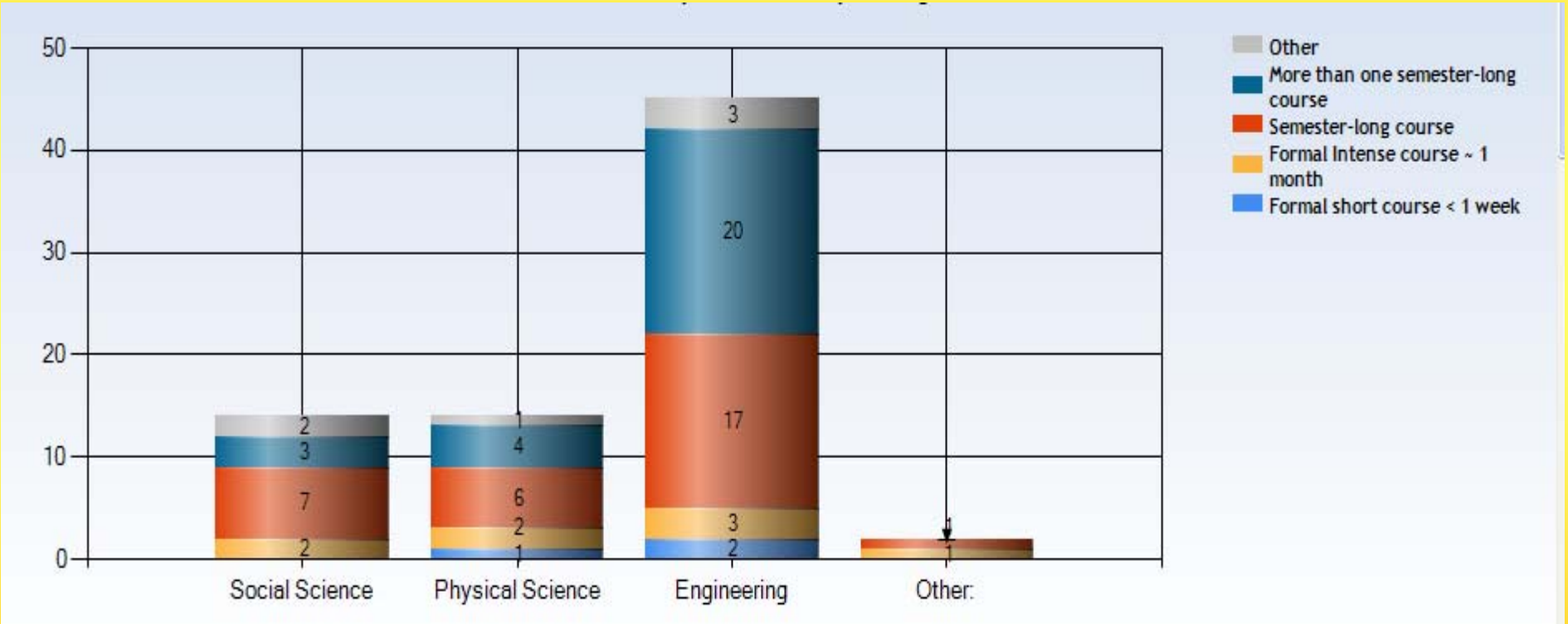
Preliminary Findings (2)

- **Program Structures:**
  - Too many cooks…
    - Academics vs. seasoned experience
  - Accessibility of opportunities
    - Follow-up to programs

Preliminary Findings (3)

- **Program Structures**

What do you feel is the ideal length for a safeguards/nonproliferation course?



Preliminary Findings (4)

- **Program Structures**

What would increase the exposure or ease of accessibility of safeguards education? (Select up to three options)

	Response
Social networking sites	1%
Other	1%
Blog	2%
A comprehensive reading list	8%
Courses offered by another educational institution, but accessible to you	11%
Internships	13%
Scholarship/Fellowship	14%
Conferences	15%
Summer course programs	15%
Courses offered by your educational institution	20%

Comments
• An accredited, non-sensitive, set of **lab sponsored on-line course work** would be very helpful.
• Giving out **money** to pay for school is the most effective way (by far) to encourage students to pursue nonproliferation/safeguards education.

Acknowledgements

- Special thanks to Michaela Eddy for assisting in survey distribution

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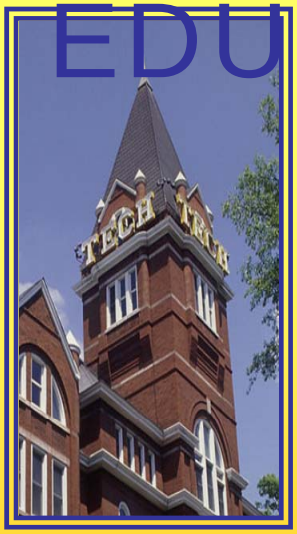

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