

A decorative graphic on the left side of the slide features a circular arrangement of dandelion seeds blowing in the wind. In the center of this arrangement is a collage of small images, including a presentation slide, a person working at a computer, and various food items. To the left of the collage is a circular text box with the title 'まとめ' (Summary) and several lines of Japanese text.

AAC&U 2018 Transforming STEM Educationの報告

北海道大学 鈴木久男



約500名参加





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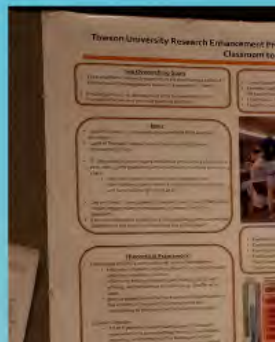


セッションスタイル

Keynote Presentation

Poster Session

Concurrent Session



Association of American Colleges and Universities
and Project Kaleidoscope



Transforming STEM Higher Education:
Confirming the Authority of Evidence >>

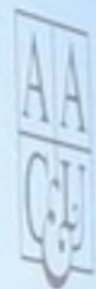
CONFERENCE PROGRAM

November 8–10, 2018 • Atlanta, Georgia





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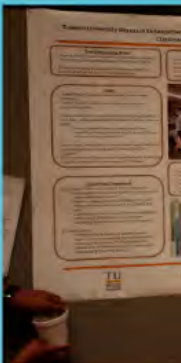
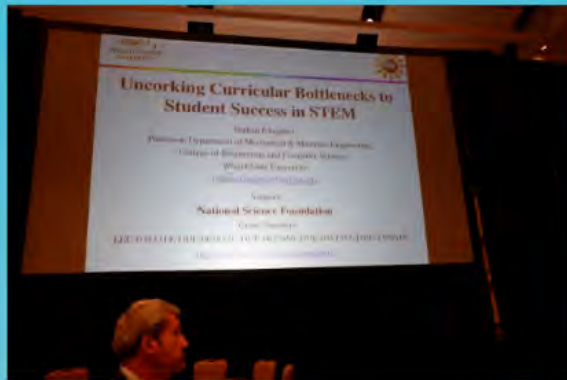
PROJECT
KALEIDOSCOPE
Teach, Lead, Inspire, Open Up

セッションスタイル

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Uncorking Curricular Bottlenecks to Student Success in STEM

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

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

Keynote Presentation

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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 bachelor's 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.

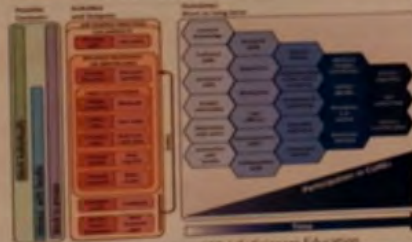
CUREs at Towson

- Course-based undergraduate research experience
- Semester-long inquiry into a topic within the research expertise of the faculty instructor
- A 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. (2017) CBE: Life Sciences Education

Professional Learning Community

- Cohort-based
- Faculty Mentorship and Support
- Year-round PD (Monthly, 30 Total Hours per year)
- Speaker Series
 - Spotlight on CURE Courses
 - CURE Course Development: Science Education Pedagogical Strategies (Course Storytelling, 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 Symposiums

Program Evaluation

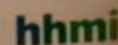
- Curriculum component
 - What are components of CUREs? What behaviors occur in these courses?
- Student component
 - Does CURE participation impact how students think about scientific research? How do students' beliefs in the process of science change as they take CURE courses?
- Faculty component
 - How might faculty thinking change during CURE and inclusion professional development? How does PD effect 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 positive learning laboratory techniques, nature of science confidence"
- Faculty participation in first PLC Cohort
 - Reported increased knowledge of CURE approaches
 - Need more emphasis on practicing teaching



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

Laura Gough, Rommel Miranda,
 Trudymae Atuobi, Matthew Hemm

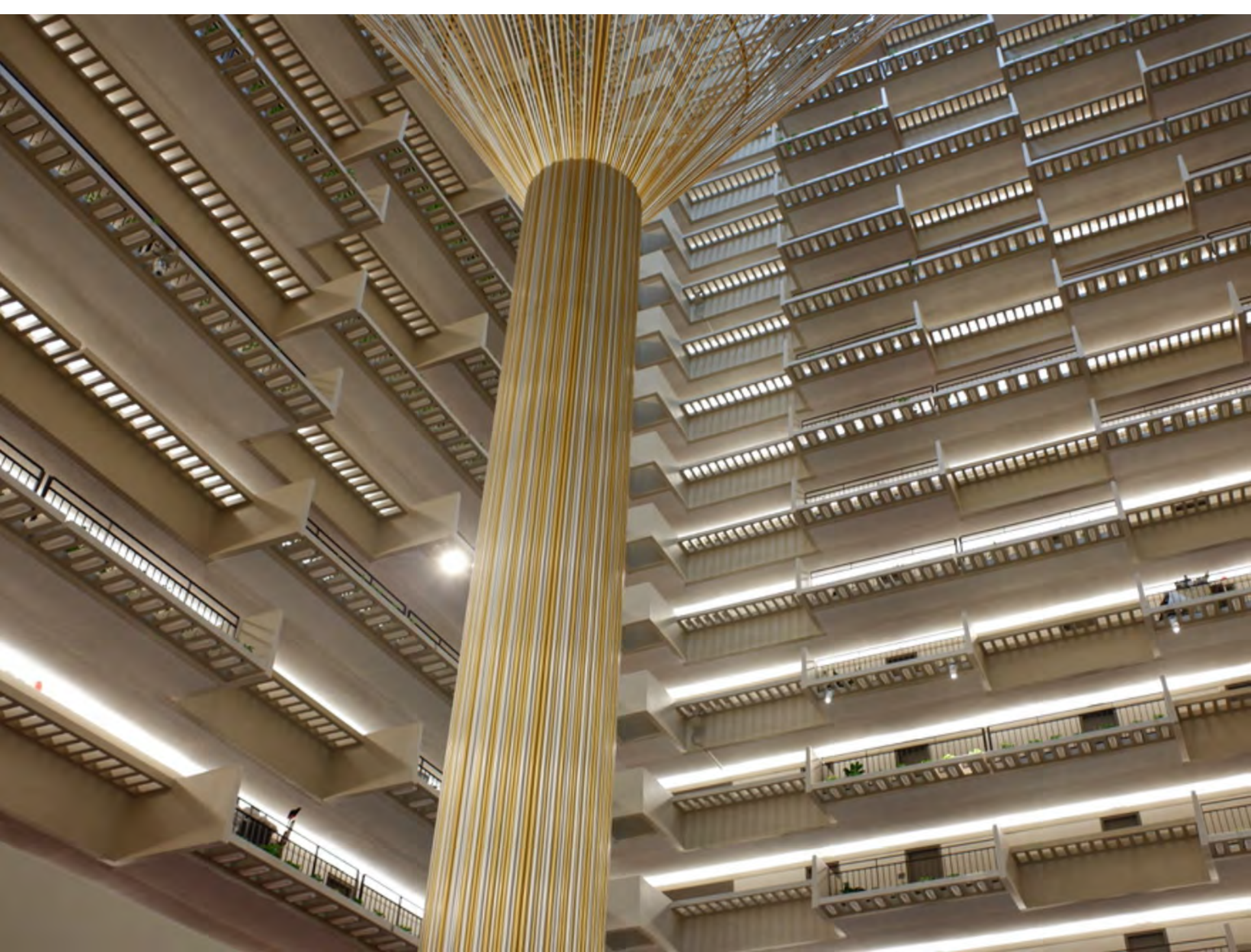
INTRODUCTION

As labs move away from traditional or "cookbook" lab towards course-based research experiences (CUREs), the learning objectives are shifting as well. Learning objectives for traditional labs generally focus on concepts from lectures or on lab techniques and send themselves to a clear set of learning objectives and progression through them. Learning objectives for CUREs tend to be more self-paced, focusing on the process of science and experimentation. The set of learning objectives and the order in which to teach them for CURE style lab courses is not well defined.

COMPETENCIES IN EXPERIMENTATION MODEL

An NSF-funded Research Coordination Network in Advancing Competencies in Experimentation (ACE-RI) has developed a set of Best Competencies of Biological Experimentation about underlying experimental research topics across 16 journals (biology, chemistry, earth and space sciences, engineering, life sciences, medicine, physics, psychology, social sciences, and technology).





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
2	given	Unfamiliar	Given	Looking for parallels to known methods
3	Incomplete	Familiar	Given	Analysis of problems to decide what further data are required
4	Incomplete	Unfamiliar	Given	Weighing up possible methods and deciding on data required
5	Given	Familiar	Open	Decision about appropriate goals; exploration of knowledge networks
6	Given	Unfamiliar	Open	Decision about goals and choice of appropriate methods; exploration of knowledge and technique networks
7	Incomplete	Familiar	Open	Once goals have been specified by the student, they are seen to be incomplete (example: Jeopardy Problems)
8	Incomplete	Unfamiliar	Open	Suggestions of goals and methods to get there

Type 1: Algorithm Problems (textbook problems, test problems)

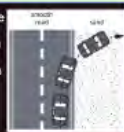
Type 2-8: Open ended Problems (appear in the real world, research and business)

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, 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. (Compare to ConceptTests)
- 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
2	Algorithmic Problems	Textbook problems, Solved by software	Quite Familiar in STEM subjects (Students tend to solve problem without understanding the underlying concepts -ConceptTests, Ranking Tasks)
3	Story Problems	Real world mathematics, physics	Familiar
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
7	Diagnosis-Solution Problems	Evaluating treatment options	Unfamiliar
8	Strategic Performance problems	Applying tactics in real time negotiation	Unfamiliar
9	Analysis Problems	Low 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!

n-Ended Problems

Att

Hisao Suzuki (Hokkaido University)

entries

Classification

1. Structural classification

Problem-Solving Skill

Attempts in Asian U

University), Keiichiro Yoshinaga (Kanazawa Univ

Classification of Problems

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2. Proble

Type	Class
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Jun Saito (Obihiro University of Agriculture and Veterinary Medicine)

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The answer depends on

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4	Incomplete	Unfamiliar	Given	Weighing methods to decide what is required
5	Given	Familiar	Open	Decision on goals; expert knowledge
6	Given	Unfamiliar	Open	Decision on choice of methods; knowledge of networks
7	Incomplete	Familiar	Open	Once goals are specified, the methods are seen to be required (example)
8	Incomplete	Unfamiliar	Open	Suggesting methods

Type 1: Algorithm Problems (textbook problems)

Type 2~8: Open ended Problems (appear in research and business)

but to enhance the skills for the 4th industrial revolution.

Problem-Solving Skills

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

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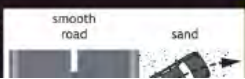
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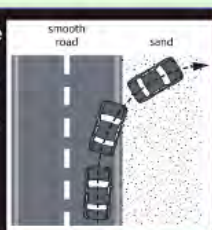
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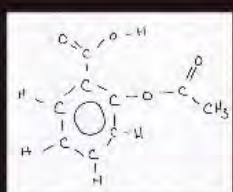
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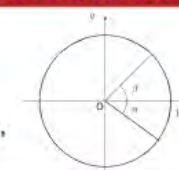


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Disadvantage: We do not know how to analyze the effectiveness.

Could be compared to what?

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

Wen Shou (Shanghai University), Katsuko Yamaguchi (Kansai University), Jan Sam (Slovak University of Agriculture in Mlada Boleslav)

Educational Reform in Asian Countries

Over the last decade, many Asian countries have been undergoing educational reforms. The reforms are aimed at improving the quality of education and fostering the development of students' problem-solving skills. This paper discusses the current status of educational reforms in Asian countries and the challenges faced by universities in fostering open-ended problem-solving skills of undergraduate STEM students.



Classification of Problems

1. Structural Classification (Lesh, 1993; Woods and Beer, 1993)

Problem Type	Characteristics	Example
1. Well-structured	Clear goal, known solution path	Mathematical problems
2. Semi-structured	Partial information, multiple solution paths	Engineering problems
3. Ill-structured	Unclear goal, no known solution path	Real-world problems

Problem-Solving Process

Stage	Characteristics	Example
1. Problem identification	Understanding the problem, identifying the goal	Identifying the problem in a real-world situation
2. Problem analysis	Breaking down the problem into smaller parts, identifying the underlying principles	Identifying the underlying principles in a complex problem
3. Solution development	Developing a solution plan, implementing the plan	Developing a solution plan for a complex problem

Challenges and Recommendations

The challenges faced by universities in fostering open-ended problem-solving skills of undergraduate STEM students are: (1) Lack of resources, (2) Lack of faculty expertise, (3) Lack of student motivation. The recommendations are: (1) Increase resources, (2) Provide faculty training, (3) Encourage student motivation.

Open-ended problems in Education

Open-ended problems are those that do not have a single correct answer. They are designed to encourage students to think critically and creatively. Open-ended problems are often used in education to assess students' problem-solving skills. This paper discusses the importance of open-ended problems in education and the challenges faced by educators in designing and implementing them.

Attempts to address them with

Several attempts have been made to address the challenges of open-ended problems in education. These include: (1) Providing students with more resources, (2) Encouraging students to work in groups, (3) Providing students with more feedback. These attempts have shown some success in fostering students' problem-solving skills.

Conclusions and Remarks

The paper concludes that open-ended problems are an important part of education. They are designed to encourage students to think critically and creatively. Open-ended problems are often used in education to assess students' problem-solving skills. The paper also discusses the challenges faced by educators in designing and implementing open-ended problems and provides some recommendations for addressing these challenges.

Extended Problem-Solving Skills of Undergraduate STEM Students: Attempts in Asian Universities

Shinichi Suzuki (Shizuoka University), Katsuhiko Yoshida (Shizuoka University), Jun Sato (Shizuoka University of Science and Technology)

Educational Reform in Asian Countries

Universities in Asian countries are getting on with many educational reforms.



Shizuoka University of Science and Technology (Shizuoka University of Science and Technology) is a leading university for active learning.

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Classification of Problems

1. Structural classification (Lewy, 1959; Woods and Sweet, 1983)

Type	Goal	Method	Process	Result
1	Goal	Method	Process	Result
2	Goal	Method	Process	Result
3	Goal	Method	Process	Result
4	Goal	Method	Process	Result
5	Goal	Method	Process	Result
6	Goal	Method	Process	Result
7	Goal	Method	Process	Result
8	Goal	Method	Process	Result
9	Goal	Method	Process	Result
10	Goal	Method	Process	Result

2. Problem type classification (Lewy, 1959)

Type	Goal	Method	Process	Result
1	Goal	Method	Process	Result
2	Goal	Method	Process	Result
3	Goal	Method	Process	Result
4	Goal	Method	Process	Result
5	Goal	Method	Process	Result
6	Goal	Method	Process	Result
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Use of open-ended problems in Education

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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