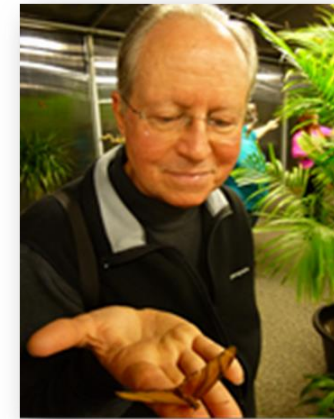


Michael Kyte Distinguished Lecture

The Meaning of Engineering Education

October 5, 2023

The University of Idaho



Karl A. Smith



Michael Kyte, Ph.D., P.E.



Professor Michael Kyte – Exemplary
engineering educator

Reflection and Dialogue

- Individually reflect on Michael Kyte as an engineering educator
 - Recall a poignant memory – what qualities/characteristics stand out?
 - If you don't have a memory of Professor Kyte, recall an excellent engineering educator
- Enter a few key words in the Q&A

Passion; Dedicated; Wonderful mentor for me and other young faculty;
Appreciative inquiry, bridge builder among research teams, fun, quality focused;
Understanding of student situation, able to explain well, excited about subject
matter; An excellent mentor

My interactions with Michael Kyte and the
transportation engineering education community

Transportation Education Conference, Portland, OR, June 2009

**Transportation Engineering Education Workshop,
Auburn University, May 2018**

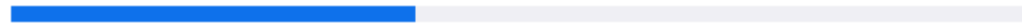


Poll: Please select your current role.

1. Poll: Please select your current role. (Single Choice) *

10/10 (100%) answered

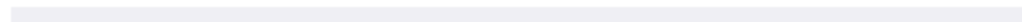
Faculty (4/10) 40%



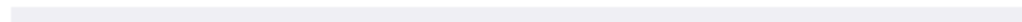
Student (6/10) 60%



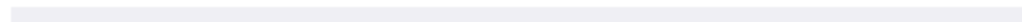
Staff (0/10) 0%



Administrator/Manager (0/10) 0%



Practitioner/Industry (0/10) 0%



The Meaning of Engineering Education

Thanks to Professor Kevin Chang for suggesting the title!

Foundational Question:

What does it mean to be an engineer?

- Individually reflect on what it means to be an engineer
- Enter a few key words in the Q&A

Uses math and science to solve problems; Problem solver; Problem solver, observer, creator; Passion for meeting stakeholder expectations using engineering knowledge/tools - connecting theory with user needs; Design things; Technical knowledge, creativity, design; Researcher; Designs that make tasks easier for human kind

Formulate-Share-Listen-Create (Think-Pair-Share)*

What does it mean to be an engineer?

- Individually **Formulate** a response to the question
- **Share** your response with a partner
- **Listen** carefully to your partner's response
- Jointly **Create** a response that you'd be willing to share if called on

*If we were meeting in person, I would use this format



The Center for the Advancement of Engineering Education

What does it mean to be an engineer?

Engineering identity and sense of community (belonging)

What is the process of becoming an engineer?

[Academic Pathways Study \(APS\) >>](#)

**. . . . investigating the engineering undergraduate learning
experience**

Engineering Education Major Shifts Prior to ~2020



Engineering science



Outcomes and accreditation



Engineering design



Education, Learning, and Social-behavioral sciences



Information, Communications,
and Computational technologies

Five Major Shifts in 100 Years of Engineering Education

By JEFFREY E. FROYD, *Fellow IEEE*, PHILLIP C. WANKAT, AND KARL A. SMITH

<http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&tp=&arnumber=6185632>

Prior Shifts



Engineering science



Outcomes and accreditation



Engineering design



Education, Learning, and Social-behavioral sciences



Information, communication, & computational technologies

Emerging Shifts



Ubiquitous remote T&L



Justice, equity, diversity, and inclusion (JEDI)

Poll: What was your most common experience with teaching and/or learning during the pandemic?

1. Remote synchronous (live/real time)
2. Asynchronous/self-paced
3. Hybrid/blended
4. In person



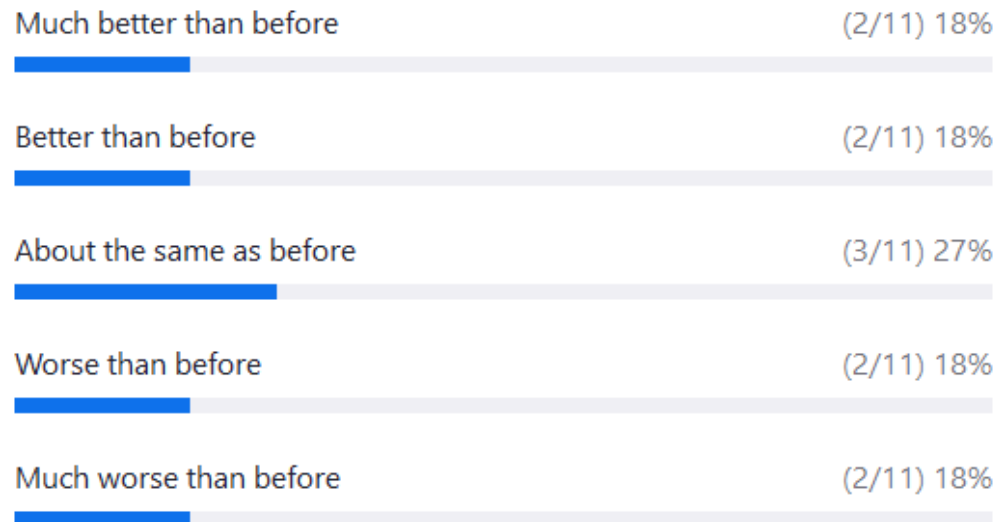
Poll: How did remote teaching/learning go (compared to pre-pandemic)?

Remote Teaching/learning poll

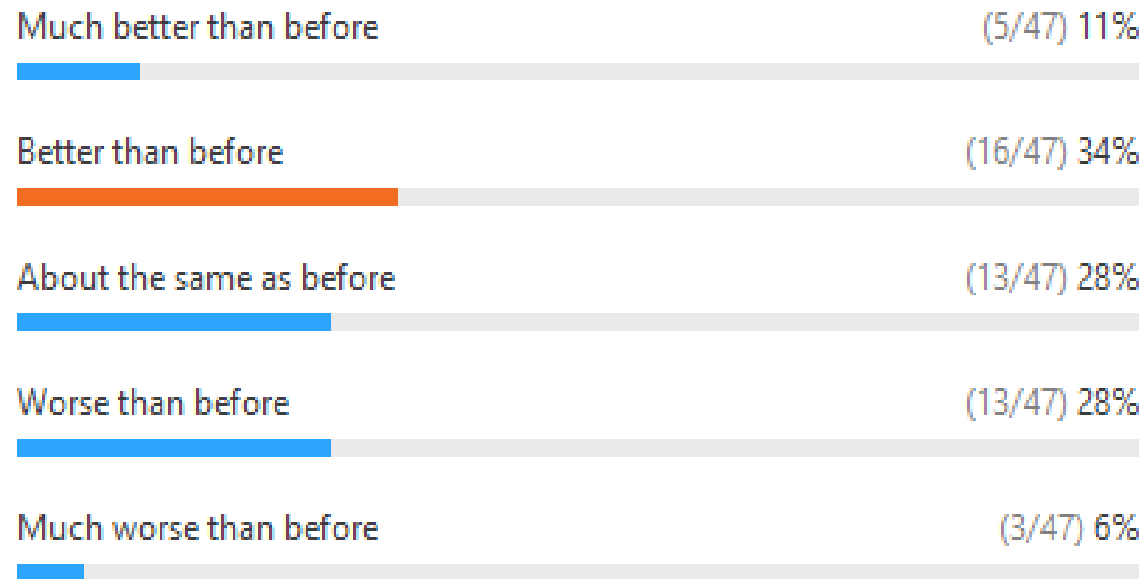
Poll ended | 1 question | 11 of 11 (100%) participated

1. Poll: How did remote teaching/learning go (compared to pre-pandemic)? (Single Choice) *

11/11 (100%) answered



Poll: How is remote teaching/learning going (compared to pre-pandemic)?



ASEE Webinar – Learning in the time of coronavirus –
Karl Smith & Rocío Chavela Guerra - 2021

Education, Learning and Social-Behavioral Sciences

How People Learn

Interactive Learning

Personal and
Academic Support

Psychological Safety



IMPLICATIONS:

Applying what we know
about learning is
essential:

Cognitive Domain

Affective Domain

Education, Learning and Social-Behavioral Sciences

How People Learn

Interactive Learning



IMPLICATIONS:

Applying what we know about learning is essential:

Cognitive Domain

Learning Requires...

Deliberate

- Cognitive load (bandwidth)
- Reflection

Distributed

- Repetition over time
- Multiple input modes

Practice

- Attentive
- Constructive
- Interactive

I-C-A-P Framework

Interactive	> Constructive	> Attentive (Active)	> Passive
Substantive dialogue on the same topic, not ignoring a partner's contribution	Producing outcomes that go beyond presented information	Doing something physically Paying attention	
Guided-construction	Self-construction	Engaging activities	
Joint creation processes	Creation processes	Attending processes	

Education, Learning and Social-Behavioral Sciences



IMPLICATIONS:

Applying what we know about learning is essential:

Personal and Academic Support

Psychological Safety

Affective Domain

Student Support is Essential

Academic Support

Classmates and faculty:

Help students succeed academically.

Personal Support

Classmates and faculty:

Care about and are personally committed to the **well-being** of each student.

**The greater the social support,
the greater the academic challenges may be.**

Creative Tension Between Challenge and Security

		ACCOUNTABILITY FOR MEETING DEMANDING GOALS	
		LOW	HIGH
PSYCHOLOGICAL SAFETY	HIGH	Comfort Zone People really enjoy working with one another but don't feel particularly challenged. Nor do they work very hard.	Learning Zone The focus is on collaboration and learning in the service of high-performance outcomes.
	LOW	Apathy Zone People tend to be apathetic and spend their time jockeying for position.	Anxiety Zone People fear to offer tentative ideas, try new things, or ask colleagues for help.

Shifts in Engineering Education: Implications



Engineering Science

Theory and research matter.



Outcomes Accreditation

Identifying and articulating enduring outcomes is a critical part of effective course design.



Engineering Design

Embracing the engineering design process for course design makes sense.



Social Sciences

Applying what we know about learning is essential:
Cognitive Domain
Affective Domain



ICC Technologies

Technology provides affordances to mediate learning—but education is a human activity.



Remote Learning

Engineering teaching and learning can be accomplished remotely—but there are challenges.



Justice, Equity, D&I

Working towards creating and maintaining equitable and inclusive learning environments is imperative.

PRIOR SHIFTS

EMERGING SHIFTS

Prior Shifts

- Were prompted by outside forces
- Were met with resistance
- Were eventually embraced (to varying degrees)
- **Did not change core values/practices**

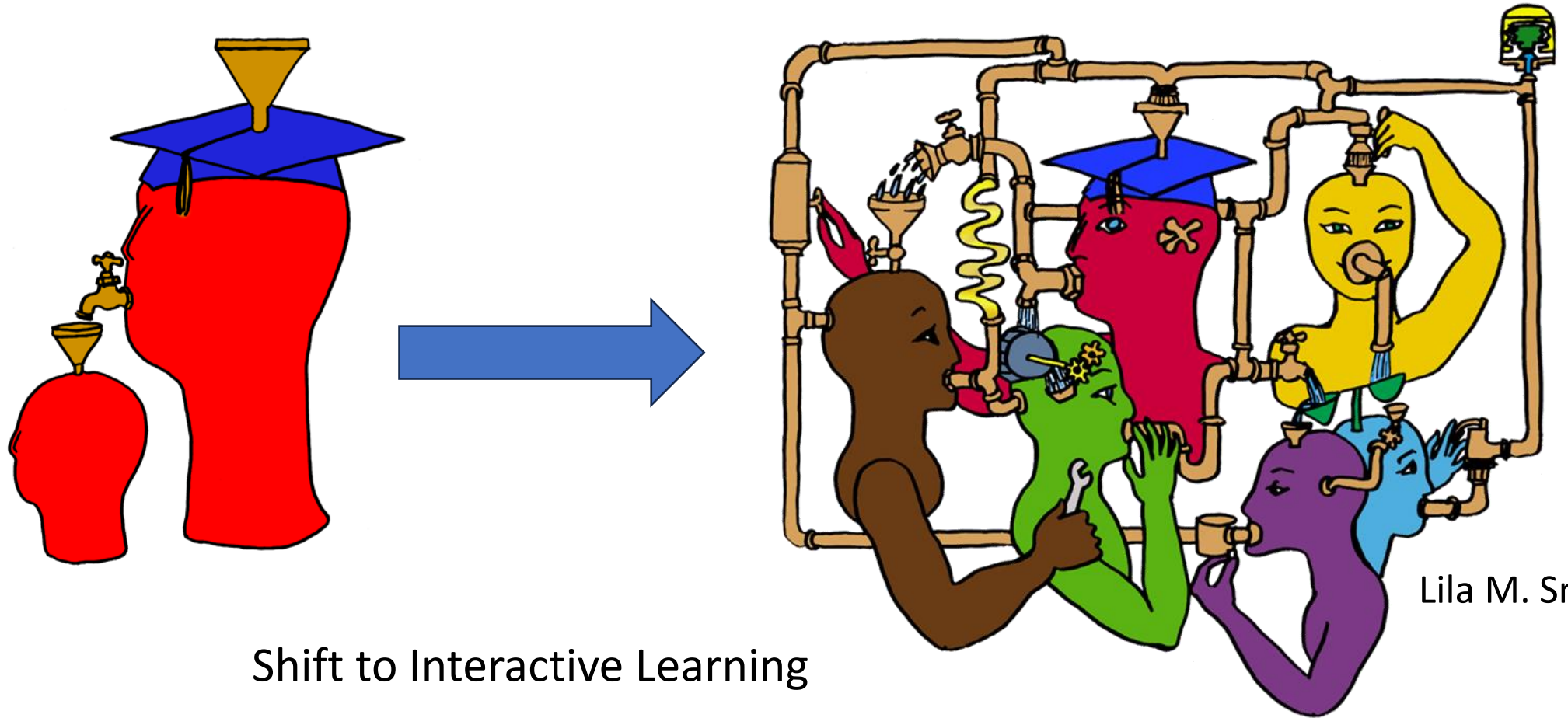


Post-Pandemic



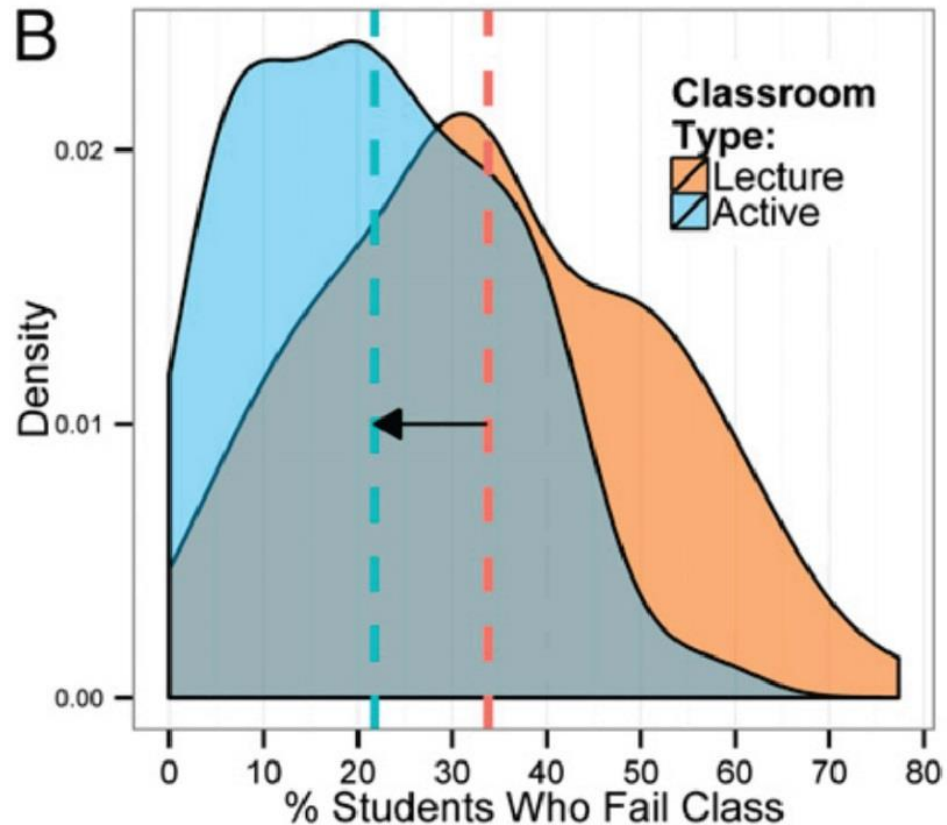
What do we want to keep?

What do we want to keep?

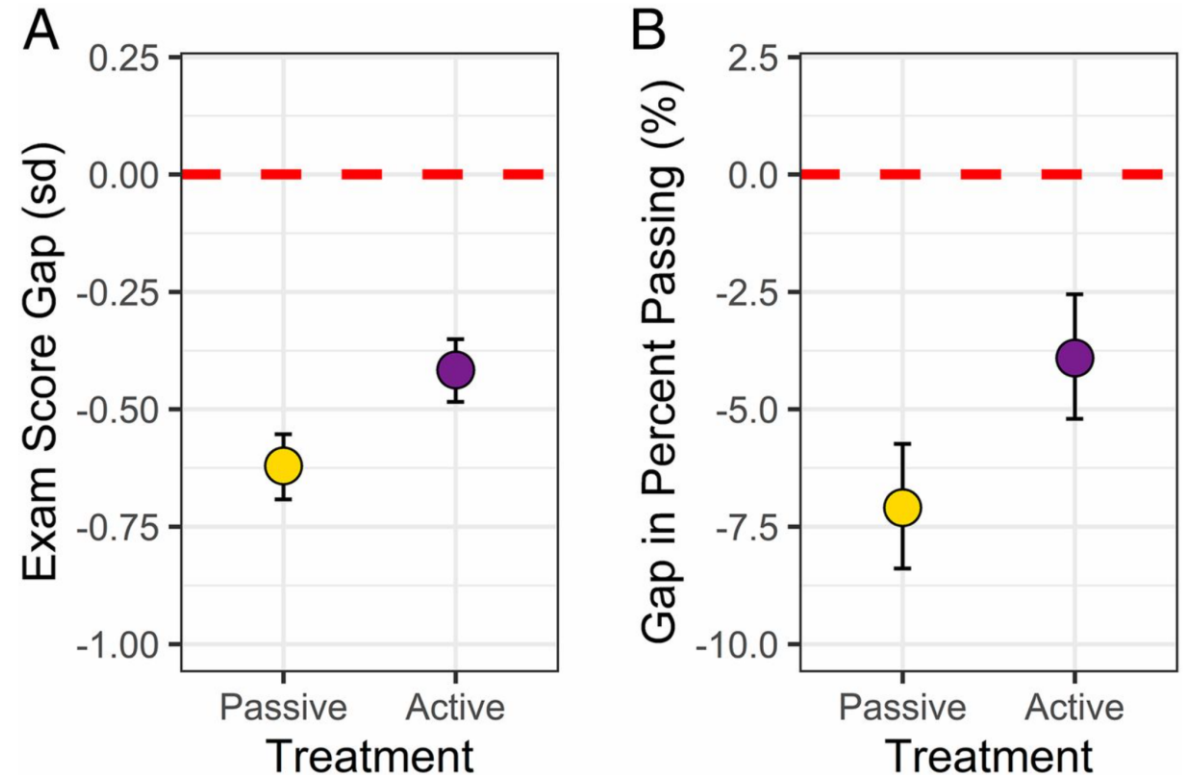


Interactive Learning

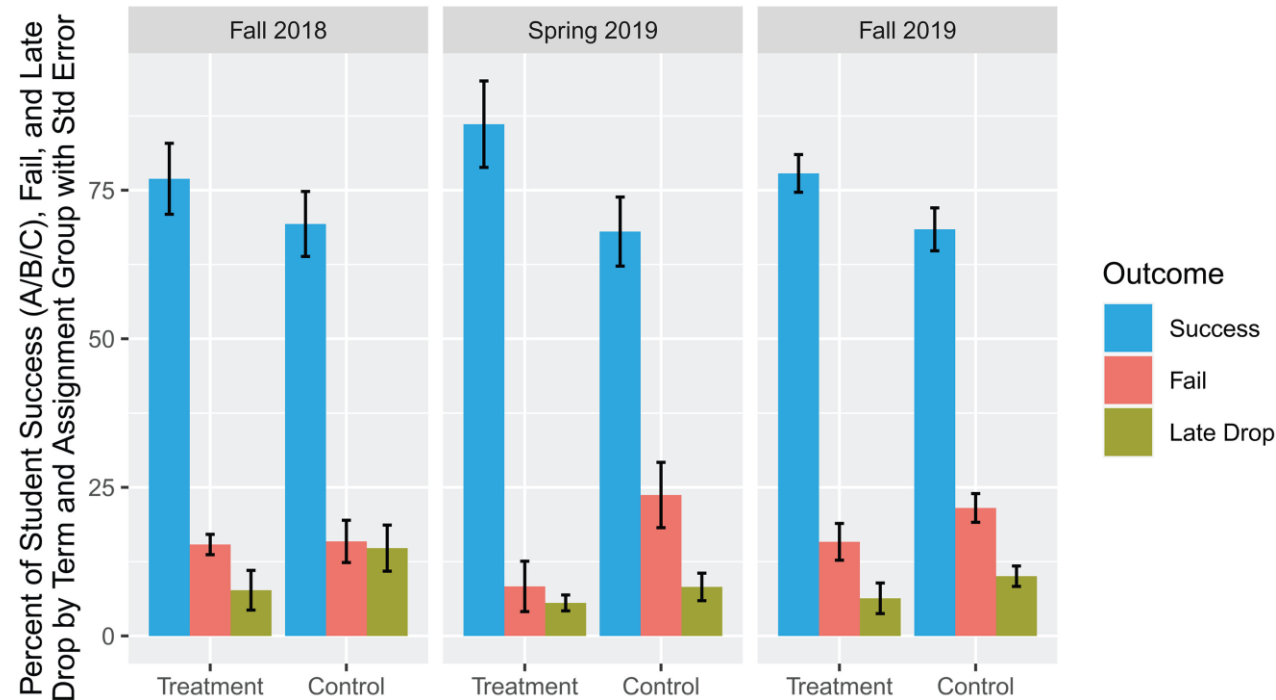
Reduces Failure Rates



Narrows Achievement Gap



Interactive Learning in Calculus



Students in the Modeling Practices in Calculus (MPC) treatment condition had improved course grades. Average grades were significantly higher by ~ 0.4 points (4.0 grade point scale) in MPC sections across all semesters of the study ($P < 0.001$, $d = 0.295$). This translated to **success rates (A, B, or C grades) averaging 11% higher** in MPC sections compared with traditional sections ($P < 0.001$, $d = 0.251$)

Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual and group accountability* (each member is accountable for the complete final outcome).

Key Concepts

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

<https://karlsmithmn.org/wp-content/uploads/2017/08/CLHks.pdf>

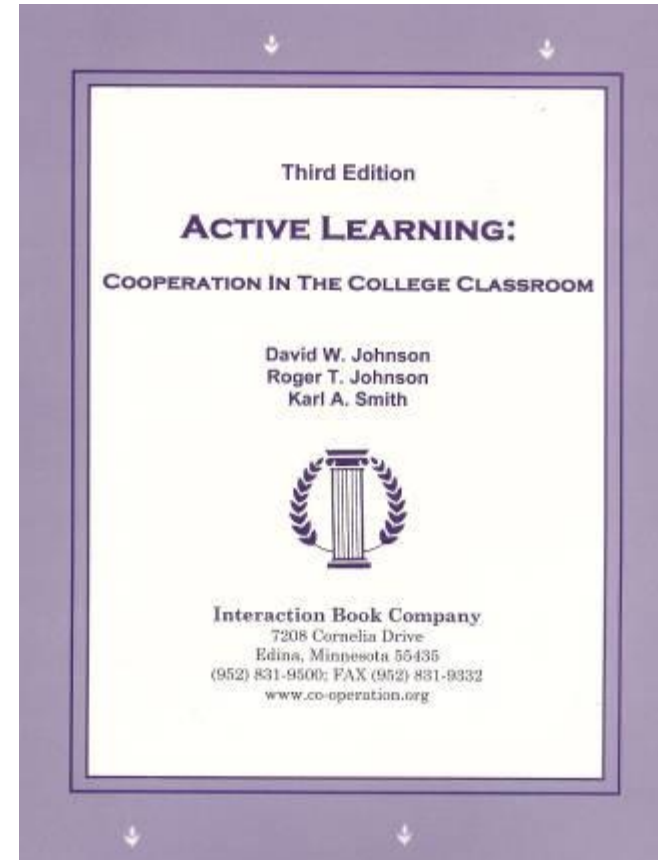
Cooperative Learning	
Positive Interdependence	Individual Accountability
Goal Interdependence (essential) <ol style="list-style-type: none">All members show masteryAll members improveAdd group member scores to get an overall group scoreOne product from group that all helped with and can explain	Ways to ensure no slackers: <ul style="list-style-type: none">Keep group size small (2-4)Assign rolesRandomly ask one member of the group to explain the learningHave students do work before group meetsHave students use their group learning to do an individual task afterwardEveryone signs: "I participated, I agree, and I can explain"Observe & record individual contributions
Role (Duty) Interdependence <p>Assign each member a role and rotate them</p>	
Resource Interdependence <ol style="list-style-type: none">Limit resources (one set of materials)Jigsaw materialsSeparate contributions	Ways to ensure that all members learn: <ul style="list-style-type: none">Practice testsEdit each other's work and sign agreementRandomly check one paper from each groupGive individual testsAssign the role of checker who has each group member explain out loudSimultaneous explaining: each student explains their learning to a new partner
Task Interdependence <ol style="list-style-type: none">Factory-lineChain Reaction	
Outside Challenge Interdependence <ol style="list-style-type: none">Intergroup competitionOther class competition	
Identity Interdependence <p>Mutual identity (name, motto, etc.)</p>	
Environmental Interdependence <ol style="list-style-type: none">Designated classroom spaceGroup has special meeting place	
Fantasy Interdependence <p>Hypothetical interdependence in situation ("You are a scientific/literary prize team, lost on the moon, etc.")</p>	
Reward/Celebration Interdependence <ol style="list-style-type: none">Celebrate joint successBonus points (use with care)Single group grade (when fair to all)	
Face-to-Face Interaction	
Structure: <ul style="list-style-type: none">Time for groups to meetGroup members close togetherSmall group size of two or threeFrequent oral rehearsalStrong positive interdependenceCommitment to each other's learningPositive social skill useCelebrations for encouragement, effort, help, and success!	

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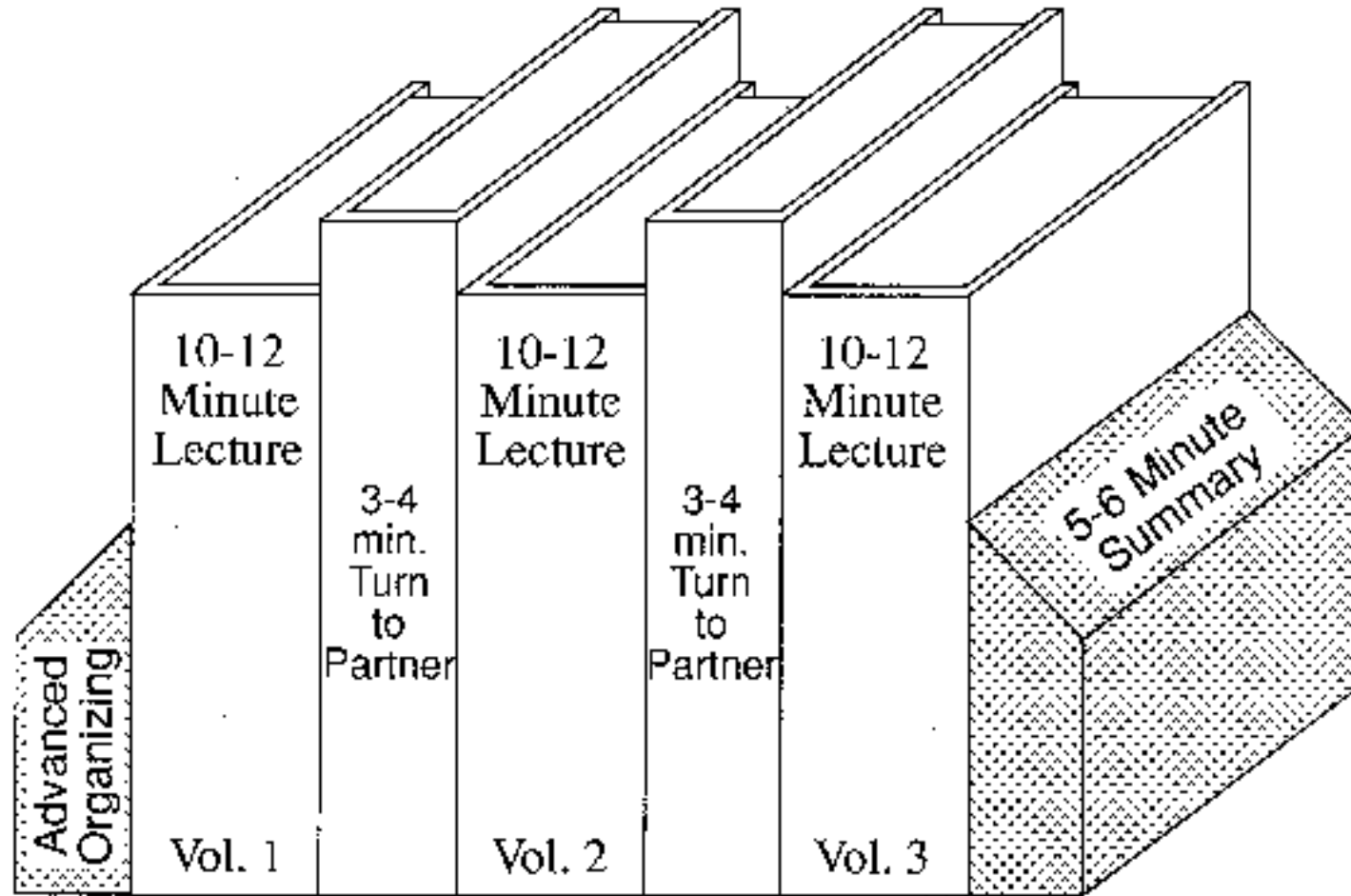
Active Learning: Cooperation in the College Classroom

- **Informal** Cooperative Learning Groups
- **Formal** Cooperative Learning Groups
- Cooperative **Base** Groups

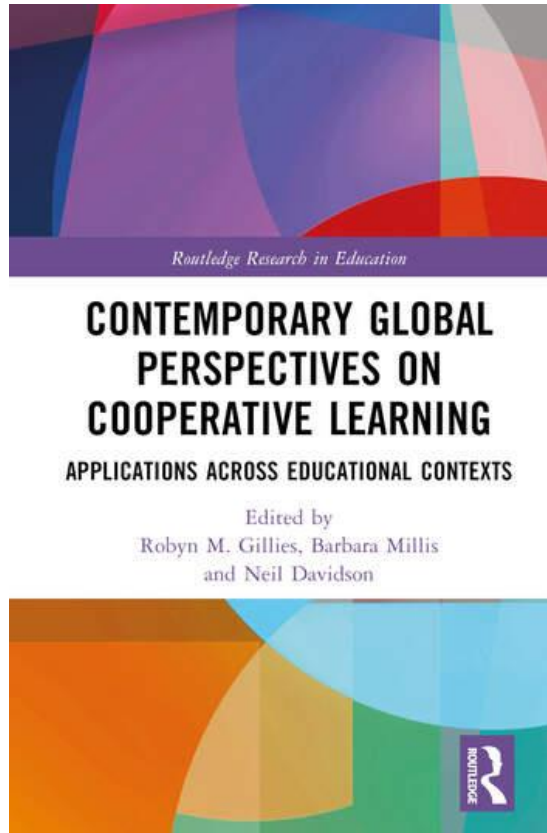
Notes: [Cooperative Learning Notes](#)



Informal Cooperative Learning (Book Ends on a Class Session)



Cooperative Learning in Engineering Education: The Story of an Ongoing Uphill Climb. Karl Smith & Rich Felder



Implementing Cooperative Learning in Engineering Courses (Formal Cooperative Learning Groups)

- 1. Team homework assignments**
- 2. In-Class Problem-Solving Teams**
- 3. Laboratory Experiments and Other Projects**
- 4. Cooperative Jigsaw**
- 5. Cooperative Problem/Project-Based Learning (PBL/PrBL)**

Session Summary (Minute Paper)

Reflect on the session

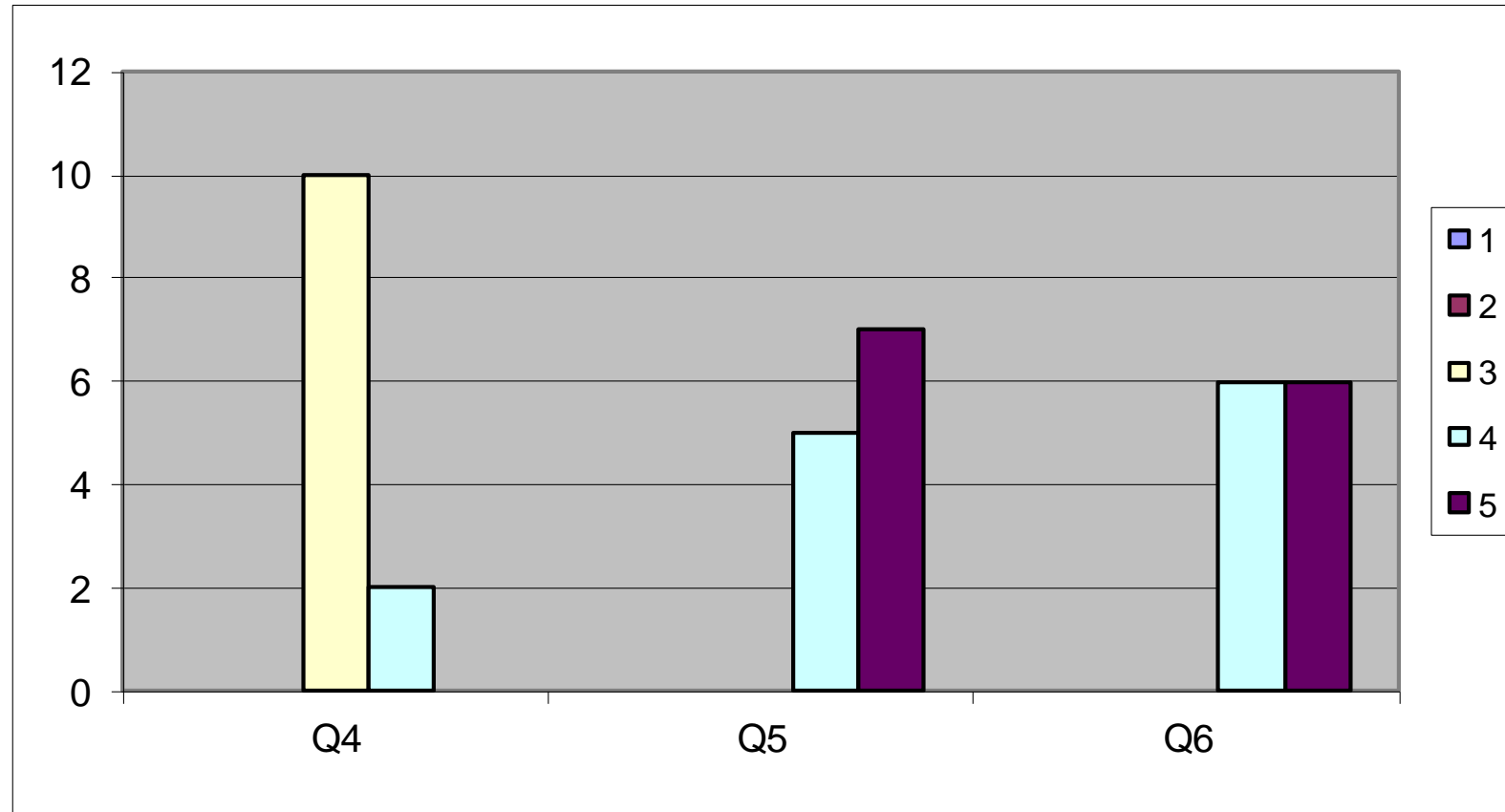
1. Most interesting, valuable, useful thing you learned.
2. Things that helped you learn.
3. Question, comments, suggestions.
4. Pace: Too slow 1 2 3 4 5 Too fast
5. Relevance: Little 1 2 3 4 5 Lots
6. Instructional Format: Ugh 1 2 3 4 5 Ah

Poll: Reflect on the session – three Likert scale questions

1. Pace: Too slow 1 2 3 4 5 Too fast
2. Relevance: Little 1 2 3 4 5 Lots
3. Instructional Format: Ugh 1 2 3 4 5 Ah



Michael Kyte Distinguished Lecture (10/5/23)

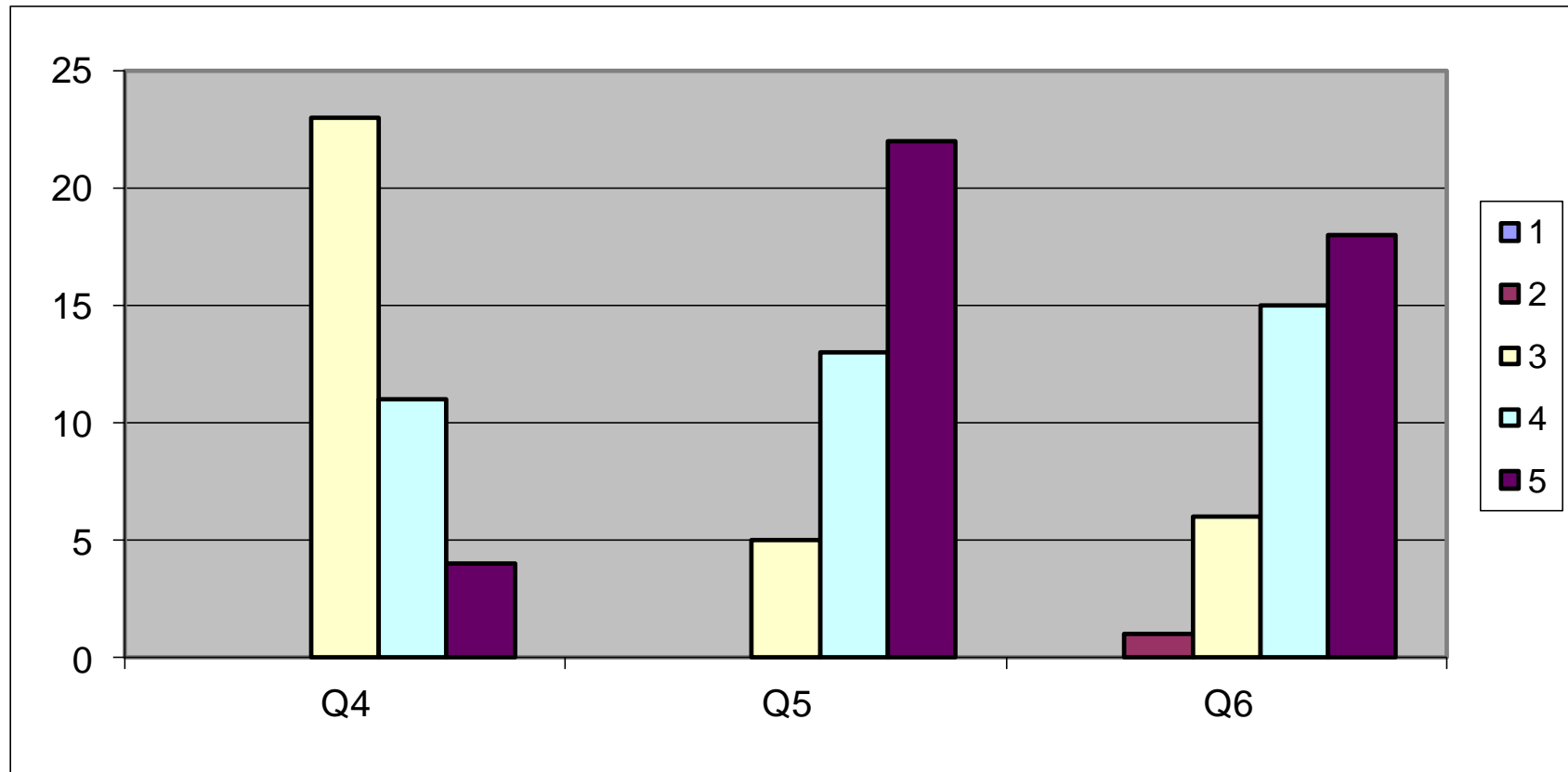


Q4 – Pace: Too slow 1 5 Too fast (3.2)

Q5 – Relevance: Little 1 5 Lots (4.6)

Q6 – Format: Ugh 1 5 Ah (4.5)

TEEW – Session 1 (5/22/18)

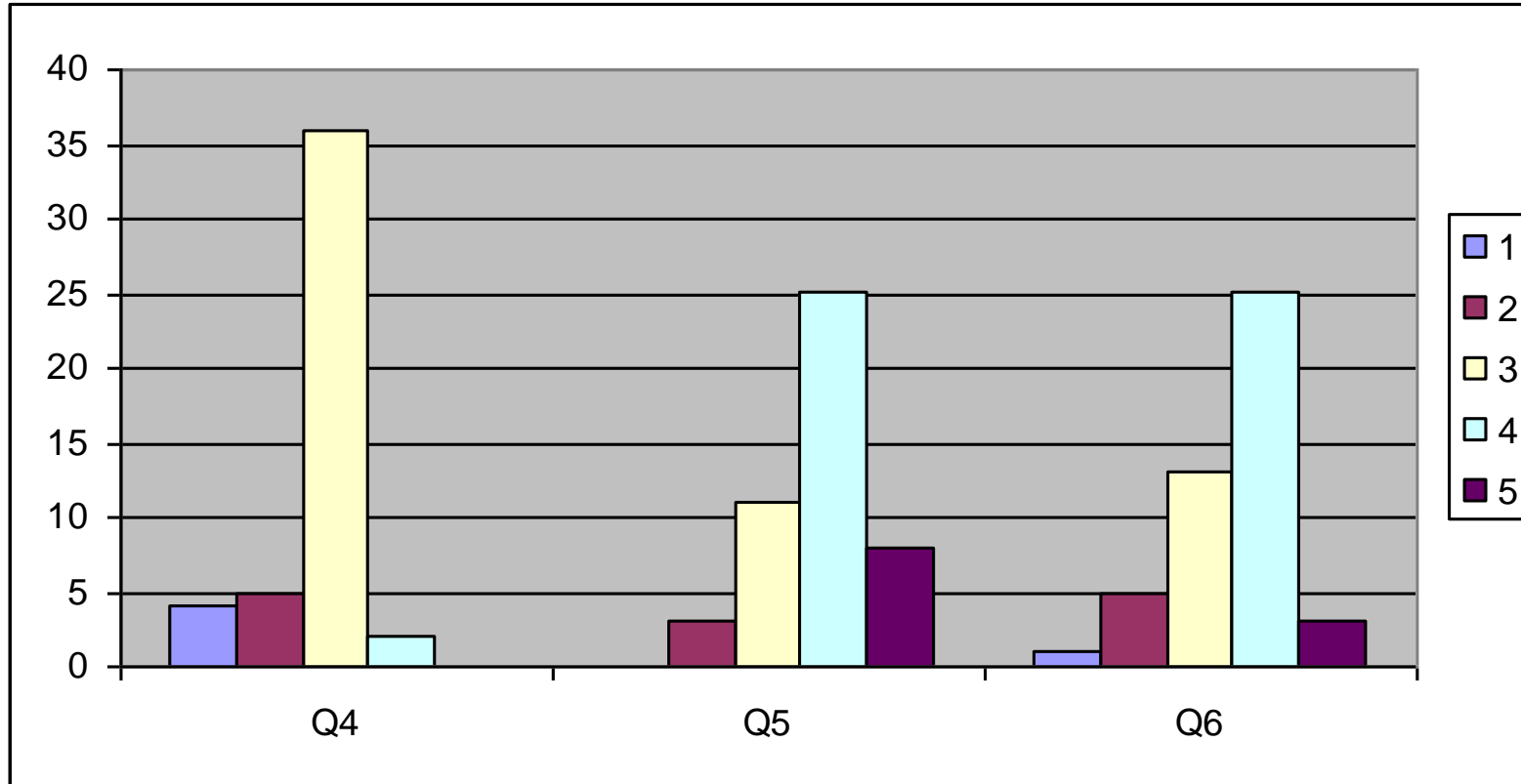


Q4 – Pace: Too slow 1 5 Too fast (3.5)

Q5 – Relevance: Little 1 5 Lots (4.4)

Q6 – Format: Ugh 1 5 Ah (4.3)

Transportation Education June 2009 – Workshop 1



Q4 – Pace: Too slow 1 5 Too fast (2.8)

Q5 – Relevance: Little 1 . . . 5 Lots (3.8)

Q6 – Format: Ugh 1 . . . 5 Ah (3.5)

Thank you!



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