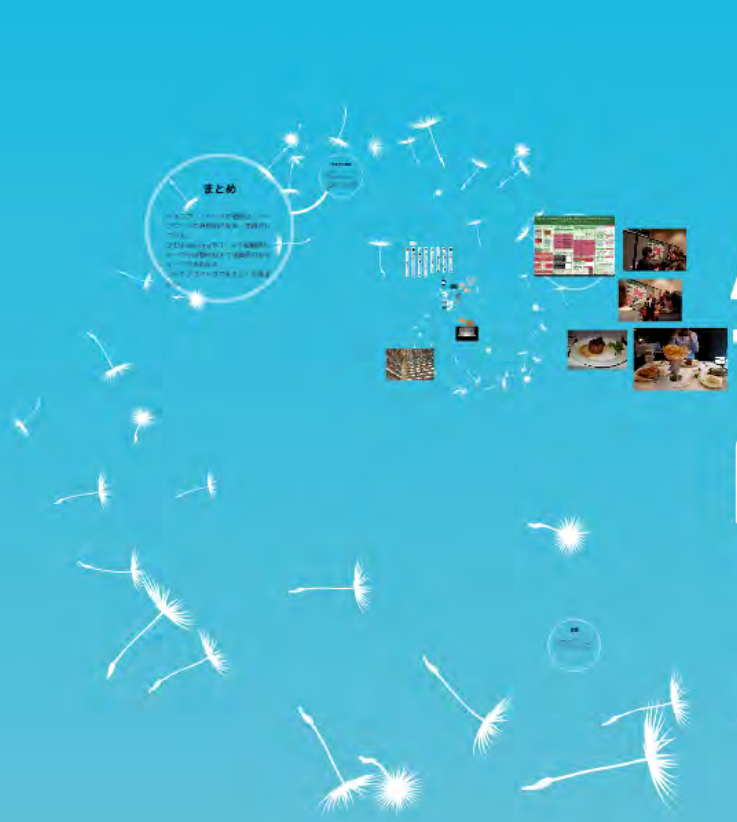

AAC&U 2018 Transforming STEM Educationの報告

北海道大学　鈴木久男

約５００名参加


AACU
Association of American Colleges and Universities
PROJECT KALEIDOSCOPE
Teach. Lead. Know. Differently.

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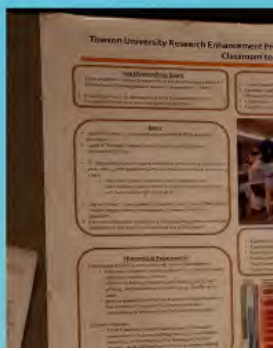
セッションスタイル

Keynote Presentation

Poster Session

Concurrent Session



Association of American Colleges and Universities
and Project Kaleidoscope

Transforming STEM Higher Education:
Confirming the Authority of Evidence

CONFERENCE PROGRAM

November 8–10, 2018 • Atlanta, Georgia

AAC&U NETWORK *for* ACADEMIC RENEWAL

PROJECT KALEIDOSCOPE
Teach. Lead. Know. *Differently.*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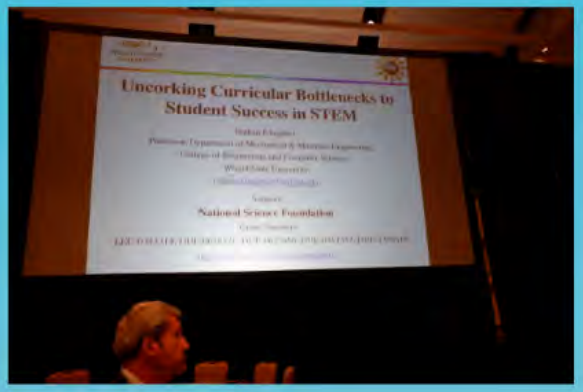

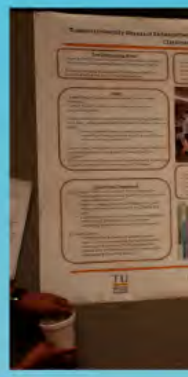

WRIGHT STATE UNIVERSITY

Uncorking Curricular Bottlenecks to Student Success in STEM

Nathan Klingbeil
Professor, Department of Mechanical & Materials Engineering
College of Engineering and Computer Science
Wright State University
nathan.klingbeil@wright.edu

Support:

National Science Foundation

Grant Numbers

EEC-0343214, DUE-0618571, DUE-0622466, DUE-0817332, DUE-1356518

http://www.cecs.wright.edu/engmath/

Keynote Presentation

Poster Session

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Keynote Presen

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Towson University Research Enhancement Program: Providing Authentic Research Experiences in the College Classroom to Better Educate all STEM Majors

Two Overarching Goals

- Create authentic research experiences via developing a series of Course-based Undergraduate Research Experiences (CUREs).
- Provide professional development (PD) for science faculty to promote effective and inclusive teaching practices.

Issue

- ~50% of Towson's undergraduates transfer in from another institution
- ~40% of Towson's natural science majors are from under-represented groups
- Of 389 natural science majors enrolled in introductory chemistry in 2011-2012, ~50% graduated with a bachelors' in natural science in 5 years
  - Given our student diversity, many students from nontraditional backgrounds are switching out of science and some will not graduate at all
- Can we "keep" more students in natural science using CUREs since we can engage many more students in research with this approach?
- If we simultaneously create more inclusive classrooms can we help students see the benefit of remaining in a STEM major?

Theoretical Framework

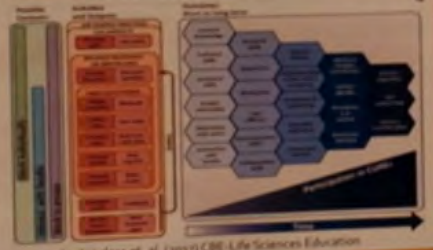
- Advantages of CUREs over traditional science laboratories:
  - help retain students including those from groups typically under-represented in science
  - effective in helping students gain research skills, self-efficacy, and persistence in science (e.g., Shaffer et al. 2010)
  - provide opportunities for more students to participate in the entirety of the scientific process while also contributing to the instructor's scholarship program.
- Situated Cognition
  - TU REP provides students with authentic research experiences in a course setting, through observations, modeling, and mentoring. This framework affords students both skill development and a contextualized understanding of scientific research.

CUREs at Towson

- Course-based undergraduate research experience
- Semester-long inquiry into a topic within the research expertise of the faculty instructor
- 2 credit lab or field courses, meet for 6 hours/week
- Taught by faculty member with Undergraduate Learning Assistants

Additional Student Support

- Preferential enrollment in upper-level courses
- Dedicated TU-REP faculty advisors
- Funding to travel to conferences
- Dedicated meeting/workspace
- Paid Undergraduate Learning Assistant positions
- Opportunities to learn more about STEM internships and careers



Auchincloss et. al. (2013) CBE-Life Sciences Education

Professional Learning Community

- Cohort-based
- Faculty Mentorship and Support
- Year-round PD (Monthly, 50 Total Hours per year)
- Speaker Series
  - Spotlight on CURE Courses
  - CURE Course Development: Science Education Pedagogical Strategies (Course Storylines, Inquiry, NOS, Scientific Practices, Assessment)
  - Diversity and Inclusion
- Journal Club
  - Characteristics of CURE Course, CURE Course Development/Implementation/Assessment
- Blackboard Discussion Group
- Summer Sessions and Symposium

Program Evaluation

1. Curriculum component
   - What are components of CUREs? What behaviors occur in these courses?
2. Student component
   - Does CURE participation impact how students think about scientific research? How do students' beliefs in the process of science change as they take CURE courses?
3. Faculty component
   - How might faculty thinking change during CURE and inclusion professional development? How does PD affect implementation of CURE courses?

Program Outcomes to Date

- CURE offerings
  - One new course in Spring 2018 plus two existing courses
  - Three new courses in Fall 2018 plus three existing courses
- Student Responses
  - Spring 2018 students responded "very large [illegible] learning laboratory techniques, nature of [illegible] confidence
- 7 faculty participated in first PLC Cohort
  - Reported increased knowledge of C[illegible] approaches
  - Need more emphasis on practic[illegible] teaching

Laura Gough (lgough@towson.edu)
Rommel Miranda (rmiranda@towson.edu)
Trudymae Atuobi (tatuobi@towson.edu)
Matthew Hemm (mhemm@towson.edu)
Chris Oufiero (coufiero@Towson.edu)

TU RESEARCH ENHANCEMENT PROGRAM

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INTRODUCTION

COMPETENCIES IN EXPERIMENTATION MODEL

POSTER 18:
TU REP: Providing Authentic Research Experiences in the College Classroom to Better Educate all STEM

Laura Gough, Rommel Miranda, [illegible] Matthew Hemm

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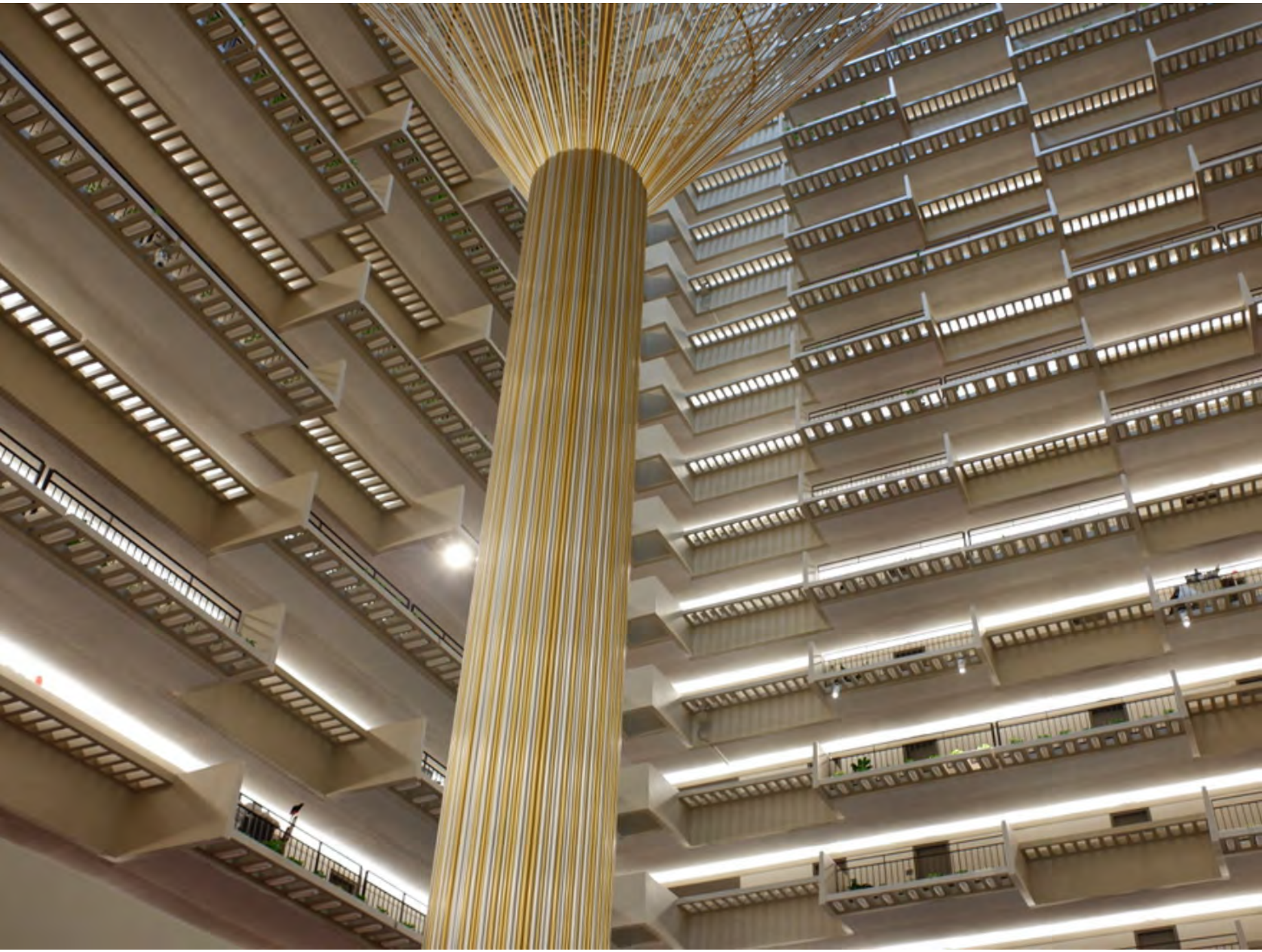
Rommel Miranda



Fostering Open-Ended Problem-Solving Skills of Undergraduate STEM Students: Attempts in Asian Universities

Hisao Suzuki (Hokkaido University), Keiichiro Yoshinaga (Kanazawa University), Jun Saito (Obihiro University of Agriculture and Veterinary Medicine)

Educational Reform in Asian Countries

STEM education reform is going on in many universities in Asian countries.

Nanyang Technological University(Singapore) has a building for active learning classes

Department of Engineering, Sydney University (Australia); They are trying to change all lecture rooms into ones for active learning

Hong Kong University of Science and Technology opens rooms for extracurricular experiments aiming for enhancing students' external motivation

Peking University and Tsinghua University (China) also provide rooms for active learning (flipped classroom)

Fudan University (China) opens classes for medical physics aiming for increasing motivation of physics major students

In Japan, the notion of active learning is getting popular. The purpose is to enhance generic skills like those described in the Essential Learning Outcomes of AAC&U.

The purpose of the reform is not to improve the level of understanding of STEM students nor to increase the number of STEM students, but to enhance the skills for the 4th industrial revolution.

Problem-Solving Skills

Problem Solving in the traditional undergraduate STEM education ≠ Problem Solving in the real world

In the integrated Science course provided at Hokkaido University, we have been developing problems which foster the problem-solving skills for the real world.

Classification of Problems

1. Structural classification (Johnstone, 1993, Woods and Sleet 1993)

Type	Data	Methods	Outcome /goals	Skills
1	given	Familiar	Given	Recall of algorithm
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Type 1: Algorithm Problems (textbook problems, test problems)

Type 2~8: Open ended Problems (appear in the real world, research and business)

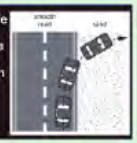
Use of open-ended problems in Education

Scottish Qualifications Authority(SQA) , the entrance exams

Physics

The use of analogies from everyday life can help better understanding of physics concepts. A car moving from a smooth surface to a rough surface, from a road to sand, can be used as an analogy for the refraction of light.

Use your knowledge of physics, comment on this analogy.



Chemistry

Aspirin is widely used as a medicine. The structure of aspirin is shown on the right.

Using your knowledge of chemistry, comment on physical and chemical properties you would expect aspirin to demonstrate.

Advantage
1)Students can answer questions based on their knowledge and understanding at the moment.
2)Not true or wrong: the average score can be higher. (Compere to ConcepTests)
3)Transferrable skills can be scored. (Written communication skills)

2. Problem type classification (Jonassen 2000)

Type	Class	Examples	Familiarity in Undergraduate STEM Education
1	Logical Problems	Rubik's cube, proofs of mathematical theorem	Familiar in mathematics, Physics
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3	Story Problems	Real world mathematics, physics	Familiar Context-rich problems
4	Rule using Problems	Formula using problem	Familiar
5	Decision Making Problems	Decision in Stock trading, Decision in situation change	Unfamiliar
6	Trouble-shooting	debugs	Familiar in programming and engineering but rare in other science
7	Diagnosis-Solution Problems	Evaluating treatment options	Unfamiliar
8	Strategic Performance problems	Applying tactics in real time negotiation	Unfamiliar
9	Case Analysis Problems	Law school problems	Unfamiliar
10	Design Problems	Planning problems	Unfamiliar
11	Dilemmas	Dilemma in real world, very familiar in real world	Unfamiliar

Attempts for problem-solving skills

The Integrated Science Course at Hokkaido University: Covering Physics, Chemistry, Astronomy, Earth Science, Biological Science by using various kinds of problems to enhance problem-solving skills

Physics — **Design Problem**

Shotgun bullets was made by templates. But William Watts invented a clever way to make shotgun ammo in 1782 without using templates. Guess his method. (Design problem)

Physics — **Case Analysis Problem**

Johannes Kepler is famous for establishing Kepler's law. But his mother was accused as a witch. How should he prove that his mother was not a witch?

Assume that the principle of "in dubio pro reo" (a defendant may not be convicted by the court when doubts about his or her guilt remain) could not apply at that time.

Environmental Science — **Decision making problems**

Which is the most economical car?
1. Toyota Prius (Hybrid car)
2. Toyota Prius PHV (Plug in hybrid)
3. Nissan Leaf (Electric car)
4. Nissan Note (gas, compact car)

The answer depends on how students define "economical"; miles per month, re-sale value…. There is no right answer but the problem would evaluate the logical thinking and decision making skills.

Biology — **Trouble Shooting**

Some students says "I think that the degeneration is the same as the evolution in biology. Evolution is a genetic change to the direction that is favorable for species. Otherwise we cannot explain the reason why all the fishes in a dark cave do not have eyes." Comment on his explanation.

Biology — **Dilemmas**

Some scientist claims that the Vitamin C cures cancers. How do you prove or disprove his claim? Consider ethics.

Biology — **Trouble Shooting**

We can get the information about genetic cancer or Down syndrome before birth. Discuss the advantage and disadvantage and find your answer for whether you will have the tests. Consider ethics and the lives of your descendant after your death.

Math — **Open-Ended problem**

Some student said that the trigonometric addition theorems can be derived by using vectors.

Using your knowledge of mathematics, comment on his statement.

Conclusions and Discussions

We have been using various kinds of problems to enhance the problem-solving skills in the integrated science course at Hokkaido University.

Disadvantage: We do not know how to analyze the effectiveness.
Could be compared to what?
However,
when we stress the importance of problem-solving skills, the students are willing to try to solve these problems which do not appear in usual classes of STEM!

Obihiro University of Agriculture and Veterinary Medicine · 金沢大学 Kanazawa · HOKKAIDO UNIVERSITY

n-Ended Probl

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Hisao Suzuki (Hokkaido University

ntries

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Hisao Suzuki (Hokkaido University), Keiichi

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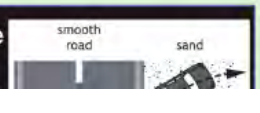

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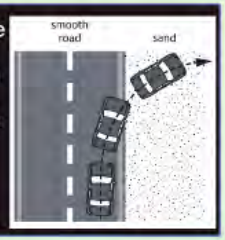

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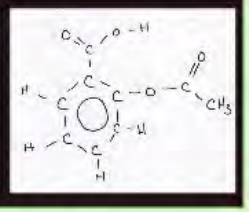

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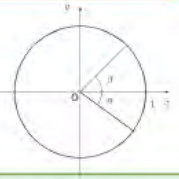

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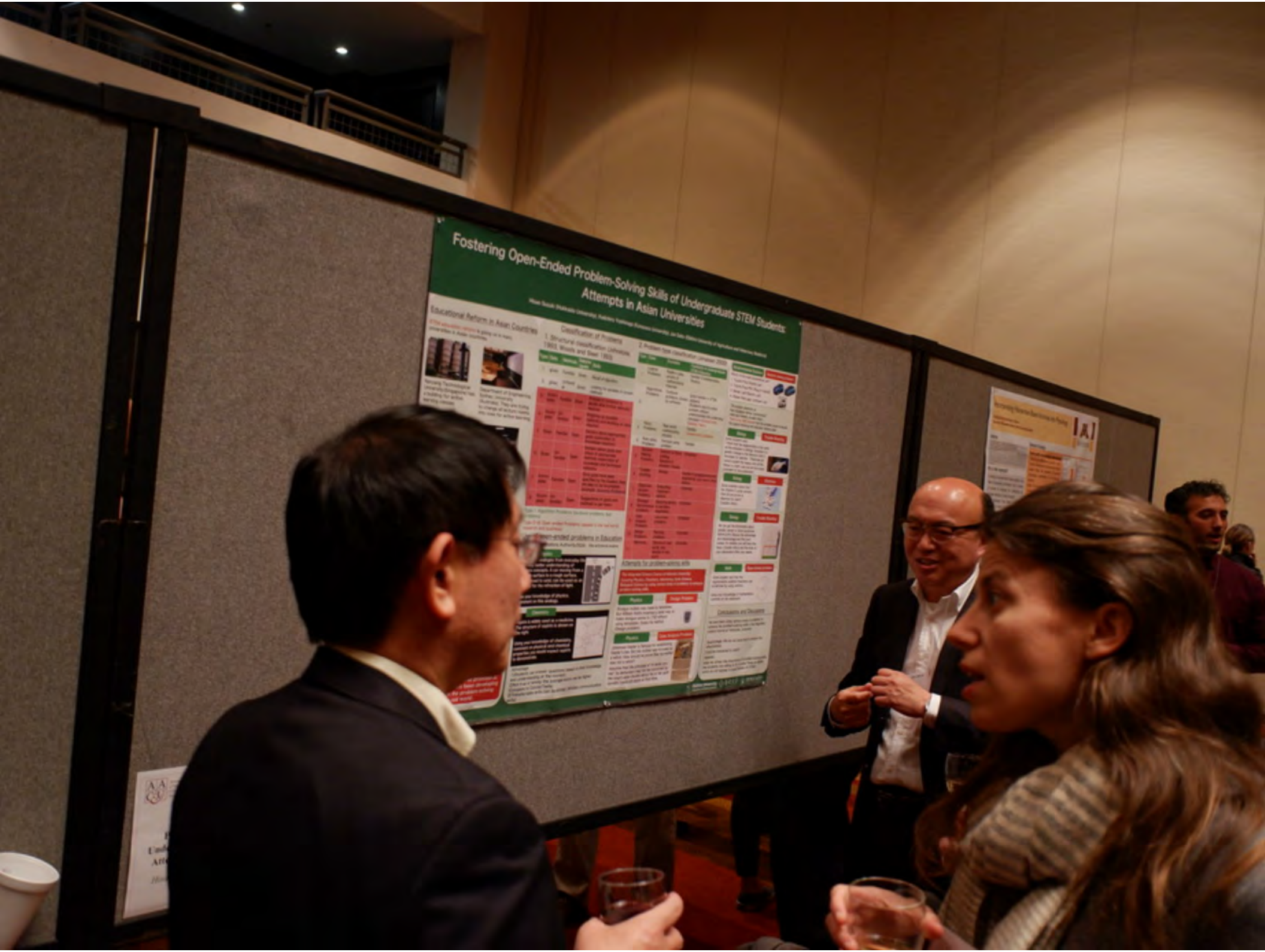
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Problem-Solving Skills

Poster Session

Concurrent Session

まとめ

ディシプリンベースの話題は、ディシプリンの分野別に研究、実践されている。
STEM Meetingでは、より組織的なテーマや分野を超えて普遍性のあるテーマが扱われる。
エビデンスベースであることが望ましい。

日本での課題

日本では学会ベースで、分野別教育研究が行われている。
STEM領域では教育に共通点が多い。
分野を超えて横断的にあるいは組織的改善の実践について議論する場が少ない。

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提案

大学教育学会のSTEM グループが
AAC&UのSTEMグループの役割を担
うと、学会の幅が大きく広がるはず