

AGU/AGI Webinar: Outcomes and Next Steps Geoscience Workforce & the Future of Undergraduate Geoscience Education

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September 16, 2016

Results from project sponsored by



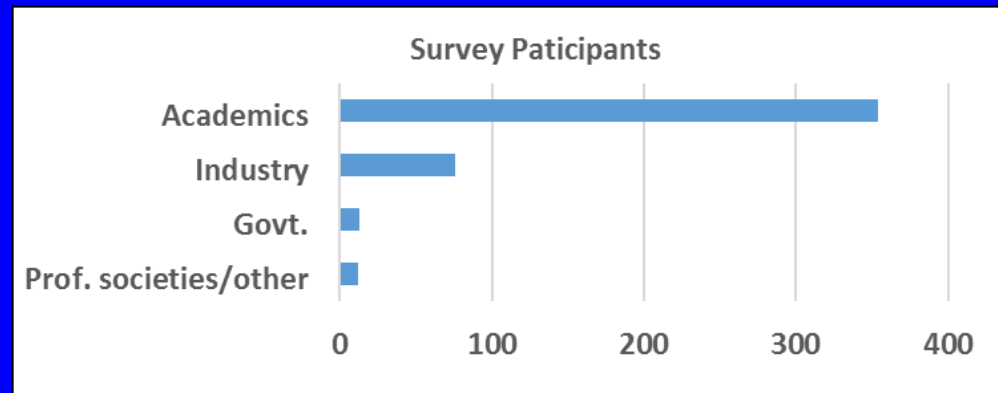
Future of Undergraduate Geoscience Education

2014 Summit:

- **~200 educators representing broad spectrum of undergraduate geoscience education community**
 - R1 research universities with undergraduate programs, 4-year and 2-year colleges
 - Faculty, heads & chairs, education researchers
 - Industry, government & professional society representatives (~20)
- **1st step in development a high-level community vision for the geosciences**
 - Surprising collective agreement

Community Survey ~ 463 respondents

- 357 academics (77%), 79 industry (17%), 14 government (3%), 7 other (1.5%), 5 professional societies (1%)
- 85% not Summit participants



2015 Geoscience Employers Workshop

- 46 participants: 6-7 each from energy, hydro/engineering/environmental, govt. agency, prof. societies, academics; 1 mining
- Plus ~13 NSF program directors
- **Agreement with 2014 Summit outcomes & survey results**
- **Added significant granularity**

2016 Summit for Heads & Chairs

- ~109 heads/chairs from R1 research universities with undergraduate programs, 4-year and 2-year colleges
- **Focused on how to implement**
- **Developed individual action plans**



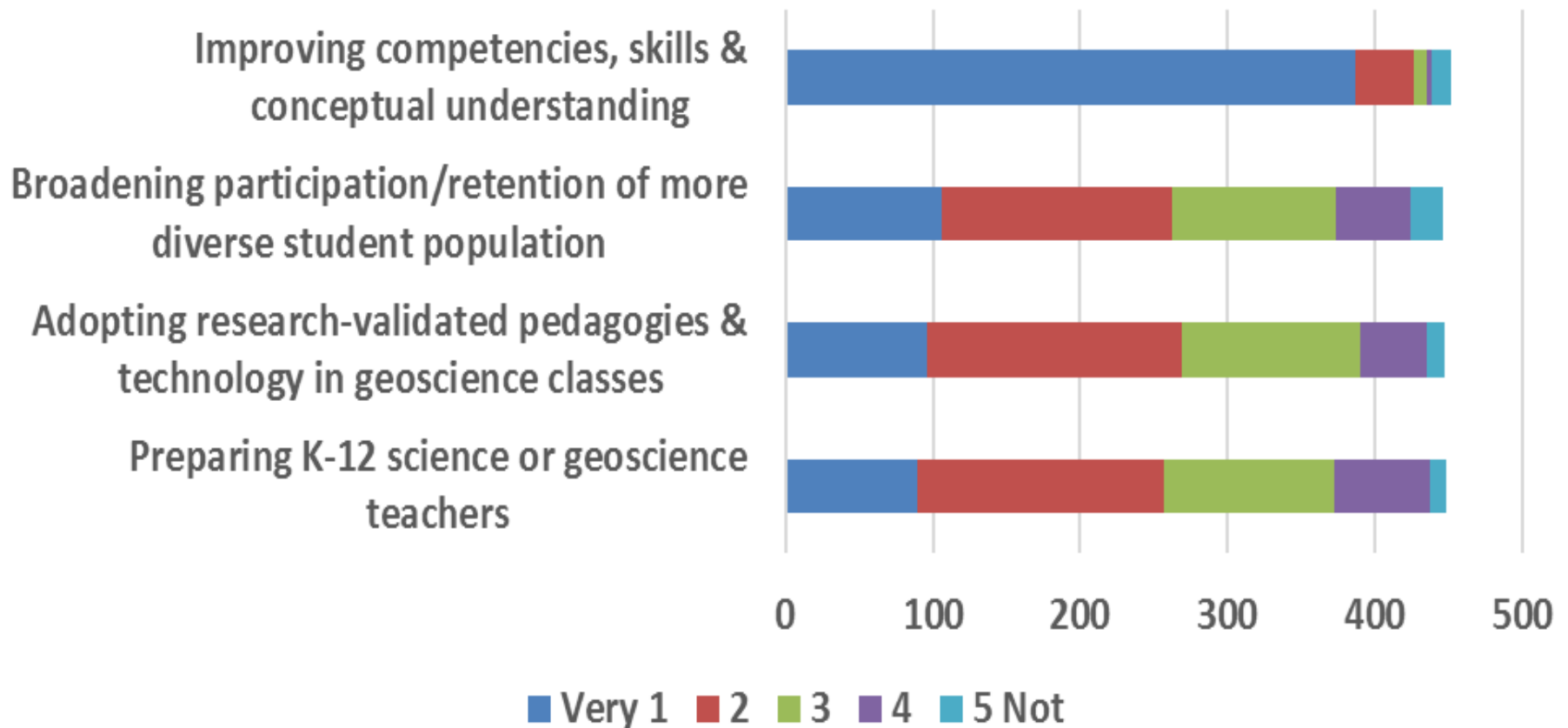
Geoscience Workforce today & in the future...

- **Need for multi-disciplinary approaches to problems**
 - More integration of different types of datasets
 - Cross disciplinarily teamwork
- **Different types of jobs for geoscientists**
- **Technological advances – changing skill sets**
 - More quantitative, computational, modeling
- **BIG DATA – integrate multiple large datasets, model, statistical analysis**
- **More interaction in business & society**
 - Economics/law/business practices/ethics/risk/environment
- **Cultural diversity, global outlook**

As the workforce changes – student learning must change

Questions Addressed

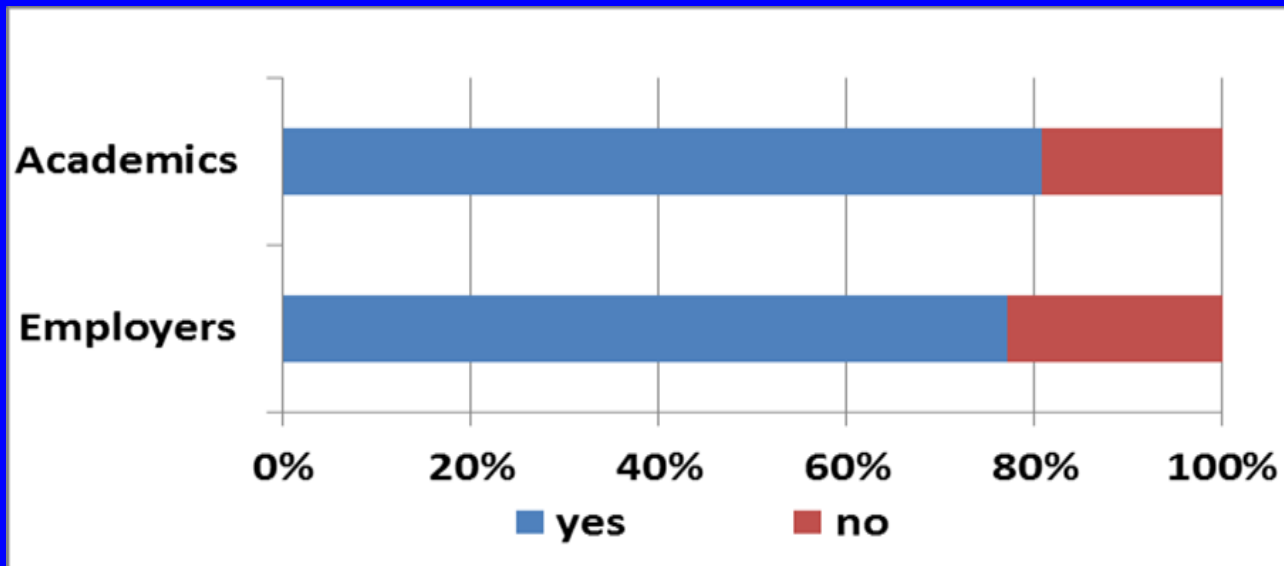
What are the most important issues from your perspective in terms of undergraduate geoscience education?



Concepts, Skills, Competencies

- **Major conclusion of 2014 Summit**
 - Developing competencies, skills, and conceptual understanding
 - More important than taking specific courses

Survey Results:



2014 Summit & Employer Workshop

- **Concepts:**

- Traditional Earth Science – most cover (deep time, structure, earth materials, surface processes, etc.)
- Other geoscience – some cover, variable extent (climate, hazards, resources, hydrogeology)

Employers added granularity, plus emphasized

- Systems Thinking
- Understanding processes
- Linkages, feedbacks, driving forces
- Impacts

- **Technical Skills**

- Data analysis of real data
- 3D/4D problem solving with non-unique answers
- Quantitative skills – higher level math competency
- Statistics, probability, uncertainty analysis & risk assessment
- Computer programming and modeling
- Field skills

- **Non-technical Skills**

- Team work , project management
- Communication skills
- Interpersonal skills
- Leadership, professionalism
- Ethics, societal relevance
- Global perspective

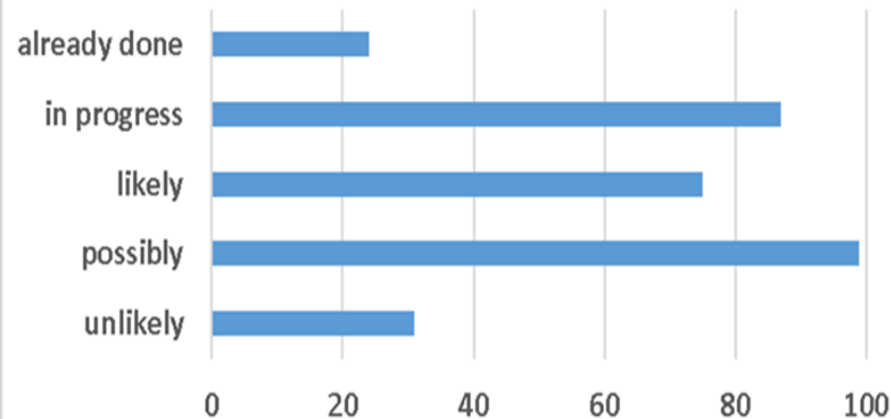
See:

<http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/>

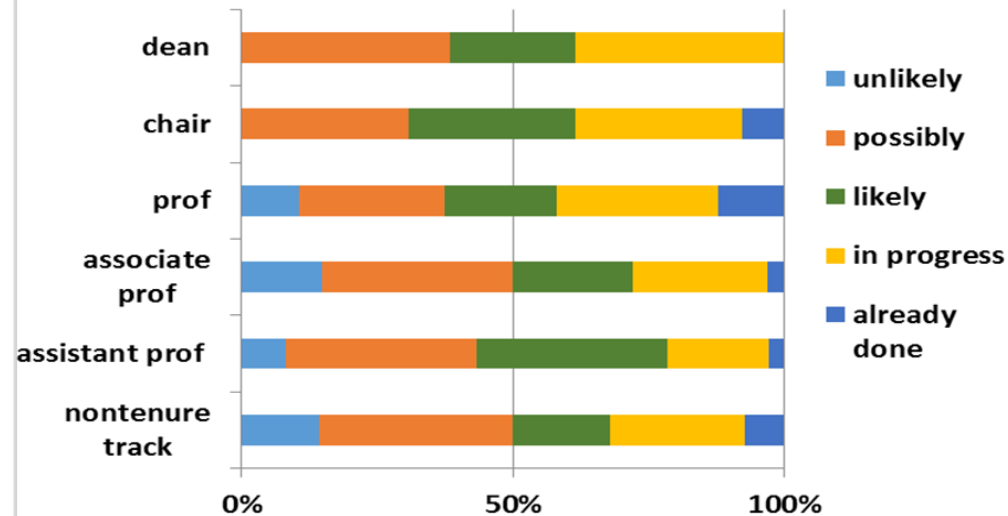
Survey results:

- Is your department interested in making changes to your undergraduate curriculum to focus on competencies, skills, and conceptual understanding? Yes 231, No 79

Will your department make an effort to improve competencies, skills, and conceptual understanding in the next few years?



Will your department make an effort to improve competencies, skills and conceptual understandings in the next few years?

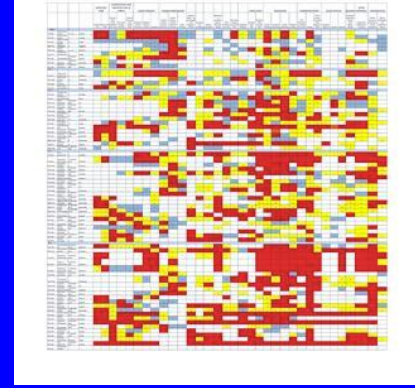


Heads/Chairs Summit - focused on implementation

- Mix of department sizes, student populations, motivations for change, and stages/scope of the change process
 - Many curricula haven't been revised/revamped since 80s or 90s
 - Some recently completed
- 2016 Summit End Results:
 - 92 individual department action plans!
- *Opportunity & challenge to demonstrate that geoscience departments are essential & central parts of each institution*
 - Geoscience Employers' workshop goals – take to faculty and administration

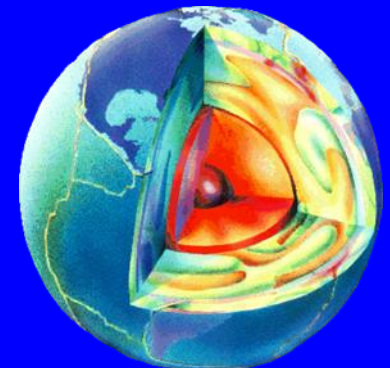


2016 Heads/Chairs Summit



How implement?

- Evaluate curriculum using matrix design approach (http://serc.carleton.edu/NAGTWorkshops/departments/degree_programs/matrix.html)
 - Use concepts/skills from Geoscience Employers Workshop
 - Review current courses to identify gaps, redundancies
 - Reconstitute courses to combine concepts – backwards design
 - Show students matrix
- Modular courses - partial semesters
- Have overarching courses that share a field or data gathering/analysis project
- Take systems approach for upper level courses

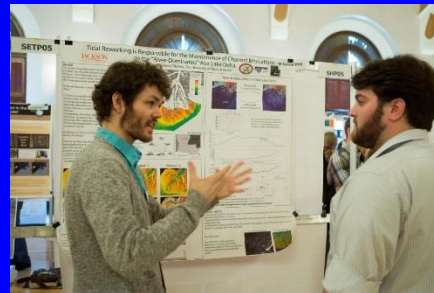


2016 Heads/Chairs Summit

How implement?

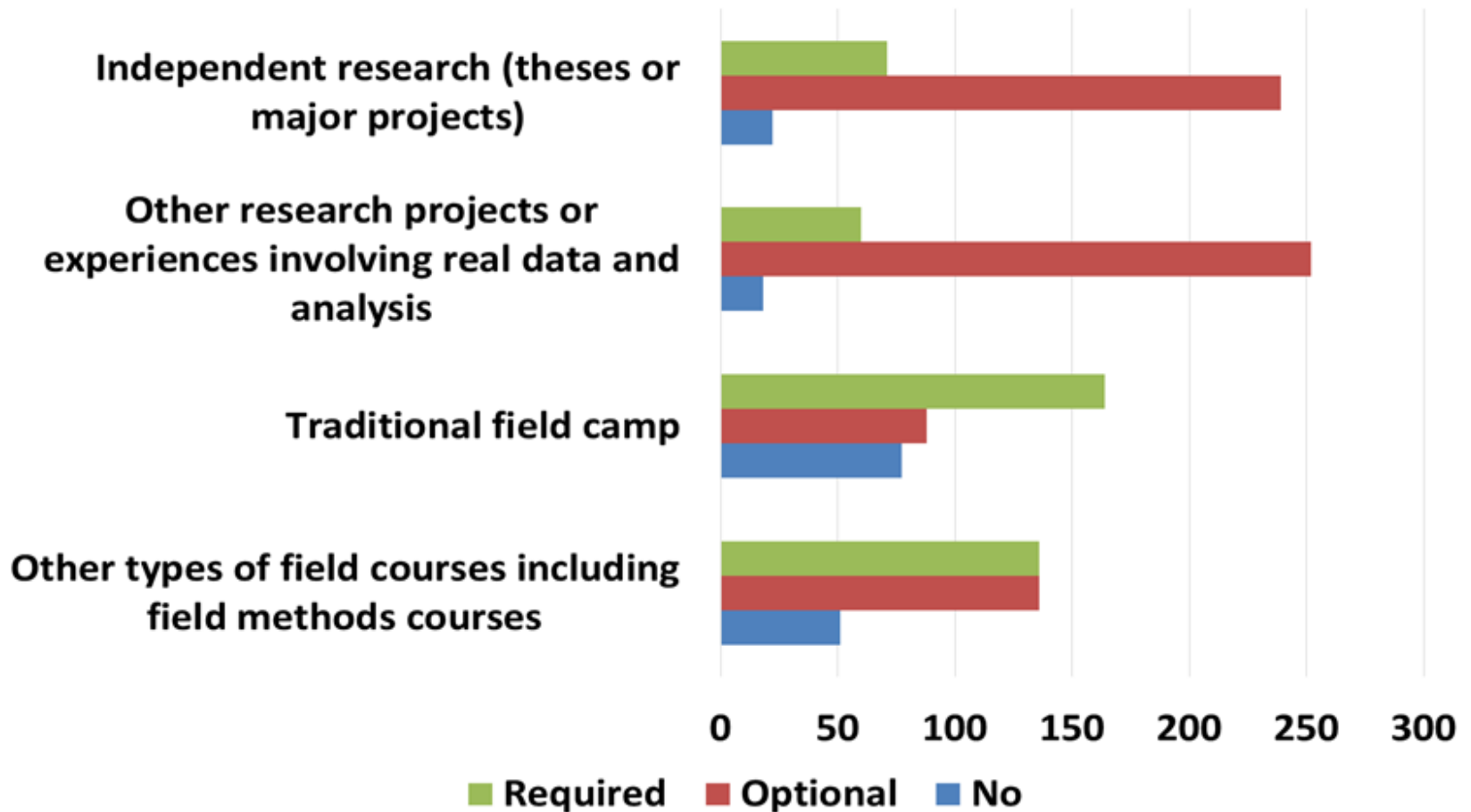
- Experiential learning
- Independent Research
- Problem solving; use of real data into classes
- Capstone, problem/project oriented courses
- Integrate math & computational methods into geo courses at all levels – use to solve geoscience problems
- Replace 2nd semester physics, chemistry , calculus plus dif. Eq./linear algebra with geo- physics, geo-chem, geo-math
- Integrate written/oral intensive courses in programs
- Internships, REUs, etc.

Research and/or experiential (discovery) learning should come as early as possible

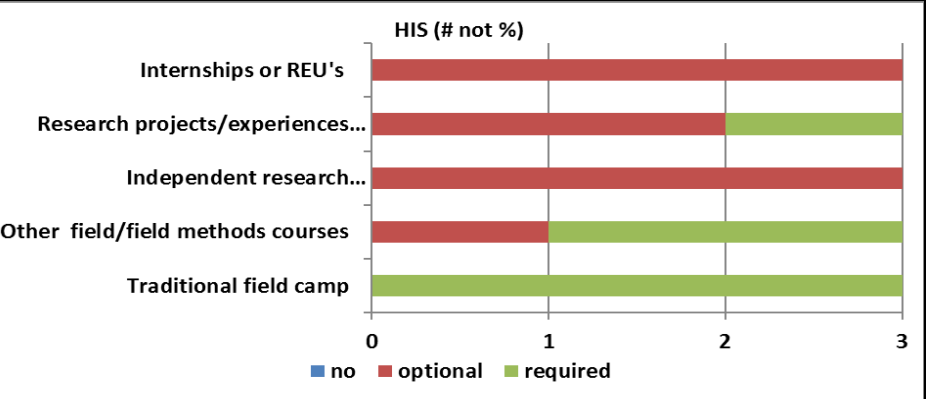
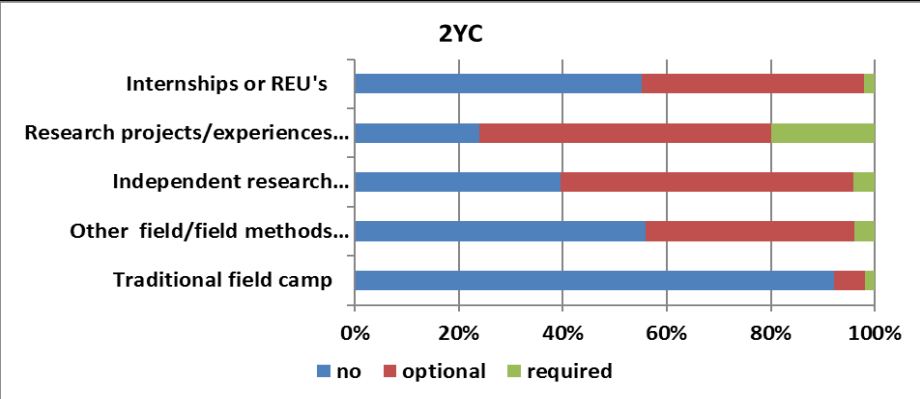
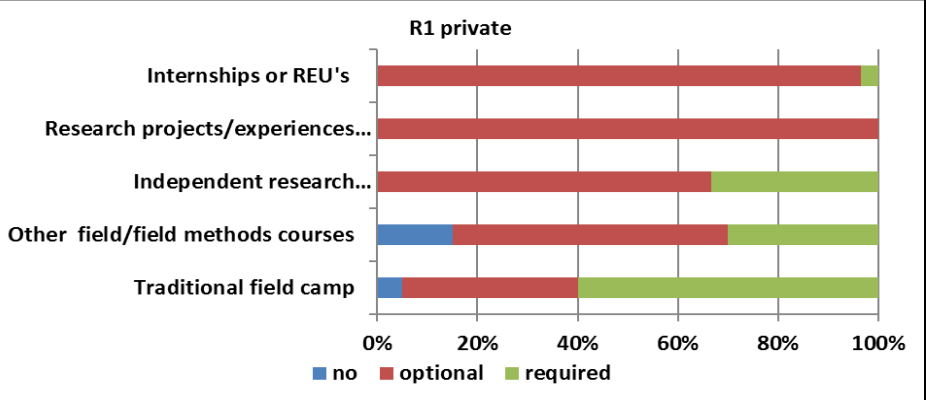
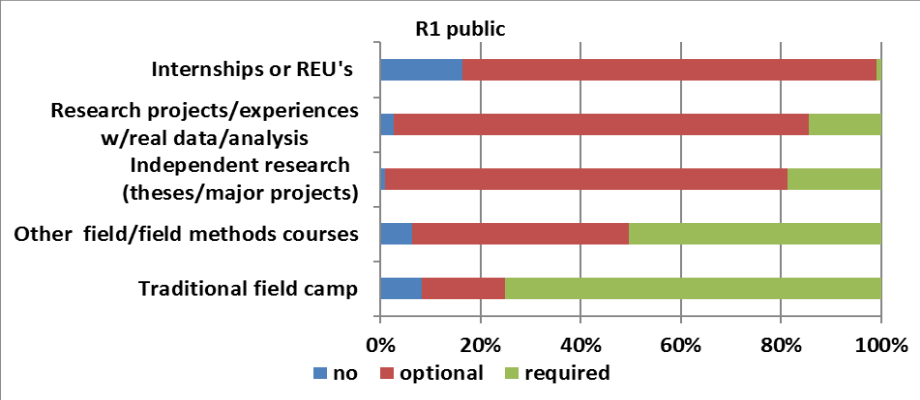
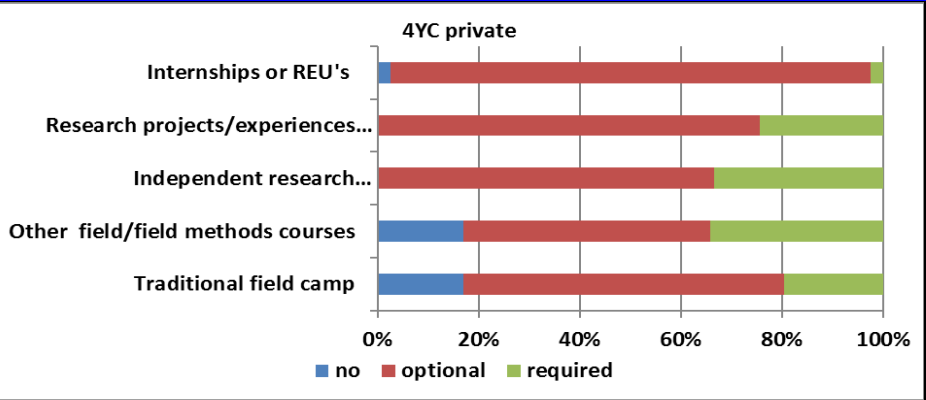
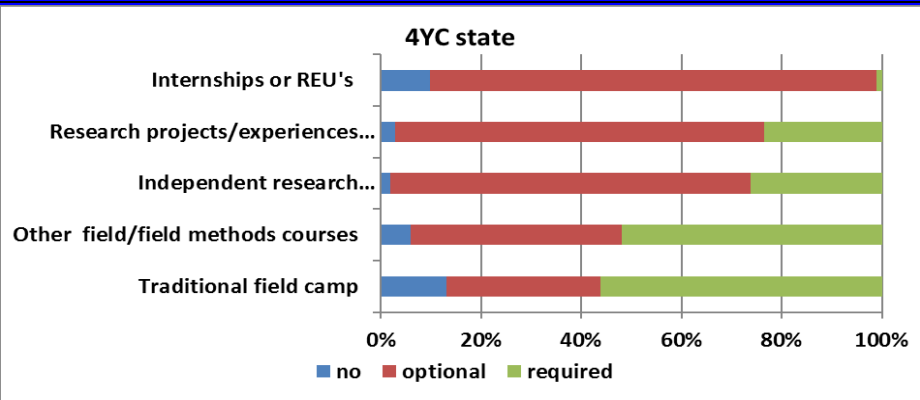


Survey Results: what is being done?

Do your undergraduates have the opportunity for the following activities?



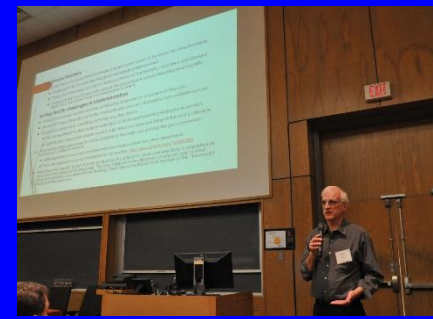
Do your undergraduates have the opportunity for the following activities?



2016 Heads/Chairs Summit

Pedagogy

- **What resources are available?**
 - On campus resources, highly variable
 - Very good geoscience resources through SERC website/early career workshops and others
 - NAGT traveling workshops
- **Tools for success:**
 - One step at a time – don't try and do it all at once
 - Share practices, things that work within program
 - Show colleagues data demonstrating benefits
 - Use peer observation to model effective practice and exchange ideas
- **Use multiple ways to evaluate teaching (peer evaluation, peer mentoring)**
- **Department head/chair**
 - Encourage experimentation, allow for failure and retrieval
 - Show “got your back” for faculty innovators
 - One-on-one negotiation – changing teaching methods/content



Robust Assessment – critical step

How assess that students are acquiring skills & understanding concepts?

- Measurable learning objectives – AAC&U assessment tools a common tool (<https://www.aacu.org/resources/assessment>)
- Programmatic evaluation of students' knowledge/skills in subsequent courses & end of program capstones
 - Feedback between colleagues on course content & outcomes
 - Importance of scaffolding
 - Show value of assessment - not a waste of time
- Gather data from exiting Seniors & recent grads



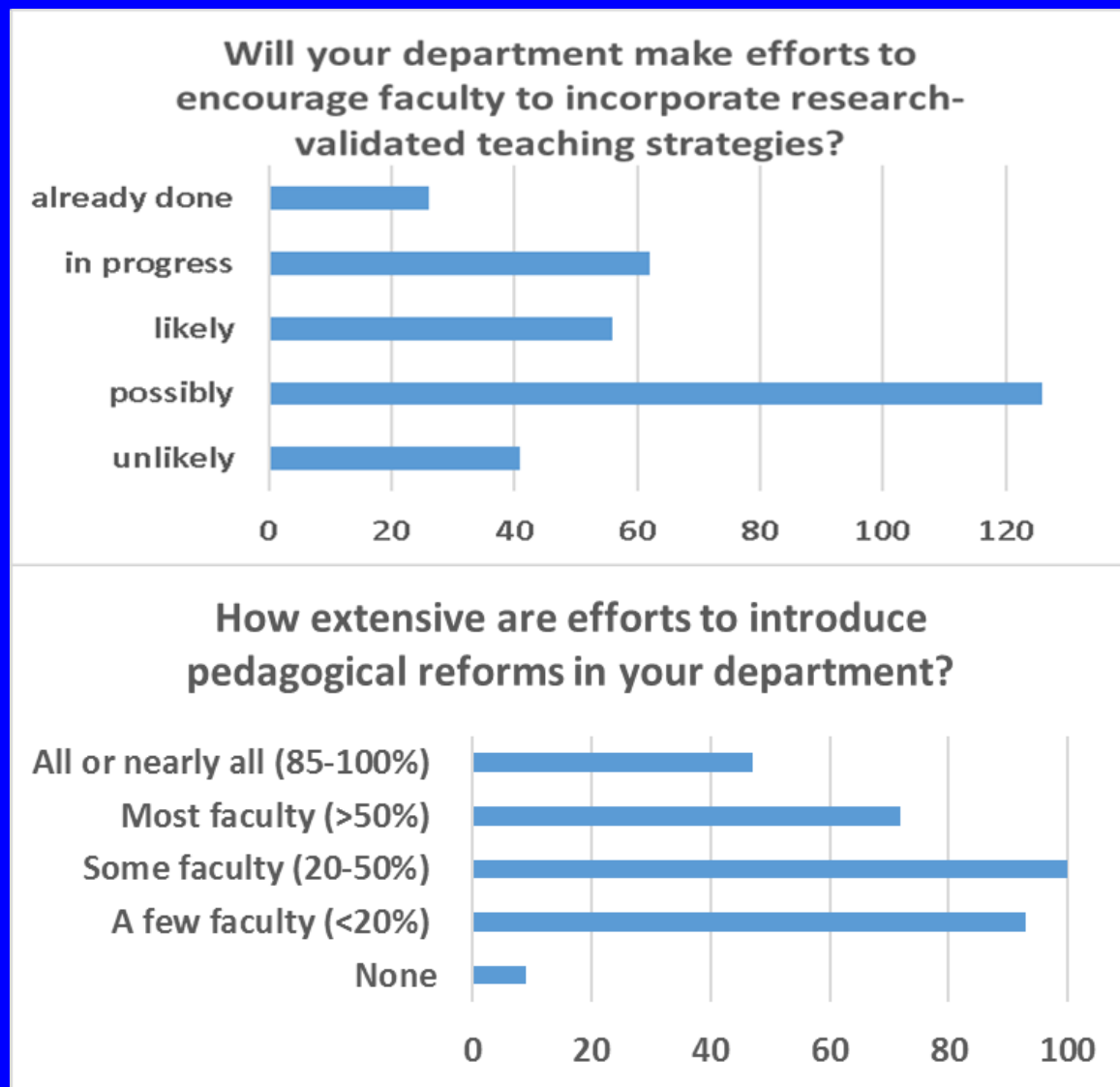
Survey Results:

Does your institution track Student Learning Outcomes or other metrics of student success with in your department?

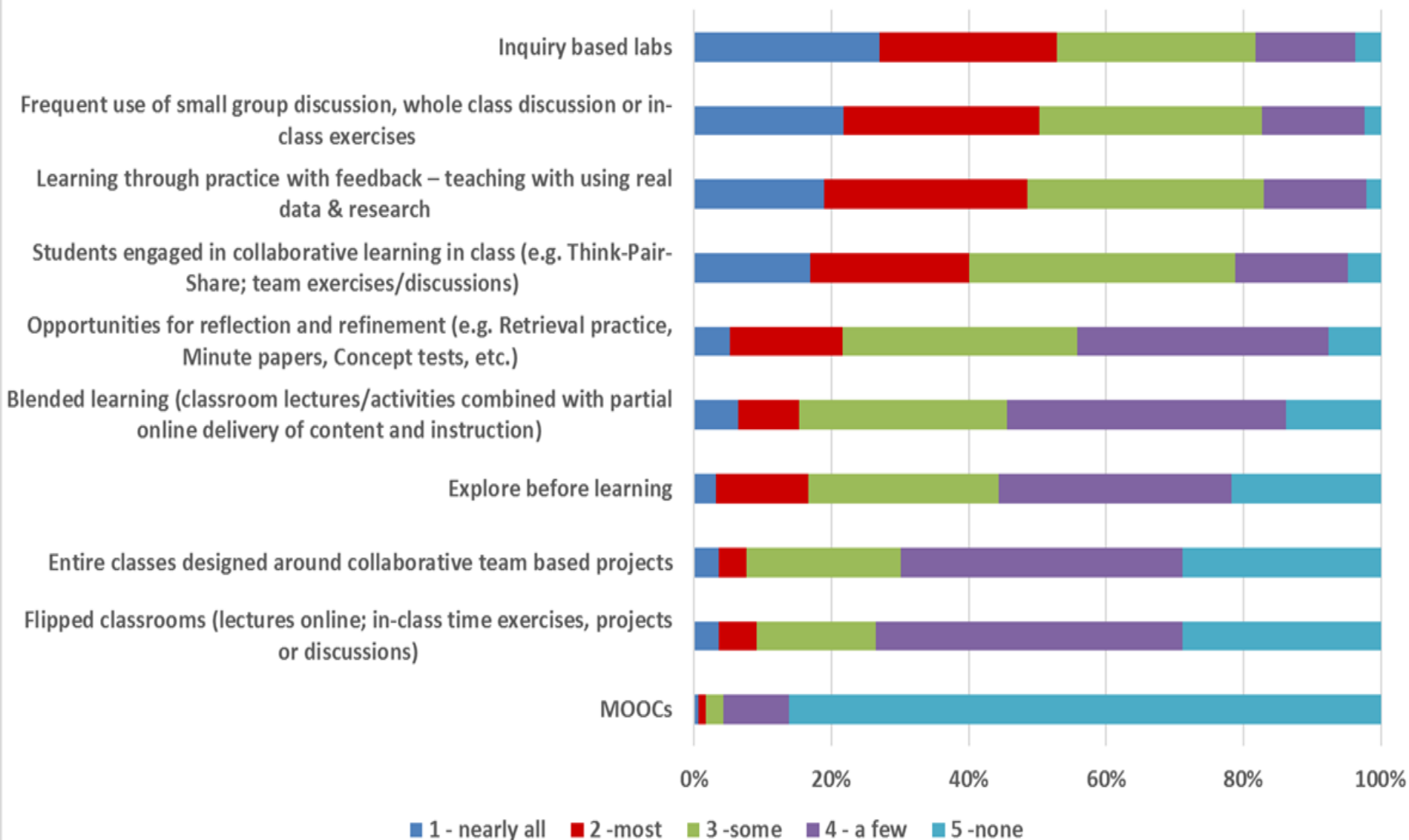
Yes 181, No 141

Survey Results: Is your department interested in making changes to how teaching is done at the undergraduate level?

- Yes 238
- No 64



From what you know about your department, which of the below teaching methods are used by faculty in your department?



Also broken down by institution type & numbers rather than %
Plus use of technology in class and field instruction

Challenges/Barriers: common concerns/comments

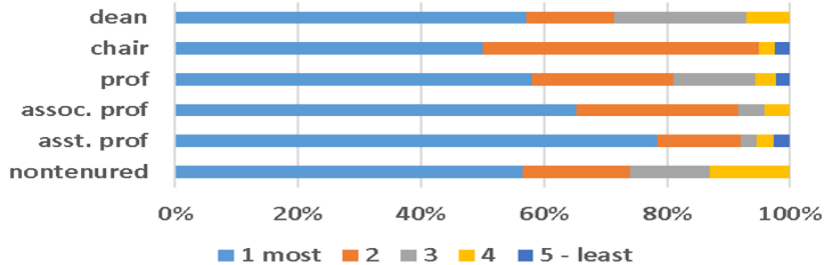
- **Emphasizing competencies results in less content?**
 - Balance between necessary content and mastery of skills
 - When is “less” really “more”?
 - Impact on flexible programs, multiple tracks
 - Small faculty, can’t cover all concepts
 - “Can’t add courses to curriculum, so what gets cut?”
 - “Everything I teach is important and can’t be cut.” “Nobody can tell me what to teach.”
- **Is change really needed?**
 - “Traditional geology education – all our employers think this is important.”
 - “If we require high level math, computational methods – will impact enrollment.”
 - “Geologist occupations are not quantitative.”
 - “These new fangled methods aren’t *real* teaching/don’t work/not rigorous.”
 - “Lecture-style has worked for 40+years; not broke, why fix?”
 - Deconstruct education jargon
- **What are barriers to change?**
 - Promotion/raises based on publications and grants, not teaching
 - Faculty are busy; teaching not top priority
 - Experiential learning, flipped classes, etc. take more resources – time, personnel, money
 - Enrollment pressures require large lecture style classes
 - Difficulty in getting other departments to work together
 - How much change? How quickly can it be accommodated?
 - Incorporating quantitative skills given extreme difference in student background
 - Increasing student carry-over of content/skills between courses



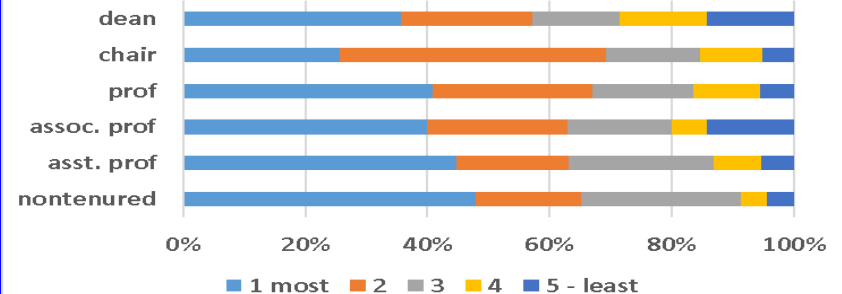
Faculty set in ways; resistance to change

Obstacles/barriers to implementing research-validated pedagogies and uses of technology

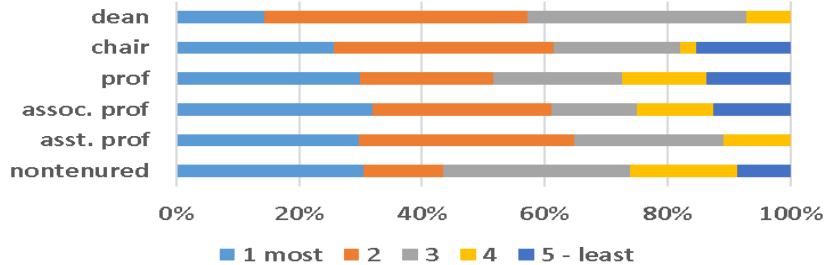
Lack of time/support needed for developing/piloting new instructional approaches



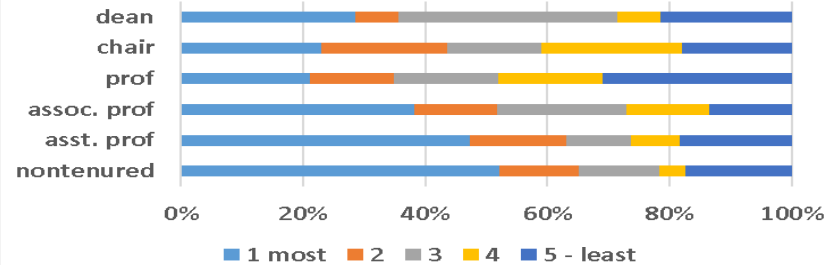
Financial Resources



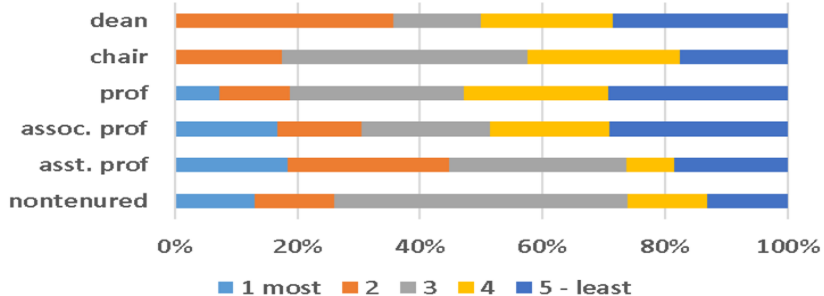
Instructional space design and teaching infrastructure



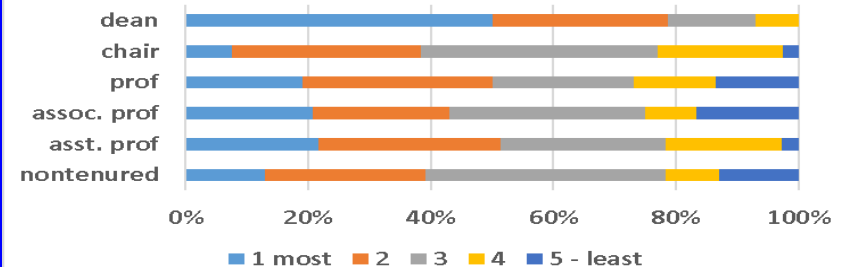
Annual performance and tenure and promotion evaluations



Concern about student evaluations

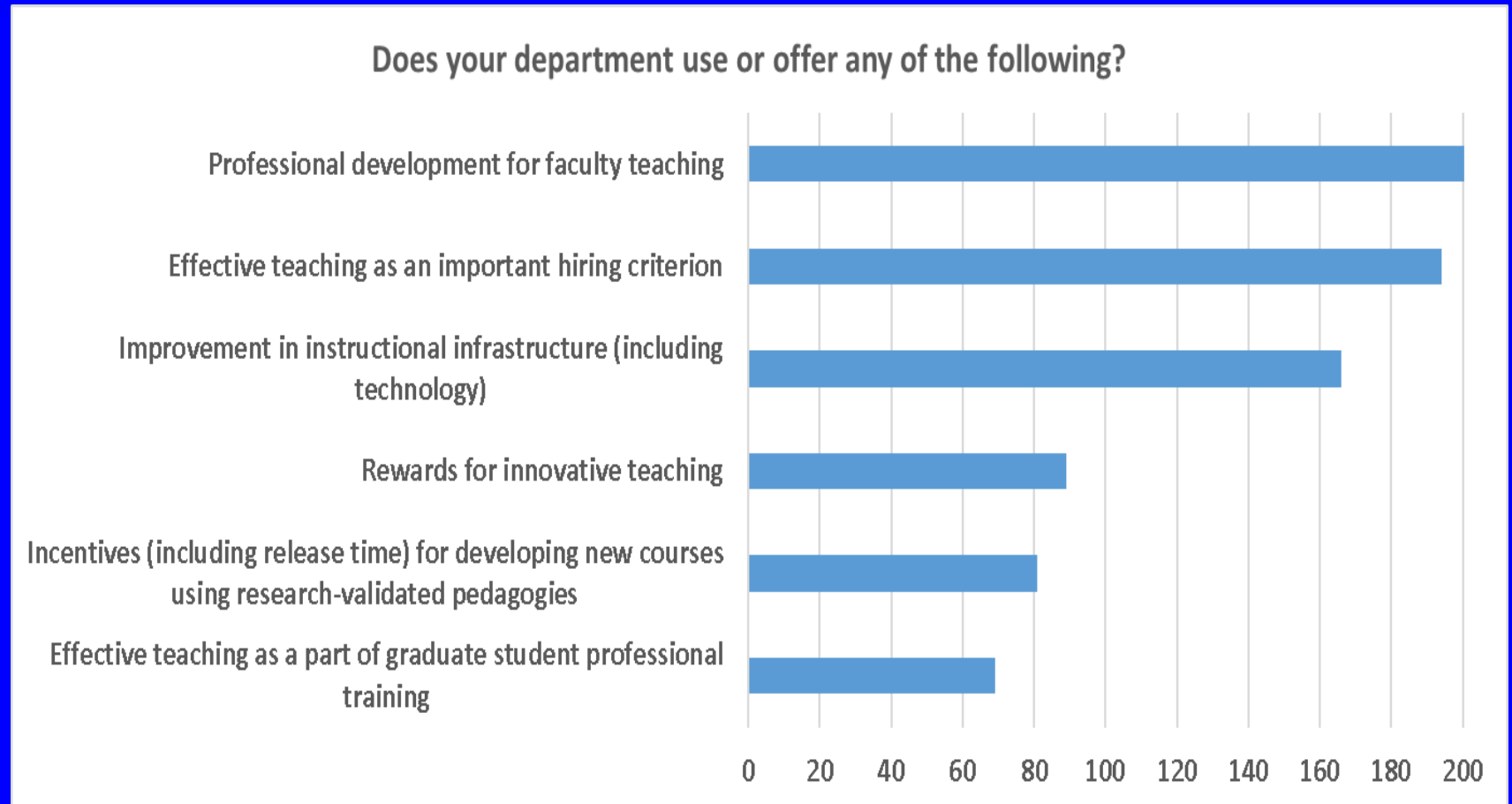


Lack of information on what techniques are research-validated



Incentives

Identified by 2014 Summit. Survey Results:



Incentives

Identified by 2016 Summit

- **Incentives to change – department head/chair**
 - Reassign time to develop new course/redesign existing course
 - Internal professional development funds
 - Faculty mentoring and sharing development of resources
 - Add undergrad TAs to increase interactions in class
- **Build an on-ramp to change pedagogy – department/external repositories**
 - Brief videos on each of the teaching strategies (link to research base)
 - Curate course-specific materials to allow faculty to customize their teaching materials
 - Adapt fully developed, tested, existing materials that cover multiple days/weeks of course material (e.g., InTeGrate modules)
- **On the Cutting Edge:** <http://serc.carleton.edu/NAGTWorkshops/index.html>
- **InTeGrate:** <http://serc.carleton.edu/integrate/index.html>
- **SERC:** <http://serc.carleton.edu/index.html>

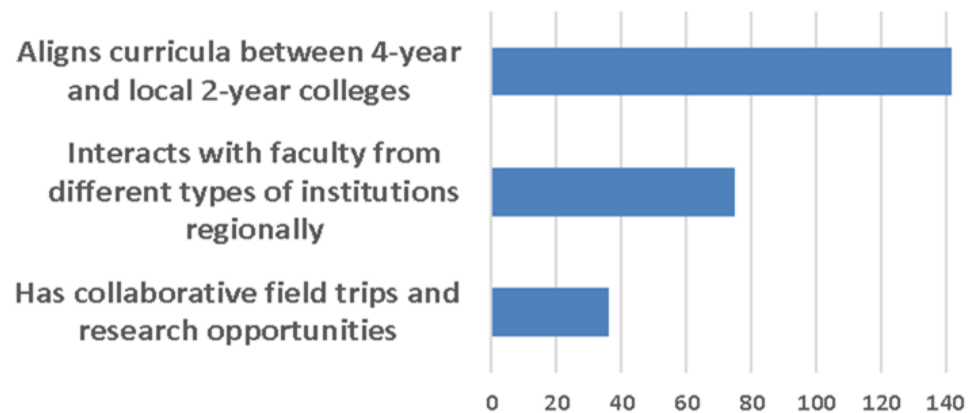
2YC → 4YC

Build relationships with local 2YC

- **4YC and 2YC faculty need to coordinate course objectives, curriculum, degree plans**
 - Many students are 2 plus 2 – communicate what should learn in 1st 2 years
 - Discuss content, objectives, evolution in degree programs
- **Articulation agreements** – goes beyond course numbers
- **Advising** – make sure transfer courses actually transfer
- **Culture bias** – underrepresentation doesn't mean underprepared
 - Data shows that 2YC students fundamentally same as 4YC students
- **Cross transfer of credits from the 4YC to the 2YC** – so students can get that Associates degree from the 2YC



Which does your department do to ease the transition between 2-year and 4-year colleges?



2YC to 4YC Transfer Support

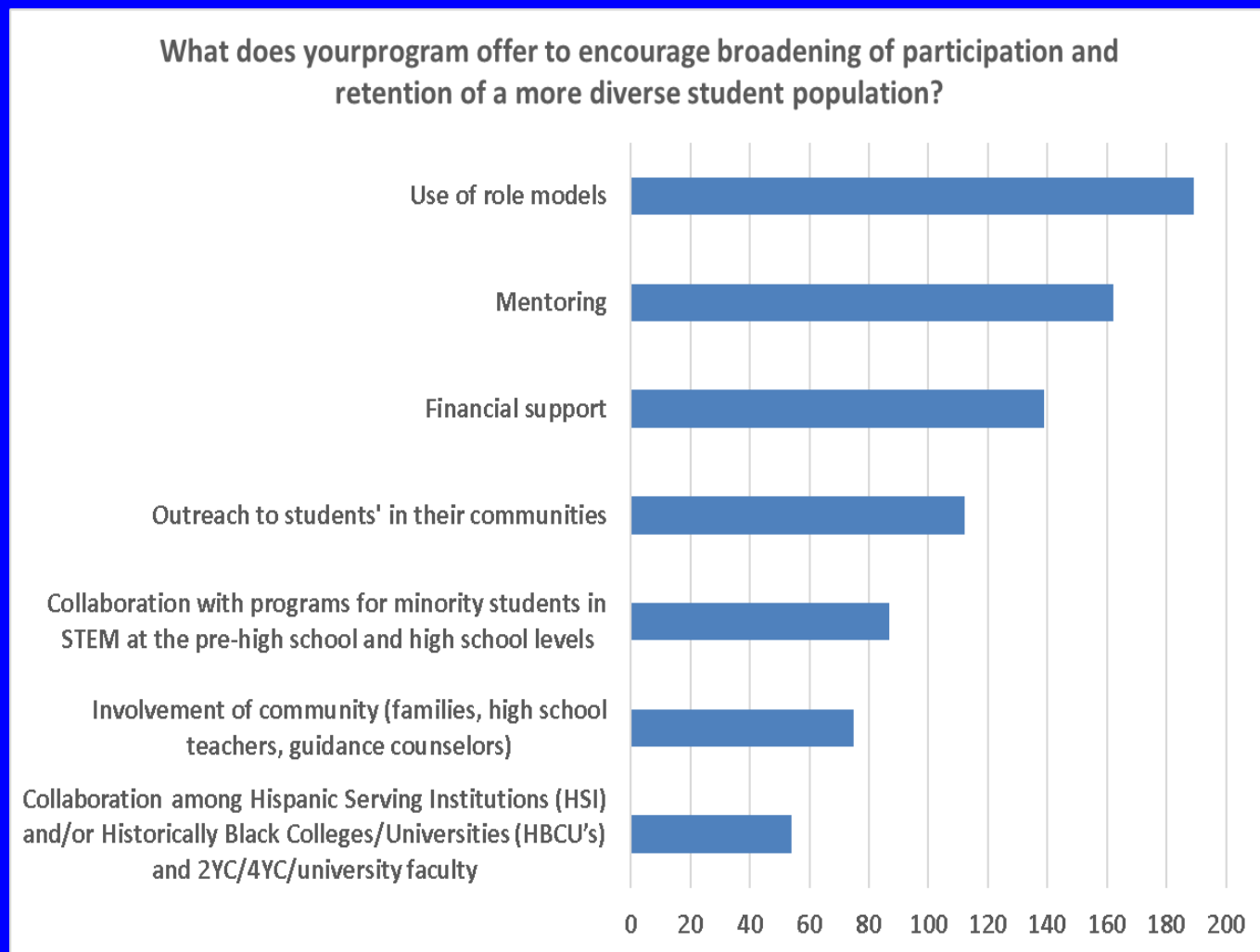
- **Build communities for transfer students – before and after**
 - Joint field trips / Upper classman collaboration
 - Research internships for 2YC students
 - Invite 2YC students to research talks/symposiums
 - Students need support/bridge programs – integrate into community
 - Peer and vertical mentoring programs
 - Co-advising
- **Build good communication between advisors at 2YCs and 4YC advisors**
- **Build relationships between faculty**
 - Increase 4YC enrollments
 - make students more successful, prepared for what to expect academically

Does your department/company/organization have or plan on any systematic efforts to encourage broadening participation and retention of a more diverse student population?

•Yes 181

•No 239

Elements of
successful programs
Identified by
2014 Summit



2016 Summit: Recruiting & Retaining Underrepresented Groups

- **Challenge: Overall lack of awareness of geosciences as an occupation**
- **Challenge: Acceptance of the geosciences as a viable occupation to the under represented minority families**
- **Retention**
 - Summer research experiences; fieldtrips
 - Peer-mentoring
 - Freshman mixed cohorts; learning experiences/tutors – not just for minorities



Recruiting

- Don't over emphasize field - can be considered manual labor Or travel – some cultures strongly community based
- Emphasize salaries and jobs/careers; ties to community and societal aspects
- Bring a successful professional on a field trip to illustrate job potential

- **Increase diversity by working with 2YC's**
 - mirror of the community demographic
- **Work with HBUCs/HSI and local high schools**
- **Utilizing available resources**
 - Funded programs – LSAMP, McNair, Gear-up, Trio
 - SACNAS; NABlackGeoscientists and GeoscienceAlliance meetings and student conferences
 - On campus resources; multicultural centers
 - InTeGrate workshop on diversity and examples
 - Emulate successful comprehensive programs: e.g. GeoForce Texas (UT Austin); Africa Array (Penn State)
 - Large financial and mentoring investments



From: Diane Doser
(UT El Paso) &
Joshua Villalobos
(El Paso
Community
College)

Next Steps: Future of Undergraduate Geoscience Education

- Synthesizing individual action plans by institution type
- Publish articles summarizing results (e.g. *EOS; Earth, GSA Today*)
- January 2017: request/receive reports from each Head/Chair participants on their progress
 - Some already have reported
 - Use results to evaluate successful implementation strategies; obstacles
 - Generate information needed by Heads/Chairs
 - Continue to disseminate and build on results
- **Final Goal:** Vision and Change document similar to that for Biology

Webpage: <http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/>

- **2106 Summit Documents & Survey Results & Matrix**
 - Overview of Geoscience Employers Workshop Outcomes
 - Breakout Questions – guide dept. discussions
 - Matrix for competencies, skills and content, & ASBOG Fundamentals exam
- **Survey Results - all**
- **2nd Summit PowerPoints**
 - Overviews & Panels PowerPoints
- **Summit Webcast - archive**

Webpage:

<http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/>

BACKGROUND READING

- **Information related to NSF Future of Undergraduate Geoscience Education Project**
 - 2015 Presentations PowerPoint slides
 - 2014 Summit Summary Report
 - 2014 Summit Webcast Archive
- **STEM and Undergraduate Educational Resources**
- **Geoscience-related Reports and Resources**
- **Underrepresented Groups - articles**
- **Competency Examples**
- **General Geoscience Resources**

- **Sustained change in geoscience undergraduate education**
 - Combined, coordinated efforts of departments and programs
 - Administrators, individual faculty innovators
 - Future workforce employers
 - Geoscience professional societies
- *Affect culture change - administration down to student level*
- *Our students and profession deserve/need it!*

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SUMMIT ON THE FUTURE OF UNDERGRADUATE GEOSCIENCE EDUCATION