Evaluating the Impact of Cyber Security Science: A Mixed Method Approach

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Overview

Goals of Program Evaluation

SoS Evaluation Strategy

Illustrative data and metrics under development

- Community/Industry Impact
- Scientific Output
- Faculty Assessment
- SoS Bibliometrics
- Methodology feedback
- Student & Alumni Assessment

What is Program Evaluation and Why are we doing it?

Program evaluation is a systematic process of information gathering and analysis to assess the **implementation and outcomes** of a program.

Purposes for Program Evaluation

- Document program **accomplishments and impact**
- Demonstrate program **effectiveness** to funders and outside stakeholders
- **Improve and refine** program implementation and effectiveness
- Document program **development and activities** to support program dissemination to other sites

Evaluating the Science of Security Lablet @ NCSU

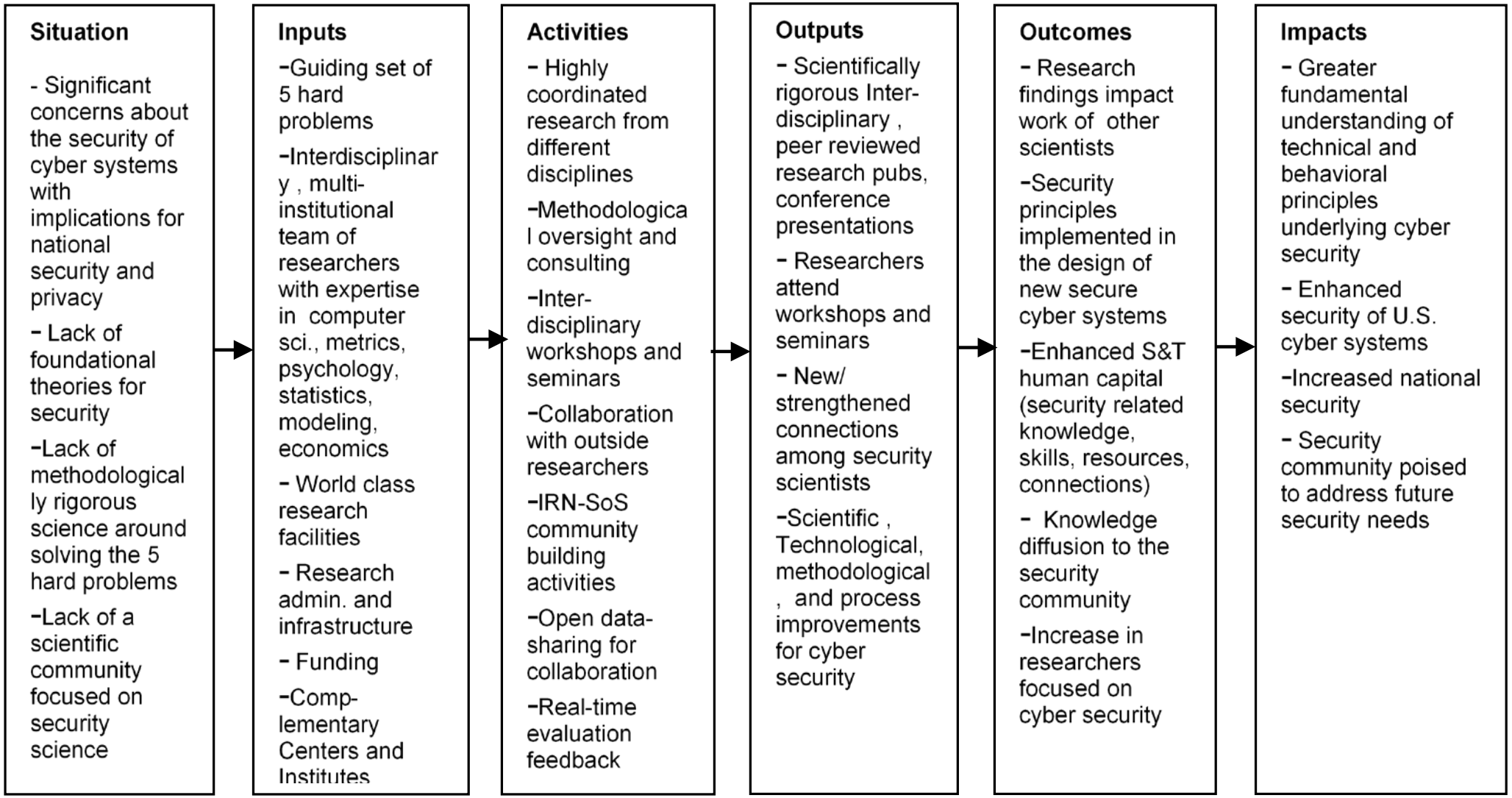
Science of Security Lablet Program

Goals:

- Conduct research to address a defined set of cyber-security **hard problems**
- Identify, develop, and adopt more rigorous **scientific methodologies** to address cyber-security concerns
- Develop a **community of practice** focused on identifying foundational principles and theories

How do you evaluate a program with multiple, diffused, long range objectives AND time limited funding?

SoSL Logic Model



Stakeholders

-Scientific community

-Security community

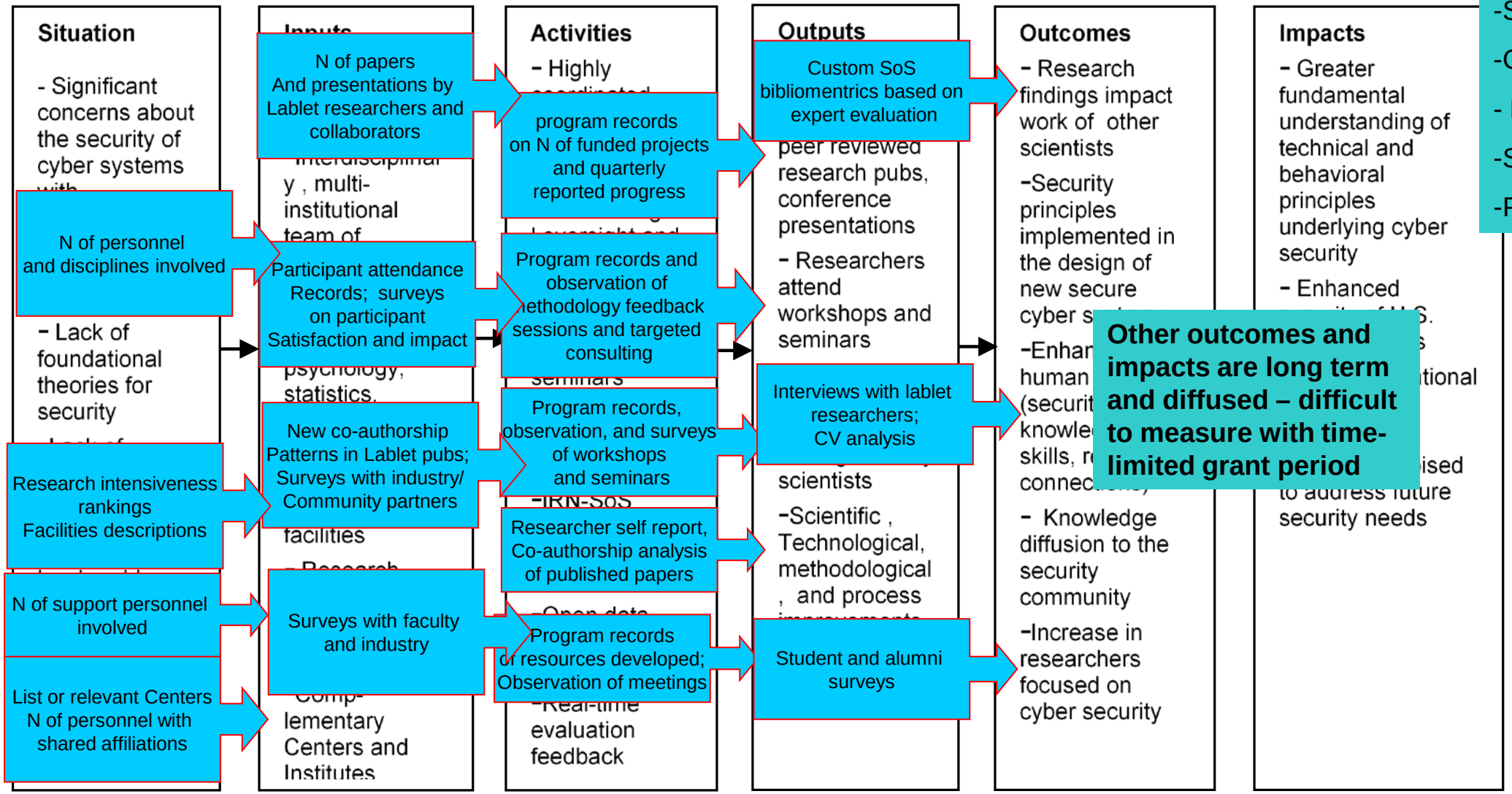
-Government agencies

- Project Scientists

-Students

-Public

SoSL Logic Model



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Other outcomes and impacts are long term and diffused – difficult to measure with time-limited grant period

Some Illustrative Examples

2014-2016 DATA

Community of Practice

Community Meetings

NCSU held 2 community meetings
- October 2014 and 2015

Attended by faculty & students from partner universities, government, and industry

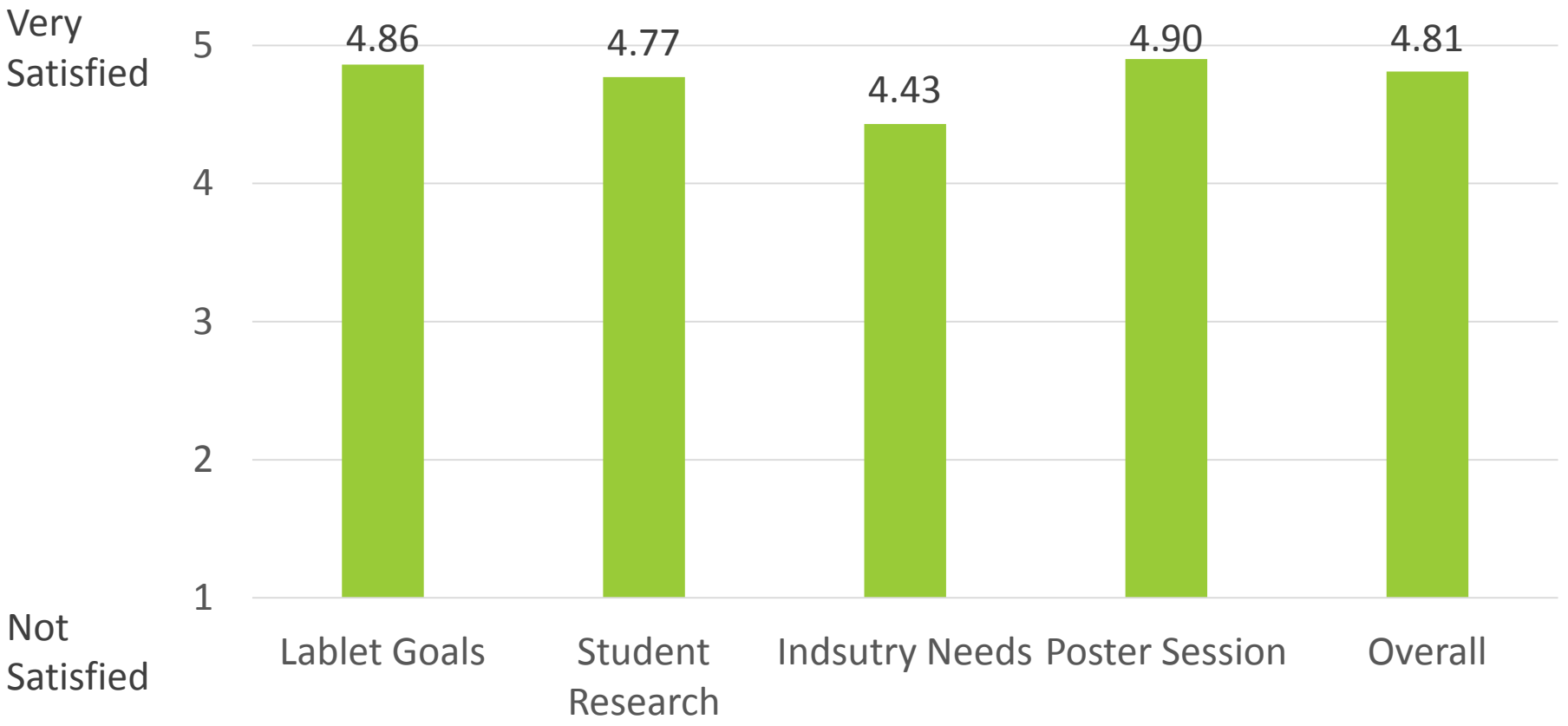
Focused on fostering collaboration
- Students present their research with emphasis on potential impact and collaboration opportunities
- Industry present their security needs and concerns with focus on potential of research to address these needs and concerns

2015 Community Attendees: N = 28
- industry (68%)
- government (21%)
- university (11%)

Response rate = 86%

Meeting Agenda
- Lablet program overview
- 14 Lablet research presentations
- 4 Industry presentations
- Networking lunch and poster session

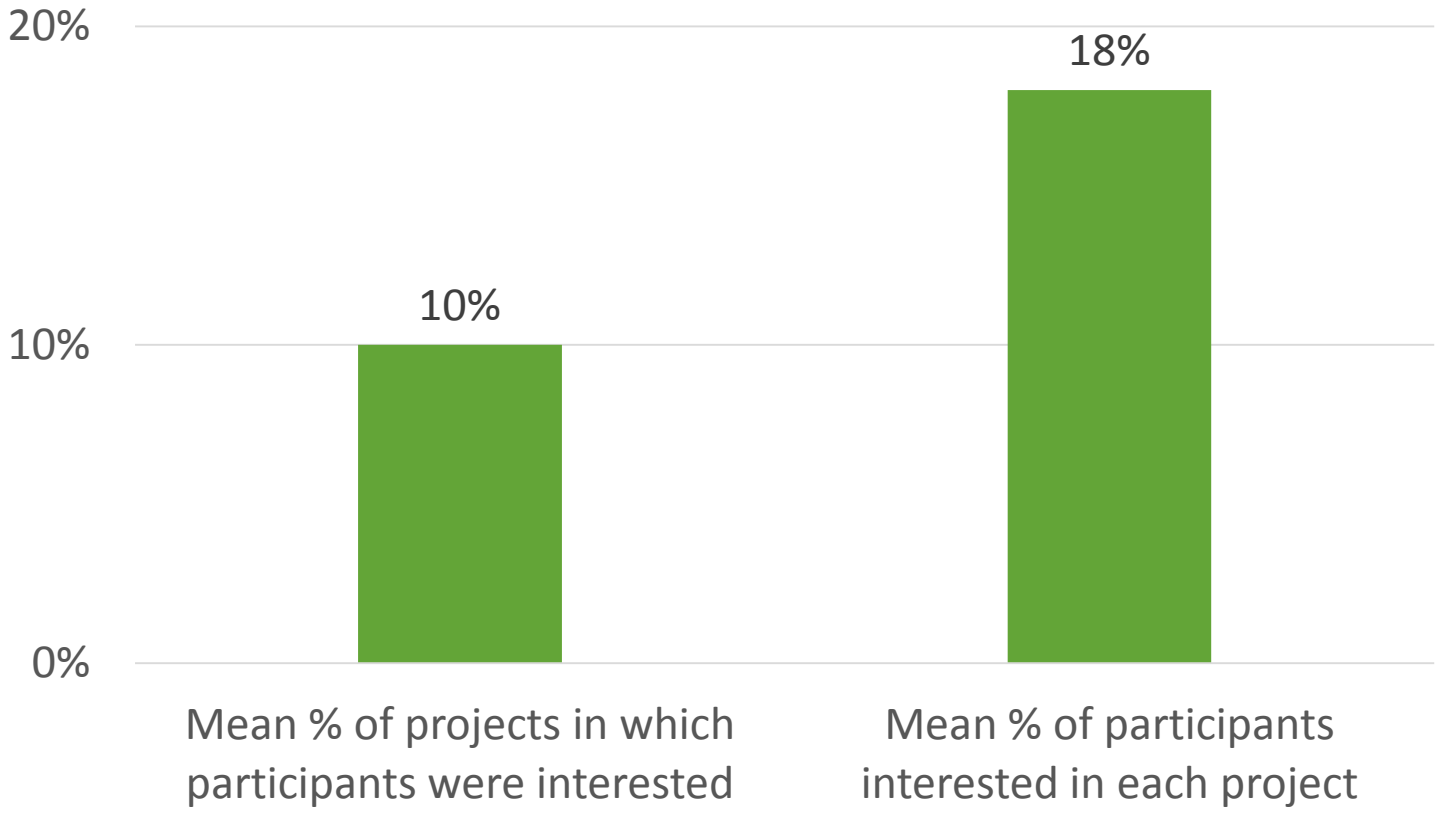
Satisfaction with Meeting Content and Delivery



"Loved the 20/20 presentations. Excellent use of my time today."

"…good focus in the presentations …"

Community Interest in Lablet Research

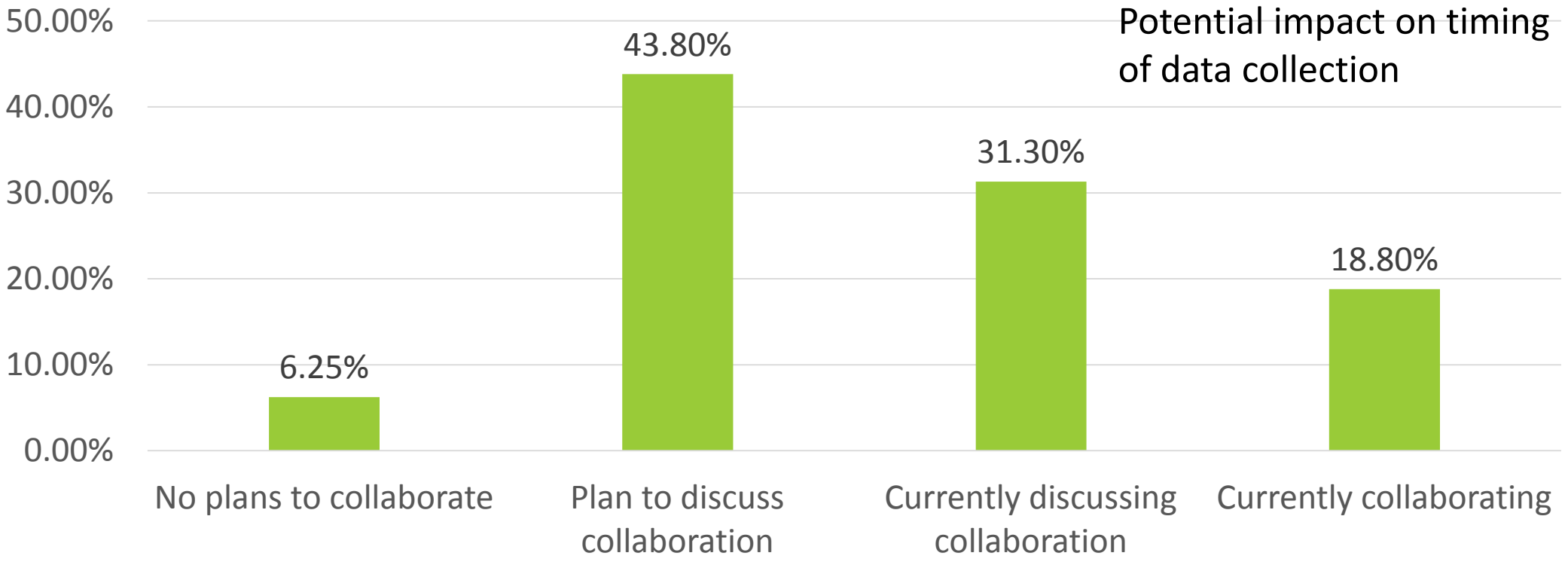


<u>Broad Community support for Lablet research portfolio</u>: 100% of research projects presented were of interest to community respondent

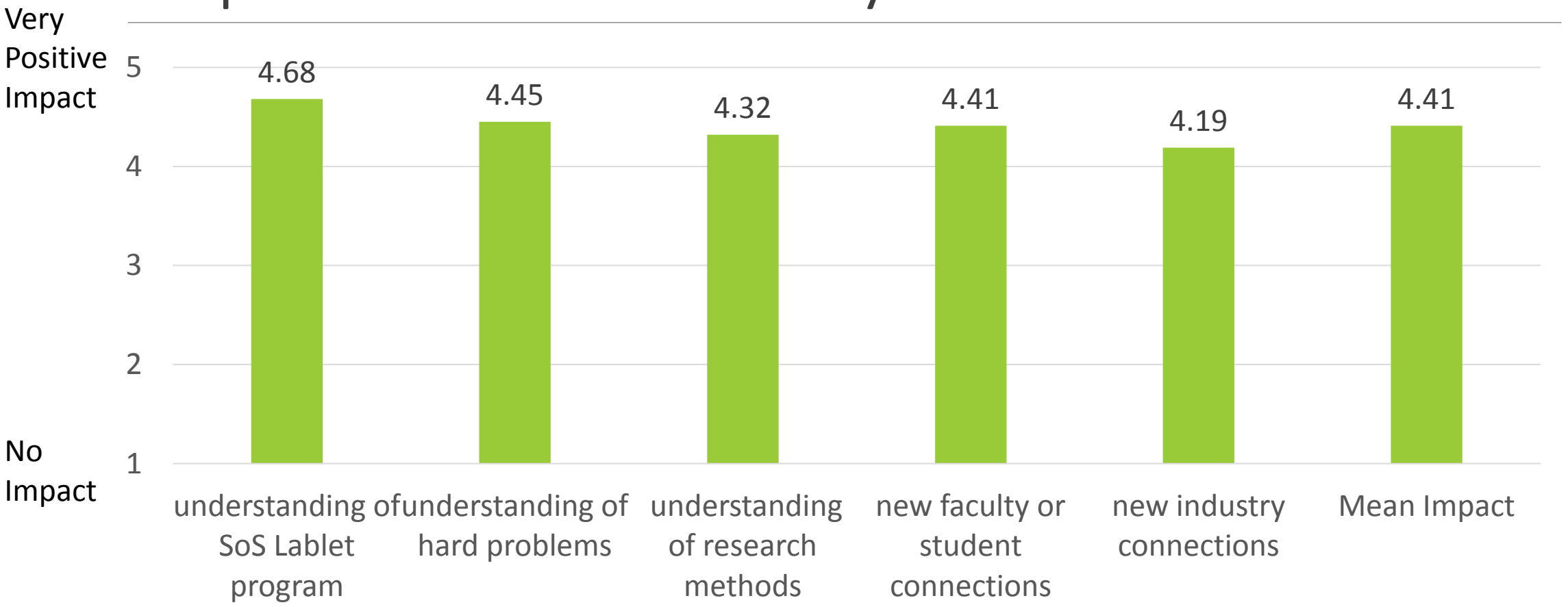
"There are many potential domains that could be explored through collaboration…"

Community Collaboration Intentions

94% intend to collaborate
Potential impact on timing of data collection



Impact on Community



Scientific Outcomes

SoS Bibliometrics

Output

- 86 Publications & Presentations since 2014 Q2 – start of current grant

Measuring Collaboration via Co-authorship

- 124 unique authors
- 36 Unique Institutions
  - All 4 lablets
  - 4 industry firms
  - 7 Int’l universities

SoS Bibliometrics

Proxy Impact Measures Under Development

- SoS Relevant Publication venues
  - Lablets published in these venues, Lablet members nominated these venues, SoS-VO library
  - 94 Venues Identified so far…
- **Selectivity**: Mean acceptance rate 2014-2016 for SoS relevant venues, % of NCSU papers published/presented in highly selective venues
- **Scale**: Mean N of accepted papers 2014-2016 for SoS relevant venues, % of NCSU papers published/presented in large scale venues
- **Expert Assessment**: Tiered expert rankings of SoS relevant venues, % of NCSU papers published/presented in each tier
  - NSA Best SoS paper expert panelists
  - Lablet nominated panelists

Please provide your input: tinyurl.com/sospubs

Faculty Semi-structured Interviews

- Need to understand the impact of scientific outcomes resulting from Lablet research
- Faculty are most knowledgeable about their own work – best able to describe findings and potential impact
  - Builds on PI impact summaries
- Document SoS/CS specific outputs
  - Prototypes, Free tools, Open source tools, Websites, Software copyrights, Licensing agreements, Github, source forge or other open source repository contributions, Open source data
- Can help us identify potential beneficiaries for follow-up
- Help identify networking and dissemination activities not otherwise evident in CV analysis
- Interview guides underdevelopment

Sample Questions

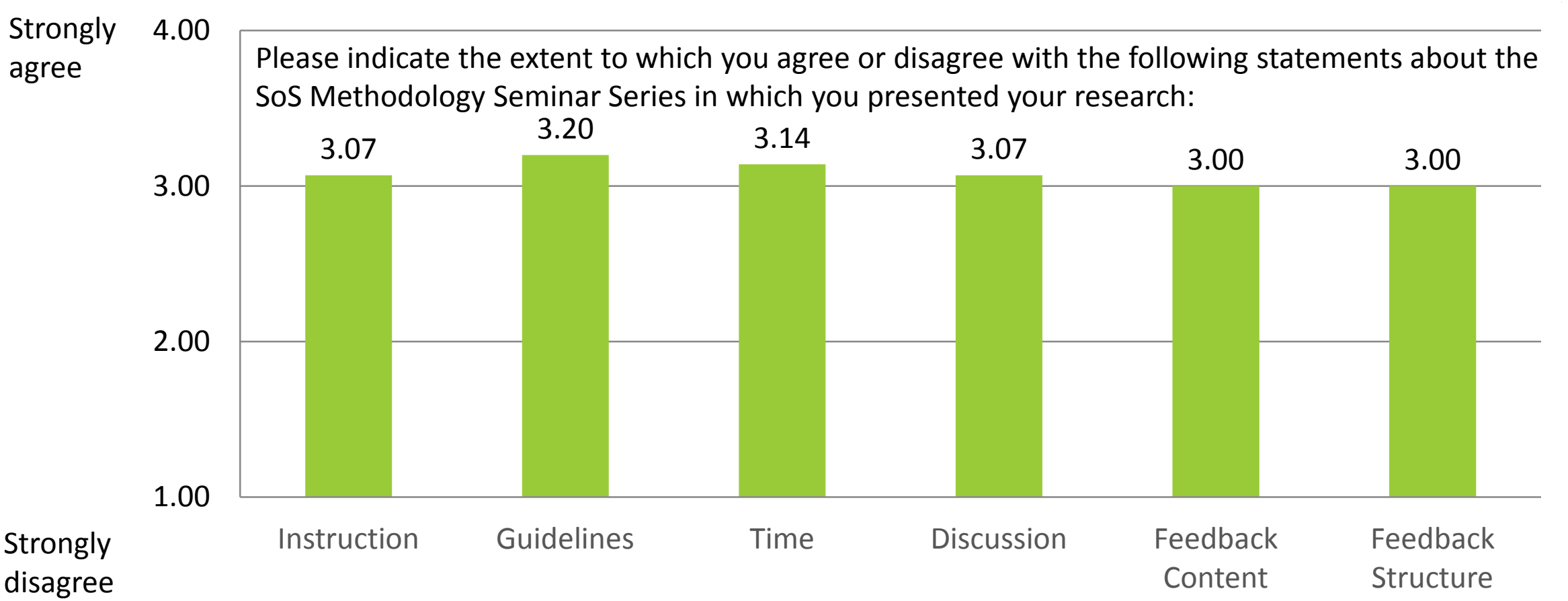
- *Scientific Contribution*
  - One of the main objectives of the NSA SoS Lablet initiative is to conduct research on cyber security that will fill knowledge and research gaps related to the five hard problems, and that has the potential in the long run to improve national security and privacy.
  - In your opinion, has your project produced any significant scientific and/or technical results that fill knowledge or research gaps?
    - **If yes,** in language an educated layperson could understand, could you explain what these achievements are and how they might ultimately affect the field of cybersecurity? National security and privacy?
    - Have you and/or your students won any awards or received any external recognition for your research?

Sample Questions

- *Dissemination Activities & Community of Practice*
  - The NSA SoS initiative is interested in the dissemination of new methodologies and research findings as a means to grow the SoS community of practice. I want to ask you about some ways you may have disseminated your work, other than though journal and conference papers and presentations.
  - Have you made visits to the labs of scientists at other universities, firms or public labs to discuss your SoS work?
    - If yes, how many individuals have you visited over the last 3 years?
  - Have scientists from other universities, firms or public labs visited you lab to discuss your SoS work?
    - If yes, how many individuals visited your lab over the last 3 years?
  - Have you begun collaborating with any of the individuals involved in these visits? How many? Please describe.

Impacts for Students

Methodology Feedback Seminars



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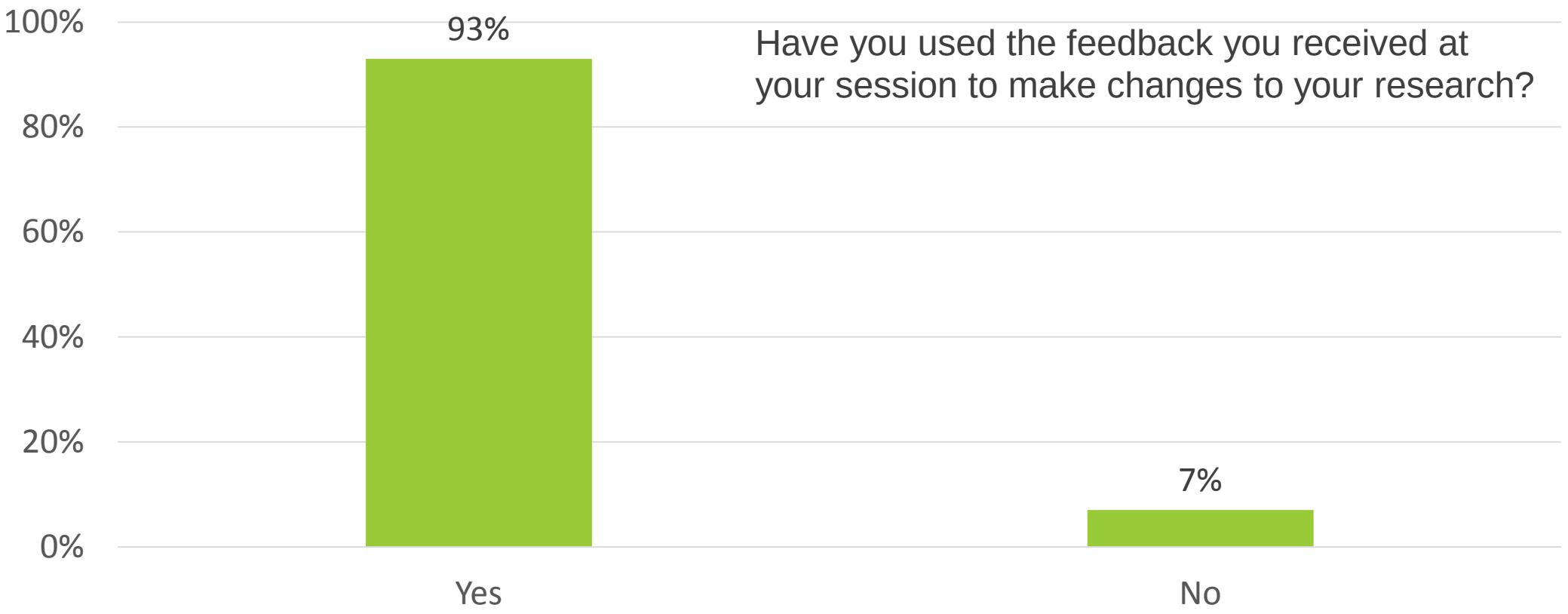

Methodology Feedback Seminars

What changes did you make?

- Study Background, Justification, Motivation
  - I have changed my documentation. For example, I needed to add more contents in introduction section for readers' understanding.
  - The feedback provides a more interesting and practical way to introduce the topic which arouses the interest of readers.
  - Layout of the introduction and the motivation.
  - Most of the feedback are related to clarity and presentation formats.
- Methodology
  - Also, I added more fine-grained methodology.
  - I've become more attuned to research procedures and more aware of the importance of planning before beginning research.
  - Make the goal, hypotheses, and the experiment more clear
  - Structure of the research
  - The presentation was also modified to identify measures to overcome the limitations outlined.
- Results & Analysis
  - The feedback helped improve structure the paper and presentation to be more result-oriented.

Student Outcomes

23 Lablet funded students graduated

- 19 PhDs
  - 7 taking industry jobs
  - 5 faculty
  - 3 postdocs
  - 4 job searching
- 4 MS
  - 3 taking industry jobs
  - 1 continuing for PhD

Student & Alumni Impact Surveys Under Development

Student & Alumni Surveys

Assessment of training participation

- Training Modalities: Courses, multidisciplinary experiences, research activity, internships, seminars, meetings and workshops
- Training Topics: Each of the hard problems, scientific methodology
- Collaboration Opportunities: Participation: Partner universities, Lablets, Industry, Government

Satisfaction with and Perceived benefits of these training modalities, topics, & collaboration

Impact for **students**:

- Career goals, publication and presentation opportunities, presentation skills, scientific skills, security knowledge, team performance, understanding security industry needs, understanding of national security needs, career preparation
- Others to be identified

Impact for **Alumni**:

- Career outcomes for alumni: Employment status, Employment sector, Job responsibilities
- Career Outputs: Academic & Commercial
- Awards & Recognition

Summary

Comprehensive Mixed-Method Evaluation

- Multiple objectives
- Multiple stakeholders
- Multiple methods

On-site, embedded, case study approach

Outcomes assessment combined with improvement oriented feedback

Based on established methodologies for STI Evaluation, Customized for SoS Lablets

Developed in collaboration with Lablet participants and NSA Input and Feedback

Questions & Comments?

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