



**BLYE FRANK**

Dean, Faculty of Education

UNIVERSITY OF BRITISH COLUMBIA

It gives us great pleasure to welcome educators and researchers from around the globe to the 3rd International STEM Education Conference here at UBC. With partners Beijing Normal University & Queensland University of Technology, the international STEM conferences have had a significant impact on Science, Technology, Engineering and Mathematics education.



**TOM SORK**

Senior Associate Dean, Faculty of Education

UNIVERSITY OF BRITISH COLUMBIA

The University of British Columbia and the Faculty of Education are indeed honoured to host delegates to our beautiful campus where we are all hosted by the Musqueam people. "STEM Education and Our Planet: Making Connections Across Contexts" is very much aligned with our principles and values.

We hope you find your time to be full of informative and interesting keynotes, presentations and discussions that will assist in advancing STEM Education.



**SAMSON MADERA NASHON**

Chair, 2014 STEM in Education Conference

Professor, Faculty of Education

UNIVERSITY OF BRITISH COLUMBIA

It is with great pleasure that I welcome everyone to the third "STEM in Education" conference. This series of biennial conferences was initiated by the Deans of Education of Queensland University of Technology (QUT), Beijing Normal University (BNU), and University of British Columbia (UBC) to promote international scholarly work including networking and research on STEM Education.

We at UBC are pleased to be hosting this third conference on the theme of "STEM Education and our Planet: Making Connections

## EXECUTIVE COMMITTEE

### UBC MEMBERS

ANN ANDERSON

DAVID ANDERSON

MARINA MILNER-BOLOTIN

SAMSON NASHON

STEPHEN PETRINA

### QUT MEMBERS

PROFESSOR KAR-TIN LEE

DR. VINESH CHANDRA

PETER HUDSON

### BNU MEMBERS

SU CAI

FENG-KUANG CHIANG

SHENGQUAN YU

Across Contexts." High quality paper presentations, workshops, symposia and posters will characterize this year's conference, and we hope you will have an engaging and enjoyable experience here in Vancouver.

On behalf of my colleagues at UBC, I welcome you to our campus and look forward to our four days together.

DAY 1: SATURDAY, JULY 12			
7:30-1:00	REGISTRATION   ESB Lobby		
9:00-10:15	<p>WELCOME ADDRESS &amp; KEYNOTE SPEAKER   ESB 1013</p> <p><b>WELCOME &amp; OPENING REMARKS:</b> Tom Sork   University of British Columbia, Canada Senior Associate Dean, International &amp; Administration, Faculty of Education</p> <p><b>KEYNOTE:</b> David Clarke   University of Melbourne, Australia DISCIPLINARY INCLUSIVITY IN EDUCATIONAL RESEARCH DESIGN: PERMEABILITY AND AFFORDANCES IN STEM EDUCATION</p>		
10:15-10:45	<p>NUTRITION BREAK   ESB Lobby</p> <p>POSTER PRESENTATIONS   ESB Lobby</p> <p>1.0.1 THE CHOICE OF TECHNOLOGY IN TEACHING READING AND WRITING LANGUAGE SKILLS <i>Ting Liu, Sepideh Fotovatian</i></p> <p>1.0.2 IMPACT OF GLOBAL CLIMATE CHANGE MONITORING ACTIVITIES ON SOUTH KOREAN 7 GRADE STUDENTS' PERCEPTIONS <i>Hyoungbum Kim, Patrice Potvin, Eun-Ji Amy Kim</i></p> <p>1.0.3 EFFECTS OF STEAM LESSONS USING SCRATCH PROGRAMMING REGARDING SMALL ORGANISMS IN ELEMENTARY SCIENCE <i>Youngmi Choi, Seung-Ho Hong</i></p> <p>1.0.4 BEGINNING EARTH SCIENCE TEACHERS' PERCEPTIONS IN INFORMAL STEAM EDUCATION IN KOREA <i>Hong Jin Kwon, Eun Ki Ban, Chan-Jong Kim</i></p> <p>1.0.5 INVESTIGATING ACTIONS AND INTERACTIONS AT A SUMMER SCIENCE AND TECHNOLOGY CAMP <i>Carol Ann, B. Rees, Spencer Morran</i></p>		
10:45-12:15	<p>CONCURRENT SESSION #1</p> <table> <tr> <td> <p><b>1.1 SWING 105</b></p> <p>1.1.1 A NEW DISCIPLINARY MODEL FOR INCREASING THE NUMBER OF UNDERREPRESENTED MINORITIES IN THE MATHEMATICAL SCIENCES <i>Leslie McClure, Casey George-Jackson, Phillip Kutzko, Kathryn Chaloner</i></p> <p>1.1.2 TEACHING FOR RELEVANCE: LINKING SCIENCE INSTRUCTION TO STEM CAREER AWARENESS <i>Isha DeCoito, Tasha Richardson, Daniella DiLucia, Philip Myszkal, Stephanie Florence</i></p> <p>1.1.3 MENTORSHIP AS SOCIALIZATION: AFRICAN AMERICAN WOMEN IN ENGINEERING AT HBCUs <i>Ezella McPherson, Virginia Tickle</i></p> <p><b>1.3 SWING 109</b></p> <p>1.3.1 A CAUTIOUS SECONDARY SCHOOL APPROACH TO THE T IN STEM <i>P John Williams, Mathew Thomas</i></p> <p>1.3.2 WHAT ARE YOU LOOKING AT? GRADUATE-ENTRY PRE-SERVICE TEACHERS' PERCEPTIONS OF STEM PEDAGOGY <i>Michelle Mukherjee, Margaret Lloyd</i></p> </td><td> <p><b>1.2 SWING 107</b></p> <p>1.2.1 CO-ORDINATION AND CONTROL: CONNECTING THE CAPABILITIES OF CHILDREN WITH/IN AN EDUCATIVE STEM CONTEXT <i>Steven Khan, Krista Francis, Brent Davis</i></p> <p>1.2.2 (TWO-WAY LEARNING) KISKIAUMATOWIN IN SUPPORT OF SASKATCHEWAN'S MULTI-VOCAL K-9 SCIENCE CURRICULUM <i>Sandy Marie Bonny</i></p> <p>1.2.3 ARGUMENTATION SCHEMES: A WINDOW ON INTERNATIONAL, INDIGENOUS AND WESTERN SCIENCES <i>Robert Anthony, Mijung Kim</i></p> <p>1.2.4 KOREAN ELEMENTARY STUDENTS' PERCEPTION ON STEAM LEARNING OPPORTUNITIES (STEAM LO) <i>Yumin Ahn, Won-Young Jung, Eun Ji Park, Seung Urn Choe, Chan-Jong Kim</i></p> <p><b>1.4 SWING 309</b></p> <p>1.4.1 PREPARING STUDENTS FOR LABORATORY CLASSES AND REDUCING COGNITIVE OVERLOAD USING INTERACTIVE ONLINE PRE-LAB TUTORIALS <i>Tracey Kuit</i></p> <p>1.4.2 CONNECTING ELEMENTARY AND ADVANCED MATHEMATICS IDEAS FROM A PERSPECTIVE OF TEACHER TRAINING <i>Margo F Kondratieva</i></p> <p>1.4.3 UNDERSTANDING HOW MIDDLE SCHOOL STUDENT ENGINEERING DESIGN THINKING TRANSLATES INTO PRACTICE <i>Wahyu Hasan, Les Dawes</i></p> </td></tr> </table>	<p><b>1.1 SWING 105</b></p> <p>1.1.1 A NEW DISCIPLINARY MODEL FOR INCREASING THE NUMBER OF UNDERREPRESENTED MINORITIES IN THE MATHEMATICAL SCIENCES <i>Leslie McClure, Casey George-Jackson, Phillip Kutzko, Kathryn Chaloner</i></p> <p>1.1.2 TEACHING FOR RELEVANCE: LINKING SCIENCE INSTRUCTION TO STEM CAREER AWARENESS <i>Isha DeCoito, Tasha Richardson, Daniella DiLucia, Philip Myszkal, Stephanie Florence</i></p> <p>1.1.3 MENTORSHIP AS SOCIALIZATION: AFRICAN AMERICAN WOMEN IN ENGINEERING AT HBCUs <i>Ezella McPherson, Virginia Tickle</i></p> <p><b>1.3 SWING 109</b></p> <p>1.3.1 A CAUTIOUS SECONDARY SCHOOL APPROACH TO THE T IN STEM <i>P John Williams, Mathew Thomas</i></p> <p>1.3.2 WHAT ARE YOU LOOKING AT? GRADUATE-ENTRY PRE-SERVICE TEACHERS' PERCEPTIONS OF STEM PEDAGOGY <i>Michelle Mukherjee, Margaret Lloyd</i></p>	<p><b>1.2 SWING 107</b></p> <p>1.2.1 CO-ORDINATION AND CONTROL: CONNECTING THE CAPABILITIES OF CHILDREN WITH/IN AN EDUCATIVE STEM CONTEXT <i>Steven Khan, Krista Francis, Brent Davis</i></p> <p>1.2.2 (TWO-WAY LEARNING) KISKIAUMATOWIN IN SUPPORT OF SASKATCHEWAN'S MULTI-VOCAL K-9 SCIENCE CURRICULUM <i>Sandy Marie Bonny</i></p> <p>1.2.3 ARGUMENTATION SCHEMES: A WINDOW ON INTERNATIONAL, INDIGENOUS AND WESTERN SCIENCES <i>Robert Anthony, Mijung Kim</i></p> <p>1.2.4 KOREAN ELEMENTARY STUDENTS' PERCEPTION ON STEAM LEARNING OPPORTUNITIES (STEAM LO) <i>Yumin Ahn, Won-Young Jung, Eun Ji Park, Seung Urn Choe, Chan-Jong Kim</i></p> <p><b>1.4 SWING 309</b></p> <p>1.4.1 PREPARING STUDENTS FOR LABORATORY CLASSES AND REDUCING COGNITIVE OVERLOAD USING INTERACTIVE ONLINE PRE-LAB TUTORIALS <i>Tracey Kuit</i></p> <p>1.4.2 CONNECTING ELEMENTARY AND ADVANCED MATHEMATICS IDEAS FROM A PERSPECTIVE OF TEACHER TRAINING <i>Margo F Kondratieva</i></p> <p>1.4.3 UNDERSTANDING HOW MIDDLE SCHOOL STUDENT ENGINEERING DESIGN THINKING TRANSLATES INTO PRACTICE <i>Wahyu Hasan, Les Dawes</i></p>
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## DAY 1: SATURDAY, JULY 12

	<p><b>1.5 SWING 405</b></p> <p>1.5.1 ANALYZING STEM 2.0 ACTIVITIES THROUGH THE PISA SCIENTIFIC LITERACY FRAMEWORK: FINDINGS OF UNIVERSITY STUDENTS' VOLUNTEERING EXPERIENCES IN A DEVELOPING COUNTRY <i>Vinesh Chandra, Andy Yeh</i></p> <p>1.5.2 A QUALITATIVE INVESTIGATION ON THE SCIENCE EDUCATION REFORM IN TAIWAN: EXAMINING THE TRANSITION INTO A CONSTRUCTIVIST SCIENCE TEACHING APPROACH IN RELATION TO THE MAINTENANCE OF A CONFUCIAN HERITAGE CULTURE <i>Ying Syuan Huang</i></p>	<p><b>1.6 SWING 407</b></p> <p>1.6.1 TEACHING A STEM-ORIENTED, ICT-BASED PROGRAM ABOUT SOUND, WAVES AND COMMUNICATION: A PILOT STUDY <i>Nayif Adil Awad, Moshe Barak</i></p> <p>1.6.2 EXPERT-GUIDED CROWD-SOURCED LEARNING CONTENT: A PILOT STUDY IN A LARGE ENROLMENT INTRODUCTORY PHYSICS COURSE <i>Simon Bates</i></p> <p>1.6.3 TEACHERS' RECOGNITION OF STEAM EDUCATION IN KOREA <i>HeeJin Noh, Paik Seoung Hye</i></p> <p>1.6.4 LESSONS FOR THE FLIPPED CLASSROOM APPROACH IN A LARGE UNDERGRADUATE CHEMISTRY COURSE: EXAMINING EXAMS SCORES BEFORE AND AFTER "FLIPPING" THE BUFFERS MODULE <i>Anka Lekhi</i></p>
	<p><b>1.7 SWING 305</b></p> <p>1.7.1 GIFTED YOUTHS' SUGGESTIONS FOR CLIMATE CHANGE MITIGATION <i>Sakari Tolppanen, Maija Aksela</i></p> <p>1.7.2 A CURRICULUM INTERVENTION TO IMPROVE CHILDREN'S UNDERSTANDING OF MATHEMATICS AND SCIENCE CONCEPTS FUNDAMENTAL TO UNDERSTANDING CLIMATE CHANGE <i>Laura Super, Linda S. Siegel, Alex Sarra-Davis, Na'ama Av-Shalom, Suzy Viragh, Jennifer Luu, Vrinda Ohri, Kristine Hui, Shuting Huo, Joana Pinto</i></p> <p>1.7.3 INTERGENERATIONAL JUSTICE, ENVIRONMENTAL EDUCATION AND OUR HOPES FOR FUTURE GENERATIONS <i>David Patrick Burns, Stephen P. Norris, Charmaine Leung, Betty Yeung</i></p> <p>1.7.4 UNDERGRADUATE STUDENTS' CONCEPTIONS OF LEARNING ENVIRONMENTAL SCIENCE AND THEIR LEARNING SELF-EFFICACY IN BEIJING <i>Jing Wang, Yan Dong, Jyh-chong Liang</i></p>	<p><b>1.8 SWING 307</b></p> <p>1.8.1 SUPPORTING INTERDISCIPLINARY APPROACHES TO STEM EDUCATION THROUGH SCIENCE FICTION <i>Janice Marie Bogstad, Changyi Fu, Rong Zhou, Yan Wu</i></p>
	<b>LUNCH   ESB Lobby</b>	
	<p><b>KEYNOTE SPEAKER   ESB 1013</b></p> <p><b>Ding Ming Wang</b>   National Hsinchu University of Education, Taiwan INTERDISCIPLINARY ART AND STEM EDUCATION - SHARING THE EXPERIENCE</p>	
12:15-1:30	<b>NUTRITION BREAK   ESB Lobby</b>	
	<b>POSTER PRESENTATIONS   ESB Lobby</b>	
	<p>2.0.1 DEVELOPMENT OF MODEL TO IMPROVE CONTENTS, METHODS AND EVALUATION OF STEAM EDUCATION FOR MATHEMATICS AND OTHER SUBJECTS IN MIDDLE SCHOOL <i>Ho-Kyoung Ko, Su-young Choi, Mihyun Yoo, Woo-Sang Oh, Jeng-Hyun Kim, Kyeong-Ryeong Lee</i></p> <p>2.0.2 COMBINING SCIENCE WITH ART FOR INTER-DISCIPLINARY EDUCATION: THE CASE STUDY OF AN UNDERGRADUATE COURSE IN KOREA <i>Hunkoog Jho, Hye-Gyoung Yoon, Mijung Kim</i></p>	
1:30-2:30		
2:30-3:00		

## DAY 1: SATURDAY, JULY 12

2.0.3 THE EFFECT OF CLASSROOM ENGAGEMENT ON STUDENT EXPERIENCE AND FINAL GRADE IN AN UNDERGRADUATE BIOLOGY COURSE AT MEMORIAL UNIVERSITY

*Anna Hicks, Trudi Johnson*

2.0.4 INVESTIGATING THE ECOLOGICAL STRATEGIC CALCULUS LEARNING APPROACH ON ACADEMIC ACHIEVEMENT OF A COLLEGE STUDENT WITH LEARNING DISABILITY IN CALCULUS

*Neerusha Baurhoo*

2.0.5 EFFECTIVE PRACTICE OF STEM CURRICULUM RESOURCES INTEGRATION FOR CHILDREN IN INFORMAL ENVIRONMENT

*RuiHui Hao*

3:00-4:30

### CONCURRENT SESSION #2

#### 2.1 SWING 105

2.1.1 INTEGRATION OF STEM INTO THE CURRICULUM FOR TECHNOLOGY EDUCATION: USA CASE STUDY

*Szu-Chun Fan, Kuang-Chao Yu*

2.1.2 TRANSFORMATION IN EDUCATIONAL PRACTICES THROUGH STEM

*Tony Rozan Sahama, Deepthi Chandrika Bandara*

#### 2.3 SWING 109

2.3.1 WHAT DIGITAL VIDEO TECHNOLOGY CAN DO FOR TEACHERS IN STEM

*Ruth Xiaoqing Guo, Stephen Edgar Gareau*

2.3.2 INTEGRATING ICTS INTO TEACHERS' PRACTICE IN THE CLASSROOM USING SUPPORTED CONTINUOUS PROFESSIONAL DEVELOPMENT (SCPD)

*Marie H Kavanagh*

2.3.3 ENGAGING STUDENTS (AND THEIR TEACHERS) IN STEM THROUGH ROBOTICS

*Christina Chalmers*

2.3.4 UNDERWATER WEB CAMERAS AS A TOOL FOR OCEAN STEWARDSHIP

*Mike Irvine, Mijung Kim*

#### 2.5 SWING 405

2.5.1 LINKING PEDAGOGICAL KNOWLEDGE PRACTICES AND STUDENT OUTCOMES IN STEM EDUCATION FOR PRIMARY SCHOOLS

*Peter Hudson, Lyn D English, Les Dawes, Donna King, Steve Baker*

2.5.2 RESTRUCTURING A PRE-SERVICE TEACHER MATHEMATICS EDUCATION COURSE TO DEVELOP MATHEMATICS CONTENT KNOWLEDGE (MCK) AND MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE (MPCK)

*Kevin Michael Larkin*

#### 2.2 SWING 107

2.2.1 STEM FUNDS OF KNOWLEDGE OF CHILDREN IN THE HOME

*Samantha Ying Ying Tan, Jessica Nga Chi Tang, Samia Khan*

2.2.2 THE STEM ISSUE IN AUSTRALIA: WHAT IS IT AND WHERE IS THE EVIDENCE?

*Sarah Hopkins, Helen Forgasz, Debbie Corrigan, Debra Panizzon*

2.2.3 THE PRACTICE OF STEM IN CHINESE SPECIAL SCHOOL

*Hui Li, Zhao Ning Ye, Jian Zhong Zhou*

2.2.4 A HORIZON OF POSSIBILITIES: A DEFINITION OF STEM EDUCATION

*Lydia Carol-Ann Burke, Krista Francis, Marie-Claire Shanahan*

#### 2.4 SWING 309

2.4.1 CHINESE SCIENCE AND TECHNOLOGY MUSEUM EDUCATORS' ROLES AND NEEDS FOR PROFESSIONAL DEVELOPMENT

*Jiao Ji, David Anderson, Xinchun Wu*

2.4.2 CHILDREN'S PERCEPTIONS OF SCIENTIFIC OBJECTS THROUGH 2D VS. STEREOSCOPIC PRESENTATIONS IN A MUSEUM

*Aaron Price, Hee-Sun Lee*

2.4.3 PLAY-BASED LEARNING FOR UNDERSTANDING PHYSICS IN MIDDLE SCHOOL

*Elizabeth Anne Holt*

2.4.4 PROMOTING STEAM EDUCATION IN THE CONTEXT OF INFORMAL SCIENCE LEARNING: THE CASE OF NATURAL HISTORY MUSEUM

*Young-Shin Park, Hyo-Suk Ryu, Jongwon Park, Youngmin Kim, Hae-Ae Seo*

#### 2.6 SWING 407

2.6.1 BEYOND THE SUBJECT SILOS IN STEM – THE CASE FOR 'LOOKING SIDEWAYS' IN THE SECONDARY SCHOOL CURRICULUM

*David Michael Barlex, Frank Banks*

2.6.2 ALTERNATIVE POWERS: DE-FRAMING THE STEM DISCOURSE

*David Blades, Matthew Weinstein, Shannon Gleason*

2.6.3 NEW CURRICULA AND MISSED OPPORTUNITIES: DEALING WITH THE CROWDED CURRICULUM 'STEMS' FROM 'BIG IDEAS'

*Chris Hurst*

DAY 1: SATURDAY, JULY 12		
	2.5.3 FROM UNKNOWN TO KNOWN: VIRTUAL WORLDS INTERACTIVE PEDAGOGY <i>Hsiao-Cheng (Sandrine) Han</i>	
	2.5.4 SUSTAINED SCHOOL-BASED COACHING AS A MODEL OF PD FOR SECONDARY MATHEMATICS TEACHERS <i>Richelle Marynowski</i>	
	<b>2.7 SWING 305</b>	<b>2.8 SWING 307 - Workshop</b>
	2.7.2 HELPING PRESERVICE TEACHERS TO DEVELOP AN UNDERSTANDING OF INQUIRY-BASED SCIENCE INSTRUCTION: LINKING THEORY AND PRACTICE THROUGH AN AUTHENTIC EXPERIENCE <i>Louise Maree Sutherland</i>	2.8.1 STEM IN THE STREAM: COMMUNITIES AND URBAN RIVER RECOVERY IN THE 21ST CENTURY <i>John Robert Michael Ames, Eleanor Hendriks, Laura Super,            Susan Chung Susan Chung, Stanley King,            Vanessa Lee, Andrew Riseman</i>
	2.7.3 SCIENCE SEEN THROUGH A CAMERA LENS: A CASE OF STEAM PROGRAM OF UNIVERSITY-COMMUNITY COLLABORATION, CALLED 'SCIENCE PHOTO ACADEMY' <i>Jinwoong Song, Jiyeon Na, Joon-young Choi</i>	
5:15-8:00	Opening Reception   Sage Bistro	

## DAY 2: SUNDAY, JULY 13

8:00-1:00	<b>REGISTRATION/INFORMATION TABLE</b>   ESB Lobby	
8:30-9:30	<b>KEYNOTE SPEAKER</b>   CIRS Auditorium, 1250	
	<b>John Robinson</b>   University of British Columbia, Canada NEXT GENERATION SUSTAINABILITY AT UBC	
9:30-10:00	<b>NUTRITION BREAK</b>   ESB Lobby	
	<b>POSTER PRESENTATIONS</b>   ESB Lobby	
	3.0.1 AN ANALYSIS OF STEAM'S EFFECT ON MATHEMATICS AND SCIENCE GIFTED STUDENTS <i>Eun Ki Ban</i>	
	3.0.2 "ARE THERE ANY WINNERS IN HIGH STAKES TESTING IN MATHEMATICS?"- AN INVESTIGATION INTO THE IMPACT OF HIGH STAKES TESTING ON THE TEACHING AND LEARNING OF MATHEMATICS IN AUSTRALIAN PRIMARY SCHOOLS <i>Linda Cranley</i>	
	3.0.3 USING AVIATION AS A THEME TO INCREASE STUDENTS' INTEREST IN STEM EDUCATION <i>Rachel K. Graf</i>	
	3.0.4 A STUDY ON THE PERCEPTION OF THE CLASSROOM RESPONSE SYSTEM (CRS) AND ITS EFFECT ON ACADEMIC ACHIEVEMENT <i>Jungsook Oh</i>	
	3.0.5 PRIMARY PRE-SERVICE TEACHERS' CONCEPTUAL KNOWLEDGE OF THE MULTIPLICATION OF FRACTIONS USING AREA MODELS <i>Elise Thurtell</i>	
10:00-11:10	<b>CONCURRENT SESSION #3</b>	
	<b>3.1 SWING 105 - Symposium</b> 3.1.1 INTEGRATIVE STEM AND THE EDUCATION PIPELINE <i>Mark Sanders, Stephen Petrina, Ken Volk</i>	<b>3.2 SWING 107</b> 3.2.1 VARIOUS WAYS OF USING AUGMENTED REALITY TECHNOLOGIES TO CHANGE THE WAY STUDENTS SEE THE WORLD <i>Ming-Chao Lin</i> 3.2.2 WHAT GOES AROUND, COMES AROUND: HOOPING TECHNOLOGY FOR LEARNER ENGAGEMENT, MOTIVATION, PHYSICAL HEALTH, AND STEM LEARNING <i>Stephen E. Gareau, Ruth X. Guo</i> 3.2.3 CAMPUS SERVICE APPLICATION BASED ON AUGMENTED REALITY AND LOCATION AWARENESS <i>Pengfei Shi, Su Cai, Qianqian Yuan, Peiwen Wang</i>
	<b>3.3 SWING 109 - Workshop</b> 3.3.1 DEVELOPING A MAKER CULTURE TO ENCOURAGE LEARNERS AS RESEARCHERS - A TOUR OF FIVE DIFFERENT MICROCONTROLLERS FOR STEAM EDUCATION <i>Colin Bronislaw Chapman</i>	<b>3.4 SWING 309</b> 3.4.1 THE EXTENT OF AWARENESS OF RESEARCH-BASED STEM LITERACY PROGRAMME AMONG NIGERIAN TEACHERS <i>Rebecca Ufonabasi Etiubon</i> 3.4.2 LANGUAGE AND LITERACY IN MATHEMATICS: STEPPING STONES OR STUMBLING BLOCKS IN ACCELERATING JUNIOR-SECONDARY STUDENTS <i>Edlyn Joy Grant</i> 3.4.3 BABY STEPS TOWARDS STEM INTEGRATION: POSSIBILITIES IN AUSTRALIAN HIGH SCHOOLS <i>Vinesh Chandra, Steve Lang</i>
	<b>3.5 SWING 405</b> 3.5.1 COLOR-BALL: A GESTURE-BASED VOCABULARY GAME TO PROMOTE CHILDREN'S STUDY <i>Gaoxia Zhu, Su Cai, Ying Kan</i>	<b>3.6 SWING 407</b> 3.6.1 TEACHING AND LEARNING DIGITAL CONTROL THROUGH REAL-TIME IMPLEMENTATION <i>Yang Cao</i>

## DAY 2: SUNDAY, JULY 13

	<p>3.5.2 WHAT DOES A STEM CURRICULUM LOOK LIKE AT THE PRE-K LEVEL? <i>Todd Milford</i></p> <p>3.5.3 STEM EDUCATION FOR SUSTAINABLE DEVELOPMENT: A SOCIOTECHNICAL ANALYSIS <i>Tony Rozan Sahama, Deepthi Chandrika Bandara</i></p> <p><b>3.7 SWING 305</b></p> <p>3.7.1 AN EXPLORATORY STUDY ON THE IMPACT OF WOODFUEL USE AND PLANNING STRATEGIES FOR ITS SUSTAINABILITY IN WESTERN KENYA <i>Festus Beru, P Opata, G Simiyu, S Ooko, P Okemwa, S Wafula, Samson Nashon</i></p> <p>3.7.2 THE DEVELOPED INQUIRY-BASED SPIRAL CURRICULUM TO PROMOTE THE RADIATION LITERACY AS STS AND SUSTAINABILITY EDUCATION <i>Hisashi Otsuji</i></p> <p>3.7.3 ZERO WASTE EFFORTS AT THE UNIVERSITY OF BRITISH COLUMBIA: EXAMINING WASTE GOALS, PROCESSES AND OPPORTUNITIES TO EDUCATE CAMPUS COMMUNITY <i>Latika Raisinghani, Ivana Zelenika, Kwesi Yaro</i></p> <p><b>3.9 SCARFE 1210 - Workshop</b></p> <p>3.9.1 DEVELOPING 21ST-CENTURY MINDS WITH VERNIER PROBEWARE <i>Vernier International Inc</i></p>	<p>3.6.2 STUDENTS' ATTITUDES TOWARDS USING OF E-SCHOOLBAG FOR LEARNING IN CHINA <i>Yi Shanshan, Feng-Kuang Chiang</i></p> <p>3.6.3 DESIGN AND DEVELOPMENT OF THE E-SCHOOLBAG PERCEPTIONS SCALE (EPS) FOR K1-12 STUDENTS <i>Juan Zheng, FengKuang Chiang</i></p> <p><b>3.8 SWING 307 - Showcase</b></p> <p>3.8.1 FOCUSING ON STEM PERSPECTIVES IN TEACHER EDUCATION <i>Sabrina Lorenz, Hye Son, Robert Jordan, Isha DeCoito</i></p> <p>3.8.2 ADDRESSING THE CHALLENGES TO STEM EDUCATION IN RURAL IDAHO <i>Melinda A Hamilton</i></p>
11:10-11:20	<b>TRANSITION</b>	
11:20-12:30	<b>CONCURRENT SESSION #4</b>	
	<p><b>4.1 SWING 105</b></p> <p>4.1.1 GOING THE DISTANCE: DESIGNING A PROSPECTIVE LONGITUDINAL EVALUATION FOR THE WOMEN IN SCIENCE AND ENGINEERING MENTORING PROGRAM AT UBC'S OKANAGAN CAMPUS <i>Stephanie McKeown</i></p> <p>4.1.2 THE TOWER BUILDERS: THE NEED TO PLACE ETHICAL CONSIDERATIONS AT THE FOREFRONT OF STEM AND STSE EDUCATION INITIATIVES <i>Astrid Steele</i></p> <p>4.1.3 GENDER AND SOCIO-ECONOMIC GAPS IN SECONDARY STUDENTS' INTEREST IN SCIENCE-RELATED TERTIARY EDUCATION: THE CASE OF ISRAEL <i>Svetlana Chachashvili-Bolotin, Marina Milner-Bolotin</i></p> <p><b>4.3 SWING 109 - Showcase</b></p> <p>4.3.1 SISTERS OF THE ACADEMY: FOCUSING ON BLACK WOMEN IN STEM <i>Virginia Cook Tickles, Ezella McPherson, LaKerri Mack, Devona Foster Pierre</i></p> <p><b>4.5 SWING 405 - Symposium</b></p> <p>4.5.1 BECOMING A TEACHER: EMBRACING STEM (K – 6) TEACHER EDUCATION <i>Mary Stordy, Susan Ryan, Todd Woodland, Ian Crewe</i></p>	<p><b>4.2 SWING 107</b></p> <p>4.2.1 ANCIENT WISDOM FOR A SHARED PLANET: REGENERATING INDIGENOUS TRADITIONAL ECOLOGICAL KNOWLEDGES <i>Pat O'Riley, Peter Cole</i></p> <p>4.2.2 AFRICAN KNOWLEDGE ON ENDOD (PHYTOLACCA DODECANDRA) AND ITS POTENTIAL FOR MEDICINAL USES IN KENYA <i>Selline Awino Ooko, J. B. Okeyo, Osano Odipo, F. Olal, Festus Beru, Peterson Ombogo, Peter Okemwa</i></p> <p>4.2.3 EXPLORING TRADITIONAL TECHNOLOGIES TO CONTEXTUALIZE LEARNING: SCIENTIFIC AND MATHEMATICAL PHENOMENA EMBEDDED IN KOSRAEAN FOOD PREPARATION AND PRESERVATION <i>Latika Raisinghani</i></p> <p><b>4.4 SWING 309 - Symposium</b></p> <p>4.4.1 USING COLLABORATION TO INCREASE STEM ENGAGEMENT FOR GIRLS <i>Karen Peterson, Brenda Britsch, Karen Bouldin</i></p> <p><b>4.6 SWING 407</b></p> <p>4.6.1 THE NATURE OF ABACUS IS ONE KIND OF WORKING MEMORY TRAINING: A FUNCTIONAL MRI AND BEHAVIOR STUDY <i>John Y.S. Cheng, Chun-Yen Chang</i></p>

## DAY 2: SUNDAY, JULY 13

		<p>4.6.2 ENHANCING MATH AND PHYSICS EDUCATION FOR HIGH SCHOOL IN ISRAEL <i>Sara Hershkovitz</i></p> <p>4.6.3 PROFESSIONAL LEARNING COMMUNITY: A CASE STUDY – MATHEMATICS IN THE VIRTUAL HIGH SCHOOL <i>Yaniv Biton</i></p>
	<p><b>4.7 SWING 305</b></p> <p>4.7.1 LEAN STARTUP PRINCIPLES AND STE(A)M IMPLEMENTATIONS: A CASE STUDY APPROACH TO THE APPLICATION OF BUSINESS INNOVATION PRINCIPLES TO EDUCATIONAL INNOVATION <i>Chris John Metcalfe, Michelle Ferguson</i></p> <p>4.7.3 A INTEGRATED CURRICULUM DESIGN STRATEGY TO SCAFFOLD ONLINE TRAINING FROM THE PERSPECTIVE OF KNOWLEDGE BUILDING <i>Duan Jinju</i></p>	<p><b>4.8 SWING 307</b></p> <p>4.8.1 STEM NATURAL PARTNERS PROJECT – LEARNING FOR SUSTAINABILITY <i>Susan Valerie McLaren</i></p> <p>4.8.3 ENGINEERING EDUCATION AND SUSTAINABLE DEVELOPMENT: A MIXED METHODS APPROACH <i>Matt Wright, Susan Nesbit, Thomas Froese</i></p>
	<p><b>4.9 SWING 409 - Showcase</b></p> <p>4.9.1 TEACHER INQUIRY IN K-6 STEM: THE IMPACT OF TEACHER-DRIVEN AND INQUIRY-BASED PROFESSIONAL DEVELOPMENT ON TEACHING AND LEARNING IN K-6 STEM <i>Karen Goodnough, Rene Wicks, Walsh Tom, Keith Power, Nancy Healey, Stephanie Collins, Jennifer Kendell</i></p>	
12:30-1:30	<b>LUNCH   ESB Lobby</b>	
1:30-2:30	<b>KEYNOTE SPEAKER   ESB 1013</b>	
	<p><b>YOSHIKAZU OGAWA</b>   University of Tsukuba, Japan COMMUNICATION BETWEEN THE PUBLIC AND MUSEUMS: DEVELOPMENT OF LIFELONG LEARNING SYSTEM TO FOSTER SCIENCE LITERACY</p>	
2:30-3:00	<b>NUTRITION BREAK   ESB Lobby</b>	
	<b>POSTER PRESENTATIONS   ESB Lobby</b>	
	<p>5.0.1 USING SCIENCE FICTION FILMS ON STIMULATING JUNIOR HIGH SCHOOL STUDENTS' CREATIVE PERFORMANCE IN CREATIVE MOTOR VEHICLE <i>Kuen-Yi Lin</i></p> <p>5.0.2 AN ISOLATED MASS MODEL FOR INTUITIVE ELECTRO-MECHANICAL ANALOGIES <i>Leo Stocco</i></p> <p>5.0.3 THE DEVELOPMENT OF STEM PROJECT-BASED LEARNING IN INTELLIGENT CLASSROOM <i>Chien-Yu Lin, Hsien-Sheng Hsiao</i></p> <p>5.0.4 OPTIMIZATION OF COORDINATED TRAFFIC SIGNAL TIMING: A GENETIC ALGORITHM APPROACH <i>Fareeza Karimushan</i></p> <p>5.0.5 METHODOLOGICAL IMPLICATIONS FOR MOLECULAR MAKING: APPLICATION OF LIQUID-PROCESS IN MATERIAL PREPARATION AND PRODUCTION <i>Ming Huang, Bo Huang</i></p>	
3:00-4:30	<b>CONCURRENT SESSION #5</b>	
	<p><b>5.1 SWING 105</b></p> <p>5.1.1 NUMERACY . . . SCIENTIFICITY: IDENTIFYING, LINKING AND USING THE 'BIG IDEAS' OF MATHEMATICS AND SCIENCE FOR MORE EFFECTIVE TEACHING <i>Chris Hurst</i></p>	<p><b>5.2 SWING 107</b></p> <p>5.2.1 A CASE FOR INTEGRATING PEER INSTRUCTION AND LEARNING CATALYTICS IN THE INTRODUCTORY PHYSICS LAB <i>N G Holmes, D A Bonn</i></p>



## DAY 2: SUNDAY, JULY 13

5.1.2 IMPLEMENTING A CONTEXTUALIZED SCIENCE CURRICULUM AND INSTRUCTION: WHAT DO TEACHERS AND STUDENTS HAVE TO SAY?

*Winston Massam*

5.1.3 DEVELOPING NUMBER FACT KNOWLEDGE FOR DIFFERING CONTEXTS

*Jenny Young-Loveridge, Brenda Bicknell*

5.1.4 CONTRIBUTION OF INDUSTRY-BASED STUDENT LEARNING PERFORMANCE FOR THE STEM EDUCATION

*Tony Rozan Sahama, Gunnar Andersson, Hong Wu, Mathias Wilichowski, Pierre-Olivier Lombarteix, Valentín Miguel Eguía*

5.2.2 DEVELOPMENT OF AN INSTRUMENT ASSESSING FRESHMAN STUDENTS' UNDERSTANDING OF DATA ANALYSIS IN THE PHYSICS LABORATORY

*Haim Eshach, Ida Kukliansky*

5.2.3 INVESTIGATING THE EFFECTS OF PEERWISE & PEER INSTRUCTION PEDAGOGY ON THE DEVELOPMENT OF PEDAGOGICAL CONTENT KNOWLEDGE OF PROSPECTIVE PHYSICS TEACHERS

*Marina Milner-Bolotin, Alexandra Leigh MacDonald, Heather Anne Fisher*

5.2.4 THE ISOTOPE PROJECT: REVEALING INSERVICE TEACHER TENSIONS OF TEACHING THROUGH A STEM-BASED APPROACH

*Richard Hechter*

### 5.3 SWING 109

5.3.1 EXPLORING UNDERGRADUATE STUDENTS' METACOGNITIVE TRANSFORMATIONS IN AN ORGANIC CHEMISTRY COURSE

*Ashley J Welsh*

5.3.2 THE STUDY HABITS OF STUDENTS ON INTRODUCTORY STATISTICS COURSES: INVESTIGATION AND INTERVENTION

*Bruce Dunham, Gaitri Yapa*

5.3.3 THE ROLES OF INSTRUCTION AND METACOGNITION IN ENHANCING SELF-REGULATED LEARNING IN A HIGH SCHOOL CHEMISTRY COMPUTER-BASED LEARNING ENVIRONMENT

*CM Lam*

### 5.4 SWING 309 - Showcase

5.4.1 INCREASING INSTRUCTIONAL INTERACTION THROUGH ADAPTAION OF LOCAL PLAY FOR RECOGNITION OF NUMBERS AND SHAPES BY PRIMARY SCHOOL PUPILS

*Thelma Uduak Ekuinam*

### 5.5 SWING 405

5.5.1 AFFECTING ATTITUDE TOWARDS SCIENCE, HIGH SCHOOL AFRICAN AMERICAN STUDENTS

*Charles Anderton, Keith Koenig, Debra Prince, Cade Smith,*

5.5.2 THE IMPORTANCE OF SCIENCE FICTION AND OTHER STEM-RELATED MASS MEDIA IN YOUNG PEOPLE'S DECISIONS TO ENROL IN UNIVERSITY STEM COURSES

*Terry Lyons, Frances Quinn*

5.5.3 GATEWAYS TO ENGINEERING: A SYSTEMIC STEM INITIATIVE TO ADDRESS CAREER PATHWAYS IN ENGINEERING

*James Joseph Watters, Hitendra Pillay, Stephen Hay*

5.5.4 WHAT'S IN IT FOR ME? MAKING THE CASE FOR PAID STUDENT PLACEMENTS IN COMPUTER SCIENCE

*Sally Smith, Colin Smith*

### 5.6 SWING 407

5.6.1 THE ROLE OF SCAFFOLDING AND THE FACILITATOR IN THE DELIVERY OF PROBLEM-BASED LEARNING ON AN UNDERGRADUATE INTERDISCIPLINARY SCIENCE DEGREE PROGRAMME

*Sarah Gretton*

5.6.2 THE EFFECT OF STRATEGY USE AND SCAFFOLDING ON LEARNING IN AN EXPLORATORY LEARNING ENVIRONMENT

*Nikki Yee, Adriana Briseno, Ido Roll*

5.6.3 ENHANCE STUDENTS LEARNING THROUGH AUTONOMY SUPPORT IN A LARGE GENETICS LABORATORY COURSE

*Jinlu Wu*

### 5.7 SWING 305

5.7.1 THE EXPLORATION OF LEARNING BEHAVIOUR ANALYSIS AND EVALUATION MODEL IN UBIQUITOUS LEARNING ENVIRONMENT - TAKING LCS FOR EXAMPLE

*Haipeng Wan*

5.7.2 COLLABORATION FOR STUDENT SUCCESS IN STEM FIELDS: A NOVEL APPROACH

*Afrin Naz*

### 5.8 SWING 307

5.8.1 A MODEL OF SHARING STEM RESOURCES WITH LINKED DATA--TAKING LCS AS AN EXAMPLE

*GuoZhu Ding*

5.8.2 DEVELOPMENT AND APPLICATION OF A GUIDED PROJECT-BASED LEARNING PROGRAM OF STEM RELATED TO LED AND CELL-PHONE SENSOR

*Youngmin Kim*

## DAY 2: SUNDAY, JULY 13

	<p>5.7.3 DEVELOPMENT AND ASSESSMENT OF A CONTINUING EDUCATION COURSE IN QUANTITATIVE LITERACY FOR HIGH SCHOOL STEM TEACHERS <i>Craig Preston McClure</i></p> <p>5.7.4 APPLICATION OF INSTRUCTIONAL TECHNOLOGY FOR ASSESSMENT OF INSTRUCTIONAL OBJECTIVES IN TEACHING-LEARNING OF BASIC SCIENCE AND TECHNOLOGY <i>Idongesit Ndifrekeabasi Udosen</i></p> <p><b>5.9 SWING 405 - Symposium</b></p> <p>5.9.1 DESIGN AND ENGINEERING COGNITION AND DESIGN-BASED RESEARCH <i>Stephen Petrina, Franc Feng, Mirela Gutica, Peter Halim, Yu-Ling Lee, PJ Rusnak, Yifei Wang, Jennifer Zhao</i></p>	<p>5.8.3 THE STUDY OF THE EFFECT OF SMARTPHONE-BASED VISUAL INTERACTION IN U-LEARNING PERFORMANCE <i>Wang Qi</i></p> <p>5.8.4 THE DESIGN AND APPLICATION OF THE MOBILE EDUCATIONAL RESEARCH ACTIVITY BASED ON QR-CODE <i>Zhi Zhou, Axi Wang, Ling Chen, Feng-Kuang Chaing</i></p> <p><b>5.10 SWING 407 - Showcase</b></p> <p>5.10.1 BRIDGING THE GAP IN STEM: COMBINING BUSINESS, INDUSTRY AND EDUCATION RESOURCES TO CREATE DYNAMIC K-12 TEACHER STEM PROFESSIONAL DEVELOPMENT <i>Anne Seifert, Louis Nadelson, Sandie Nadelson</i></p>
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## DAY 3: MONDAY, JULY 14

8:30-1:00	REGISTRATION/INFORMATION TABLE   ESB Lobby	
9:00-10:00	KEYNOTE SPEAKER   ESB 1013	
	<b>Wolff-Michael Roth, Lansdowne Professor</b>   University of Victoria, Canada STEM CURRICULUM THROUGH THE EYES OF THE LEARNER: THE UNSEEN AND THEREFORE UNFORESEEN	
10:00-10:30	NUTRITION BREAK   ESB Lobby	
10:30-11:45	CONCURRENT SESSION #6	
	<b>6.1 ANGU 350 - Showcase</b> 6.1.1 PROJECT SOS (SCIENCE OF SUSTAINABILITY): DEVELOPMENT AND DELIVERY OF A UNIQUE MODEL FOR STEM EDUCATION <i>Katherine Dawes, Kathleen Ryan, Christine Berven, Anne Kern, Victoria Coats, Patricia McNamara, Dana Dawes</i>	<b>6.2 ANGU 347</b> 6.2.1 MEASURING SHORT TERM EFFECTS OF SELF-REGULATORY PROMPTS ON PROBLEM-SOLVING ABILITIES IN INTRODUCTORY GENETICS <i>Heather Anne Fisher, Marina Milner-Bolotin, Ido Roll, Deborah Butler, Alexandra MacDonald</i> 6.2.2 TRANSLATIONS OF INDUSTRY-BASED STUDENT LEARNING AND ACADEMIC PERFORMANCES <i>Tony Rozan Sahama</i>
	<b>6.3 SWING 409</b> 6.3.2 PHYSICS TEACHERS' BELIEFS AND INTENTIONS ABOUT THE USE OF FORMULA IN MOTION CONTEXT <i>Zahra Parvaneh-Nezhad, Samson Nashon</i> 6.3.3 THE DEVELOPMENT OF PHYSICS TEACHER AGENCY IN THE CHINESE CURRICULUM REFORM CONTEXT: A NARRATIVE APPROACH <i>Guopeng Fu</i>	<b>6.4 SWING 309</b> 6.4.1 OPENING REAL SCIENCE: INTRODUCING AUTHENTIC SCIENTIFIC METHODOLOGY INTO MATHEMATICS AND SCIENCE TEACHER PREPARATION <i>Joanne Mulligan</i> 6.4.2 ENHANCING MATHEMATICS AND SCIENCE TEACHER EDUCATION IN REGIONAL AUSTRALIA: ITERATIONS, INTERACTIONS AND MODULES <i>Geoff Woolcott</i> 6.4.3 AN INVESTIGATION OF SECONDARY STUDENTS' ENGAGEMENT IN A SCIENCE INQUIRY THROUGH A STUDENT-SCIENTIST PARTNERSHIP <i>Michelle Lasen, Clifford Jackson, Amy Beavan, Bryn Johnson, Robert Callin</i>
	<b>6.5 SWING 405 - Showcase</b> 6.5.1 FLIPPING CALCULUS: WHY, HOW, AND WHAT <i>Fei Xue, John Williams</i>	<b>6.6 SWING 407</b> 6.6.1 ELECTRICAL AND COMPUTER ENGINEERING UNDERGRADUATE STUDENT PERCEPTIONS OF THEIR ACHIEVEMENT OF ENGINEERING GRADUATE ATTRIBUTES <i>Chris David Campbell, Steven J.E. Wilton, Andre Ivanov</i> 6.6.2 UNIVERSITY STEM SCHOOL ENGAGEMENT – SUPPORTING GRADUATE CAPABILITIES <i>Maria June Barrett Silva</i> 6.6.3 BUILDING PEDAGOGICAL BRIDGES BETWEEN SECONDARY AND TERTIARY BIOLOGY: A MULTI-INSTITUTIONAL, NATIONAL ENDEAVOR <i>Gerry Rayner, Karen Burke da Silva</i>
	<b>6.7 SWING 305</b> 6.7.1 STIMULATING CREATIVE IDEAS OF FRESHMEN STUDENTS THROUGH DESIGN COURSE <i>Haifa Salman El-Sadi, Richard Roberts, Ali Moazed</i> 6.7.2 AN ANALYSIS OF INSTRUCTIONAL DESIGN FOR STUDENTS OF EDUCATION TECHNOLOGY IN TERTIARY INSTITUTION IN NIGERIA <i>Edem Archibong Ntuk</i>	<b>6.8 ANGU 343 - Workshop</b> 6.8.1 MAKING LEARNING VISIBLE IN UNDERGRADUATE RESEARCH EXPERIENCES <i>Susan Howitt</i>

## DAY 3: MONDAY, JULY 14

	<p>6.7.3 INTERPRETING STUDENTS' UNDERSTANDING OF CHOKING IN CHILDREN THROUGH WEB-BASED LEARNING EXPERIENCES <i>J. Douglas Adler, Samson Madera Nashon, Sandra Scott, Jeffrey Ludemann</i></p> <p><b>6.9 ANGU 345</b></p> <p>6.9.1 TO ENGAGE OR NOT ENGAGE – HOW IS THE QUESTION! <i>Pamela Anne Hagen</i></p> <p>6.9.2 USE OF GENETIC DECOMPOSITIONS TO SCAFFOLD THE DEVELOPMENT OF A STRUCTURALLY SEQUENCED CURRICULUM FOR MATHEMATICS ACCELERATION <i>David John Nutchey, Edlyn Grant, Tom Cooper</i></p> <p>6.9.3 TRIGGERING WHAT YOU HAVE: BRICOLAGE AS A MATHEMATICAL WAY OF THINKING FOR MIDDLE SCHOOL STUDENTS <i>Alayne Cheryl Armstrong</i></p>	
11:45-12:45	<b>LUNCH   ESB Lobby</b>	
12:45-1:45	<b>KEYNOTE SPEAKER   ESB 1013</b>	
	<p><b>Rina Zazkis</b>   Simon Fraser University, Canada IMAGINING TEACHING VIA SCRIPTING TASKS</p>	
1:45-2:15	<b>NUTRITION BREAK   ESB Lobby</b>	
2:15-3:30	<b>CONCURRENT SESSION #7</b>	
	<p><b>7.1 ANGU 350 - Showcase</b></p> <p>7.1.1 PREPARING STEM-CENTRIC ELEMENTARY TEACHERS <i>Elissa Hozore</i></p> <p><b>7.3 SWING 409</b></p> <p>7.3.1 FACILITATING SCIENCE METHODS THROUGH AN INQUIRY FOCUSED APPROACH <i>J. Douglas Adler, Sandra Scott</i></p> <p>7.3.2 THE PRACTICE OF INQUIRY-BASED TRAINING MODE ON PROMOTING PRIMARY SCIENCE TEACHERS' TECHNOLOGY AND ENGINEERING LITERACY IN CHINA <i>Xia Fan, Zhaoning Ye</i></p> <p><b>7.5 SWING 405</b></p> <p>7.5.1 PRESERVICE TEACHERS AND THEIR BELIEFS ABOUT TEACHING AND LEARNING SCIENCE: THE IMPACT OF A SCIENCE METHOD COURSE ON SCIENCE TEACHING EFFICACY <i>Jacinta Elise Petersen</i></p> <p>7.5.2 BECOMING A SCIENCE TEACHER - THE DEVELOPMENT OF PRE-SERVICE TEACHERS IDEAS ABOUT TEACHING THROUGH AN INQUIRY BASED APPROACH <i>Louise Sutherland</i></p>	<p><b>7.2 ANGU 347</b></p> <p>7.2.1 FEMALE ENGINEERING STUDENTS' EXPERIENCE WITH STEREOTYPE THREAT: A NARRATIVE INQUIRY <i>Stacie LeSure Gregory</i></p> <p>7.2.3 MEASURING UNDERGRADUATE ELECTRICAL AND COMPUTER ENGINEERING PERCEPTIONS OF THEIR ENGINEERING COMPETENCE – AN OVERVIEW OF A SURVEY DEVELOPMENT PROCESS <i>Chris David Campbell, Steven J. E. Wilton, Andre Ivanov</i></p> <p><b>7.4 SWING 309</b></p> <p>7.4.1 THE DISJUNCTURE OF LEARNING AND RECOGNITION: CREDENTIAL ASSESSMENT FROM THE STANDPOINT OF CHINESE IMMIGRANT ENGINEERS IN CANADA <i>Hongxia Shan</i></p> <p>7.4.2 CASE STUDY OF CHINA'S ENGINEERING EDUCATION MODEL AND EMPLOYMENT IN STEM OCCUPATIONS <i>Lihui Xu</i></p> <p><b>7.6 SWING 407</b></p> <p>7.6.1 HOW TO MAKE THE CLASSROOM MORE ACTIVE: THE TYPES AND FEATURES OF SILENCE IN ELEMENTARY SCIENCE CLASSROOM <i>Jiyeon Na, Joon-young Choi, Jinwoong Song</i></p> <p>7.6.2 CHANGES IN TEACHERS' BEHAVIOUR IN SECONDARY SCIENCE EDUCATION: IMPLEMENTING A STANDARDS-REFERENCED NATIONAL CURRICULUM <i>Carmel Mary Diezmann</i></p>

## DAY 3: MONDAY, JULY 14

		<b>7.6.3 THE ENRICHMENT OF STEM EDUCATION: A PRACTICE OF INQUIRY INSTRUCTION AND EDUCATIONAL TECHNOLOGY</b> <i>Xinxin Fan, David Geelan, Wei Liang</i>
	<b>7.7 SWING 305</b> <b>7.7.1 ESD (EDUCATION FOR SUSTAINABLE DEVELOPMENT) AND DISASTER PREVENTION IN JAPAN: AFTER THE 2011 OFF THE PACIFIC COAST OF TOHOKU EARTHQUAKE</b> <i>Tatsuya Fujioka</i> <b>7.7.2 THE CHARACTERISTICS OF STEAM PROGRAM OF CLIMATE CHANGE ISSUE THROUGH PBL (PROJECT BASED LEARNING) APPROACH</b> <i>Young-Shin Park, Jongwon Park, Hyo-Suk Ryu, Hae-Ae Seo, Youngmin Kim</i>	<b>7.8 ANGU 343 - Symposium</b> <b>7.8.1 INTEGRATED PROJECT-BASED CURRICULUM INNOVATIONS IN BIOLOGICAL SCIENCES AND SCIENCE EDUCATION AT SIMON FRASER UNIVERSITY</b> <i>Allan Murray MacKinnon, Cindy Xin, Lynn Quarmby, Ivona Mladenovic, Shawn Bullock</i>
	<b>7.9 ANGU 345</b> <b>7.9.1 ON INSTRUCTOR EXPERIENCES IN THREE FLIPPED LARGE MATH UNDERGRADUATE COURSES</b> <i>Cindy Xin, Jamie Mulholland, Veselin Jungic, Harpreet Kaur</i>	
3:30-3:45	<b>NUTRITION BREAK   ESB Lobby</b>	
3:45-5:00	<b>CONCURRENT SESSION #8</b>	
	<b>8.1 ANGU 350</b> <b>8.1.1 ANALYZING UNDERGRADUATE STUDENTS' ATTITUDES AND BELIEFS ABOUT PHYSICS: INFLUENCE OF GENDER AND YEAR OF STUDY</b> <i>Alexandra Leigh MacDonald, Marina Milner-Bolotin, James Carolan, Heather Anne Fisher, Samson Nashon, Sandra Scott</i> <b>8.1.2 EXPLORING GRADE 6 GIRLS' ATTITUDES AND INTEREST IN STEM</b> <i>Isha DeCoito, Stephanie Florence, Daniella Di Lucia, Philip Myszkal, Tasha Richardson</i> <b>8.1.3 A LOOK AT STUDENT ATTITUDES AND MEASURED PERFORMANCE AFTER A NEW STEM INITIATIVE'S FIRST YEAR</b> <i>Thomas Francis Meagher</i> <b>8.3 SWING 409 - Showcase</b> <b>8.3.1 STEM 'FOUNDATIONS': DIMENSIONS OF SCIENCE LEARNING IN EARLY CHILDHOOD</b> <i>Jane R Kloecker, Ilana April, Caitlin Coe, Natalie Tahsler</i> <b>8.5 SWING 405</b> <b>8.5.1 BUILDING A COMMUNITY OF LEARNERS WITHIN THE STEM HIGHER EDUCATION CLASSROOM</b> <i>Shaun Nykvist</i>	<b>8.2 ANGU 347 - Workshop</b> <b>8.2.1 USING SCRATCH TO TEACH ROBOTICS ENGINEERING AND MULTIMEDIA GAME DESIGN</b> <i>Mark John Lockett</i> <b>8.4 SWING 309 - Workshop</b> <b>8.4.1 LOST IN TRANSLATION: CONNECTING BIOLOGISTS AND MATHEMATICIANS TO FURTHER UNDERGRADUATE STUDENTS' QUANTITATIVE SKILLS</b> <i>Deborah Martina King, Karen Burke Da Silva, Kelly Matthews</i> <b>8.6 SWING 407</b> <b>8.6.1 101 TECHNOLOGY FUN: EMPOWERING GIRLS AS TECHNOLOGY INNOVATORS AND ENTREPRENEURS</b> <i>PJ Rusnak</i> <b>8.6.2 CHALLENGES IN EMBEDDING NUMERACY THROUGHOUT THE CURRICULUM IN THREE QUEENSLAND SECONDARY SCHOOLS</b> <i>Merilyn Carter, Klenowski Valentina, Christina Chalmers, Peta-Anne McNaught, Malcolm Carter</i>

## DAY 3: MONDAY, JULY 14

	<b>8.7 SWING 305 - Workshop</b> 8.7.1 INSPIRING MATHEMATICS AND SCIENCE IN AUSTRALIAN TEACHER EDUCATION: MAKING CONNECTIONS ACROSS DISCIPLINARY CONTEXTS <i>Merrilyn Goos, Kim Beswick, Tricia Forrester</i>	<b>8.8 ANGU 343</b> 8.8.2 DOES USABILITY ENGINEERING MATTERS FOR STEM EDUCATION? <i>Tony Rozan Sahama, Andre Kushniruk, Elizabeth Borycki</i> 8.8.3 DIALOGICAL PRACTICES IN STEM CLASSES: THE CASE OF A BEGINNING TEACHER <i>James Joseph Watters, Carmel Mary Diezmann</i>
	<b>8.9 ANGU 345</b> 8.9.1 MATHEMATICS WORKSHEETS: THE LANGUAGE OF THE TEXT <i>Ozlem Deniz</i> 8.9.2 A MODEL FOR AN OPEN-ENDED TASK-BASED APPROACH IN GRADE 11 MATHEMATICS CLASSES <i>RK Mahlobo</i> 8.9.3 "ARE THERE ANY WINNERS IN HIGH STAKES TESTING IN MATHEMATICS?"- AN INVESTIGATION INTO THE IMPACT OF HIGH STAKES TESTING ON THE TEACHING AND LEARNING OF MATHEMATICS IN AUSTRALIAN PRIMARY SCHOOLS" <i>Linda Cranley</i>	
6:00-9:00	<b>STEM Banquet</b>   Life Sciences Centre	



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**DAY 4: TUESDAY, JULY 15**

8:30-1:00	<b>REGISTRATION/INFORMATION TABLE   ESB Lobby</b>	
8:30-9:30	<b>CONCURRENT SESSION #9</b>	
	<b>9.1 ANGU 243 - Workshop</b> 9.1 AN AUSTRALIAN SOLUTION TO STEM EDUCATION USING LEGO EDUCATION RESOURCES <i>Mark John Lockett</i>	<b>9.2 ANGU 296 - Workshop</b> 9.2 THE REFRAMING MATHEMATICAL FUTURES RESEARCH PROJECT– ADDRESSING THE EIGHT-YEAR GAP IN MATHEMATICS LEARNING IN JUNIOR SECONDARY SCHOOLS <i>Dianne Elizabeth Siemon</i>
	<b>9.3 ANGU 347 - Workshop</b> 9.3 LIFE-CYCLE ANALYSIS OF A PRODUCT IN TEACHING SCIENCE – STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS <i>Marianne Juntunen</i>	<b>9.4 ANGU 237 - Showcase</b> 9.4 THINKING SCIENCE AUSTRALIA - COGNITIVE ACCELERATION THROUGH SCIENCE EDUCATION (CASE). IMPROVING TEACHER PEDAGOGY AND STUDENT THINKING <i>Sonia Hueppauff</i>
	<b>9.5 ANGU 235 - Workshop</b> 9.5 KID'S S.T.E.M CONVENTION: INSPIRATION, INVESTIGATION, CELEBRATION <i>David Colin Willis</i>	<b>9.6 ANGU 354 - Workshop</b> 9.6 AUTOMATA IN THE PRIMARY CLASSROOM- A PRACTICAL DEVELOPMENTAL APPROACH <i>Alwyn Powell</i>
	<b>NUTRITION BREAK   ANGUS</b>	
9:30-9:45	<b>CONCURRENT SESSION #10</b>	
9:45-10:45	<b>10.1 ANGU 243</b> 10.1.1 STEM AND SCIENCE FICTION COURSES <i>Fu Changyi, Zhou Rong</i> 10.1.2 CREATING CONTEXTS FOR GENERATING PRODUCTIVE KNOWLEDGE THROUGH COLLABORATIVE ACTION RESEARCH: CASE STUDIES IN CONSTRUCTIONIST STEM EDUCATION <i>Karen Goodnough, Keith Power</i> 10.1.3 THE IMPACT OF WHOLE-SCHOOL INQUIRY-BASED TEACHER PROFESSIONAL DEVELOPMENT ON STEM ACHIEVEMENT: A CASE STUDY <i>Michael Shane Tutwiler</i>	<b>10.2 ANGU 296 - Workshop</b> 10.2 PATHWAYS TO IMPROVING MATHEMATICS AND SCIENCE LITERACY: STEM COMMUNITY ENGAGEMENT <i>Jo-Anne Marion Naslund, Shar Levine, Leslie Johnstone, Marina Milner-Bolotin</i>
	<b>10.3 ANGU 347 - Workshop</b> 10.3 CONFLICTS IN CHEMISTRY: THE CASE OF PLASTICS <i>Gigi Naglak, Stephanie Corrigan</i>	<b>10.4 ANGU 237</b> 10.4 CREATING A MAKERSPACE: USING LITTLEBITS TECHNOLOGY TO ENHANCE A LANGUAGE ARTS UNIT <i>Dereck Benjamin Dirom</i>
	<b>10.5 SCARFE 1210 - Workshop</b> 10.5 DEVELOPING 21ST-CENTURY MINDS WITH VERNIER PROBEWARE <i>Vernier International Inc</i>	
	<b>CLOSING KEYNOTE   ESB 1013</b>	
	<b>Elizabeth Croft</b>   University of British Columbia, Canada THE NEXT GENERATION OF WOMEN IN STEM: MAKING TRANSFORMATIVE CHANGE	
	<b>CLOSING SESSION   ESB 1013</b>	
12:00-1:00	Awards Ceremony STEM 2016 – Beijing Presentation	
2:30-4:00	<b>TRIUMF TOUR</b>	
	Optional tour of TRIUMF <i>Pre-registration is required at the TRIUMF booth in ESB, and is limited to 60 participants.</i>	

# KEYNOTE SPEAKERS

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**DAVID CLARKE**

Professor

UNIVERSITY OF MELBOURNE

SATURDAY, JULY 12 | 9:15 A.M.

## **DISCIPLINARY INCLUSIVITY IN EDUCATIONAL RESEARCH DESIGN: PERMEABILITY AND AFFORDANCES IN STEM EDUCATION**

The disciplines encompassed by STEM are currently distinguished by associated bodies of practice, particularly in the practice of research. Analogous distinctions apply in STEM Education, extending to the signature pedagogies that characterise each discipline. Research within STEM Education is similarly differentiated with respect to methods, theories, and questions investigated. Current curricular design reflects restrictive conceptions of field-specificity and the unique integrity of bodies of

knowledge encrypted as school subjects. However, references to STEM-related subjects, STEM industries, STEM occupations, STEM ideas and STEM practices are made most frequently not in celebration of interconnected fields of endeavour, but in lament of their fragmented dissolution. Attention must be paid to the affordances of affiliation and research undertaken to explore the legitimacy of STEM disciplines as connected bodies of knowledge and communities of practice offering enhanced

educational opportunities through their interconnection. The approach pursued in this presentation is to examine those constructs to which the boundary walls of the STEM disciplines seem most permeable. Employing necessarily inclusive research designs, one consequence could be the reconceptualization of the organising principles of the curriculum.





**DING MING WANG**

Professor

NATIONAL HSINCHU UNIVERSITY  
OF EDUCATION

SATURDAY, JULY 12 | 1:30 P.M.

**INTERDISCIPLINARY ART AND STEM EDUCATION – SHARING THE EXPERIENCE**

Human endeavors in the fields of science, technology engineering and mathematics (STEM) contribute to technological innovation and the construction of modern and post-industrial societies. However, this progress also finds human beings in the midst of unprecedented environmental challenges. Relevant issues like environmental pollution, food and water shortage, and urbanizing tendencies brought about by modernization challenge STEM education in schools, leading students to comprehend present circumstances through the past developments and to ponder over the promotion of human civilization as well as environmental sustainable development by making good use of resources.

Digital technology changes the lifestyle landscape, and its cybercultural applications also create a new paradigm for education. The abundance of resources on the Internet not only offers students great convenience for information searching and knowledge acquisition, but also establishes conditions for cooperative learning. The function of art education consists in its leading students to understand art history and culture through interrelationships among optical space, color, and shape. Integrating the arts in STEM to create STEAM education focuses on the coordination of learning resources and enables students to develop creativity and

expressive capabilities for dealing with challenging cognitive and environmental problems.

The main purpose of this Keynote Presentation is to share an innovative experience of incorporating art education into STEM for the past twenty years. Simultaneously, the presentation will also address how the STEAM curriculum can incorporate four properties—experience, sharing, learning, and creativity—through web 2.0 learning environments. It is intended to provide the STEM 2014 audience with the qualities of an established STEAM learning network.



**JOHN ROBINSON**

Professor

UNIVERSITY OF BRITISH COLUMBIA

SUNDAY, JULY 13 | 8:30 A.M.

**NEXT GENERATION SUSTAINABILITY AT UBC**

The entire University of British Columbia (Vancouver, Canada) campus is a living laboratory for sustainability, a 402-hectare “societal test-bed” in which researchers, students, operational staff and private- and public-sector partners can build, test, learn, teach, apply, and share the outcomes of their inquiries. In November 2011, UBC opened North America’s greenest building, the Centre for Interactive Research on Sustainability (CIRS), one of only a handful of buildings worldwide that will provide “net positive” benefits to the environment. It reduces UBC’s carbon emissions,

powers itself and a neighboring building with renewable and waste energy, creates drinking water from rain and treats wastewater onsite. CIRS is one of four flagship projects – valued collectively at more than \$150 million—that will help UBC to achieve the most aggressive carbon-reduction targets at any major research university: a 33 per cent reduction in Vancouver campus institutional GHG emissions by 2015, a 67 per cent reduction by 2020 and 100 per cent by 2050. It is also a physical hub for the University’s efforts to deeply integrate academic and operational sustainability

on campus and ensure any student, regardless of their area of study, can earn up to a minor in sustainability. Join Professor John Robinson, the man responsible for CIRS and UBC’s Associate Provost, Sustainability as he describes the ways in which UBC is striving to prove out the technical, economic and behavioural aspects of sustainability in its simpler institutional environmental, share those innovations with society, and prepare the next generation of sustainability leaders.



**YOSHIKAZU OGAWA**

Adjunct Professor

UNIVERSITY OF TSUKUBA

NATIONAL MUSEUM OF NATURE  
AND SCIENCE

SUNDAY, JULY 13 | 1:30 P.M.

**COMMUNICATION BETWEEN THE PUBLIC AND MUSEUMS: DEVELOPMENT OF LIFELONG LEARNING SYSTEM TO FOSTER SCIENCE LITERACY**

Science literacy is vital if people are to properly respond to the problems concerning science and technology they face in everyday social life. Although schools are still required to play a basic role in the process, the lifelong fostering of science literacy should be conducted by diverse bodies such as museums. In order to satisfy this, we designed a Framework to foster science literacy that consists of four goals and five generations.

According to the Framework, we created an online database system called "Science Literacy Passport β" which can help science communication between the public and museum curators. It was launched in 2013 with 17 partner institutions including

NMNS. The alliance is composed of Japanese museums in five areas and abroad. Fukushima, which is in one of the five areas, has museums that run outreach programs about radiation. Examples like this will be explained together with the system itself.

In the system, curators input the data of their educational programs into the database using the Framework. The data is shared between not only curators but also the museum users who have a special card called PCALi (Passport of Communication and Action for Literacy). This card is scanned when taking part in the program at museums and the personal learning history is recorded on the system. In addition to that,

curators can receive feedback from the participants to run better programs or to develop new ones. Users themselves can share their thoughts between each other by leaving comments and recognize one's tendencies in selecting learning resources of museums and evaluate their learning pathways.

There are two purposes of the project. One is to establish the museum utilization model in which science literacy is fostered. Another one is to establish an interactive lifelong learning system as a new museum function.



**WOLFF-MICHAEL ROTH**

Lansdowne Professor

UNIVERSITY OF VICTORIA

MONDAY, JULY 14 | 9:00 A.M.

**STEM CURRICULUM THROUGH THE EYES OF THE LEARNER: THE UNSEEN AND THEREFORE UNFORESEEN**

Learning tends to be theorized, in research and curriculum practice, from the perspective of the known and seen, as is apparent in the idea that learners intentionally “construct” knowledge. We need to ask, however, how students who do not know the learning object (what the teacher wants them to know) can orient towards this unknown, unseen, and therefore unforeseen knowledge.

The purpose of this presentation is to bring the problematic of this learning paradox into sharp relieve by drawing on empirical examples from my research in a variety of settings. I then exhibit some core aspects of my findings, which, most importantly, highlight (a) the simultaneously active and passive aspects involved in any (perceptual) learning and (b) how the world and the objects it contains becomes

independent of perception. I conclude by articulating some of the advantages that come with theorizing learning from the perspective of the learner – i.e., the perspective of the learning object as unknown, unseen, and unheard-of – including the often-forgotten emotional component.

**RINA ZAZKIS**

Professor

SIMON FRASER UNIVERSITY

MONDAY, JULY 14 | 12:45 P.M.

**IMAGINING TEACHING VIA SCRIPTING TASKS**

Seeking ways to support and improve teacher education in STEM is a continuous challenge. My colleagues and I developed a method – scripting, or imagined role-playing – to help address this challenge. This is where

prospective teachers create a script for a play that presents an imaginary interaction between a teacher and her students. The scripting method was used as both a pedagogical approach and a research tool in mathematics

education. I will present the results of several recent studies which utilize scripting, consider advantages and limitations of this approach, and suggest adaptation and implementation in other STEM disciplines.

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**ELIZABETH CROFT**

Professor

UNIVERSITY OF BRITISH COLUMBIA

TUESDAY, JULY 15 | 11:00 A.M.

### **THE NEXT GENERATION OF WOMEN IN STEM: MAKING TRANSFORMATIVE CHANGE**

Women in STEM have made great strides over the past century. Presently, women make up 37% of Canada's undergraduate STEM enrolment similar to most developed countries. Yet the participation of women in technology focused disciplines like engineering and computer

science has stalled at below 20%. Moreover, the further one looks up the ranks, the smaller the number of women. Meanwhile, the demand for STEM professionals is outstripping supply and the need for women participate in developing the technology that will profoundly affect our society has

never been greater. In this talk I will unpack some of the facts and fiction around girls' and women's attitudes and experiences in STEM careers and look at some surprising yet successful strategies for changing participation rates.

## **SPECIAL EVENTS**

TUESDAY, JULY 15 | 2:30-4:00 P.M.

### **TOUR OF TRIUMF**

[triumf.ca](http://triumf.ca)

TRIUMF is one of the world's leading subatomic physics laboratories. It brings together dedicated physicists and interdisciplinary talent, sophisticated technical resources, and commercial partners in a way that has established the laboratory as a global model of success.

Registration is at the TRIUMF booth in the STEM Exhibition Hall, and is limited to 60 participants.

SUNDAY, JULY 13 | 10:00-11:00 A.M.

TUESDAY, JULY 15 | 9:45-10:45 A.M.

### **VERNIER WORKSHOP**

Neville Scarfe Building, Rm. 1210  
[vernier.com](http://vernier.com)

Developing 21st-Century Minds with Vernier Probeware: Are you preparing future science teachers for the expectations of the 21st-Century science classroom? Explore state-of-the-art probeware solutions that help teach core science topics in physics, chemistry, biology, Earth science and environmental science. Educators

receive hands-on training with Vernier's new LabQuest2, LoggerPro software and the Connected Science System, and a suite of commonly used probes and sensors.

Limited to 24 participants per workshop

# ABSTRACTS

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## POSTER

### 1.0.1 THE CHOICE OF TECHNOLOGY IN TEACHING READING AND WRITING LANGUAGE SKILLS

TING LIU

Simon Fraser University

SEPIDEH FOTOVATIAN

The use of technology in language teaching has become popular since several decades ago. Specifically, the use of computers in assisting the teaching and learning of reading and writing skills has received much attention from the educators. This paper elaborates on three commonly accepted principles: individuality, accessibility and

authenticity while using technology in the classroom. In this paper, I tend to describe the technology involved in teaching reading and writing skills to English language learners. Besides, the discussion also focuses on the steps of teaching reading and writing skills using the internet. Based on the theoretical framework, the analysis

of past studies is divided into three aspects, namely, Developed Program, Online Activities, and Software/Courseware. Some suggestions are given in the discussion part in selecting the appropriate technology tools to help nurturing the aforesaid skills.

## POSTER

### 1.0.2 IMPACT OF GLOBAL CLIMATE CHANGE MONITORING ACTIVITIES ON SOUTH KOREAN GRADE 7 STUDENTS' PERCEPTIONS OF STEAM EDUCATION

HYOUNGBUM KIM

Université du Québec à Montréal

EUN-JI AMY KIM

PATRICE POTVIN

South Korea has recently started a STEM-like approach named STEAM (Science, Technology, Engineering, Arts, and Mathematics) to train the next generations as innovators. The STEAM skills that students acquire in middle school require competencies in science, math and logical thinking prior to engagement in problem solving. Therefore, it is vital to prepare and develop interest in middle school students to participate in the STEAM. This study examined the impact of hands-on global climate

change monitoring projects of Six Structured Inventive Thinking (SSIT) on middle school students' STEAM content knowledge and perceptions. The participants for study were 68 middle school students (Grades 7) from middle school in Seoul, Korea. Employing a quasi experimental design, the participants who participated in the project activities were measured on their STEAM knowledge and dispositions before and after project participation. The findings indicate that participants who

participated in global climate change monitoring activities not only reported gains in their STEAM content knowledge, but also showed an improvement in their perceptions about STEAM subjects. This increase in STEAM perceptions was more pronounced for female middle school students than for male students. The results of this study suggest that carefully designed project of SSIT based environmental activities can be very effective at the middle school level.



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POSTER

**1.0.3 EFFECTS OF STEAM LESSONS USING SCRATCH PROGRAMMING REGARDING SMALL ORGANISMS IN ELEMENTARY SCIENCE**

SEUNG-HO HONG

Jeju National University

YOUNGMI CHOI

The aims of the present study are to develop STEAM Scratch programming regarding small organisms and examine whether the STEAM lessons can affect creative personality, creative problem solving ability and scientific attitude of elementary science gifted students. The STEAM lessons were designed that

learners could experience creative design and emotional touch through the instructional method of contents convergence to integrate scientific knowledge and Scratch programming. It was applied to 26 science gifted students, and both quantitative and qualitative approaches were used for data collection. As a result, the STEAM

lessons were effective on creative personality and scientific attitude ( $p < .05$ ). This study suggests that the integration of effective means for STEAM lessons such as life science and computer programming may result in increased creativity and interest of students for science and technology.

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POSTER

**1.0.4 BEGINNING EARTH SCIENCE TEACHERS' PERCEPTIONS IN INFORMAL STEAM EDUCATION IN KOREA**

HONG-JIN KWON

Gyeonggi Science High School for Gifted

EUN KI BAN

CHAN-JONG KIM

The purpose of this study was to investigate the newly-appointed Earth Science teachers' perceptions of informal STEAM education. In total, 116 teachers answered the questionnaire about informal STEAM education. This questionnaire was divided into five parts: necessity, educational values, teachers' experiences, difficulties, and teaching methods for informal STEAM education. The results indicated that the respondents have perceived informal STEAM education importantly in the Earth Science education and

answered in the affirmative on the educational values of informal STEAM education. Most of the teachers have experienced informal STEAM education, but have not learned how to teach students during informal learning in pre-service training. Some teachers have got experiences of informal STEAM learning and teaching students in informal STEAM programs during in-service period. Most of the participants perceived that teaching students in informal settings is difficult because of their lack of experience.

In order to overcome the difficulty, teachers suggested that they need to learn more about informal STEAM education during in-service training. They also suggested that the desirable teaching method of teaching students in informal settings is teachers' explanation and introduction of outdoor sites before their visit, teachers' scaffolding and students' group study during the informal STEAM learning, and the presentation and discussion about results after the informal STEAM learning.



## POSTER

**1.0.5 INVESTIGATING ACTIONS AND INTERACTIONS AT A SUMMER SCIENCE AND TECHNOLOGY CAMP**

CAROL REES

Thompson Rivers University

SPENCER MORRAN

Evidence collected in diverse settings over several decades indicates that children learn most effectively when they have opportunities for dialogue about the activities they are engaged in. However such opportunities remain rare in classrooms. Engle and Conant (2002) characterize such learning as productive disciplinary engagement and propose four features of environments that foster it: problematizing content; student authority; student accountability; and student access to resources. This study focuses on

episodes of productive disciplinary engagement that arise in two settings at a summer science camp at a science and technology centre; structured labs. and free-time at an interactive exhibit area. Preliminary findings suggest that episodes of productive disciplinary engagement are more frequent in the structured lab settings than at the interactive exhibit area where campers tend to interact with exhibits independently and rarely engage in discussion. Examination of pre-and post-camp responses to content questions explicitly

directed to lab. and interactive exhibit topics suggest that while both labs and interactive exhibits are sites for learning, the labs. are more effective as learning sites. Ideas for fostering productive disciplinary engagement at interactive exhibits are discussed. This presentation will be of interest to science and technology teachers and interactive exhibit designers. This work has the potential to contribute to knowledge about conditions that foster productive disciplinary engagement.

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M PAPER

### **1.1.1 A NEW DISCIPLINARY MODEL FOR INCREASING THE NUMBER OF UNDERREPRESENTED MINORITIES IN THE MATHEMATICAL SCIENCES**

LESLIE MCCLURE  
University of Alabama at  
Birmingham

PHILLIP KUTZKO  
KATHRYN CHALONER

CASEY GEORGE-JACKSON

It is well known that minorities are underrepresented in science, technology, engineering and mathematics (STEM) fields. While about 30% of the US population is considered a member of a minority group, minority representation in STEM fields is considerably lower, with some estimates suggesting that minorities comprise only 22% of the STEM workforce. In mathematical sciences, underrepresented minorities (URMs) are awarded doctoral degrees at rates lower than their population representation. The National Alliance for Doctoral Studies in the Mathematical Sciences (The Alliance) aims to ensure that every

underrepresented or underserved American student with the talent and ambition has the opportunity to earn a doctoral degree in the mathematical sciences. The Alliance is a coalition of faculty in predominantly undergraduate mathematics departments ("predoctoral mentors") who work with underrepresented and underserved students to identify outstanding prospective doctoral students ("alliance scholars"). The predoctoral mentors work with mathematical science faculty in Departments offering PhDs in the mathematical sciences to help alliance scholars identify graduate programs which are a good fit for

them. Alliance-affiliated graduate programs have demonstrated a commitment to ensuring the success of URM and other students. The result, in addition to increasing minority representation in careers in the mathematical sciences, is to build a community of scholars with a shared commitment to increasing diversity in the mathematical sciences. The Alliance, founded in 2001, currently has over 900 scholars, and more than 250 mentors from 90 colleges and universities and hopes to serve as a model for growing diversity in all STEM fields.



## S PAPER

### **1.1.2 TEACHING FOR RELEVANCE: LINKING SCIENCE INSTRUCTION TO STEM CAREER AWARENESS**

ISHA DECOITO  
York University

Motivating students' interest in math and science requires improved teaching strategies in the classroom and opportunities within and outside the classroom to demonstrate linkages between math and science, real-world applications, and future careers. Teaching in ways that inspire students and deepen their understanding of STEM content and practices is demanding. Elementary science and mathematics teachers are underprepared for these

TASHA RICHARDSON  
DANIELLA DI LUCIA

demands and reflected in their lack of comfort in teaching STEM content, often blamed on weak initial teacher preparation. This paper highlights data collected as part of a larger mixed-methods longitudinal study on the impact of outreach workshops on the efficacy and attitudes of teachers and students to STEM education. Preliminary findings suggest that while grades 6, 7, and 8 teachers possess the confidence to answer students' questions about science,

PHILIP MYSZKAL  
STEPHANIE FLORENCE

most teachers do not feel confident in their own knowledge of possible STEM careers (i.e., lack of STEM career awareness). Furthermore, findings indicate that interactive science instruction was positively correlated with STEM awareness. This data will be triangulated with interviews, workshop observations, and other forms of secondary data for discussion at the STEM conference.

## E PAPER

### **1.1.3 MENTORSHIP AS SOCIALIZATION: AFRICAN AMERICAN WOMEN IN ENGINEERING AT HBCUS**

EZELLA MCPHERSON  
Wayne State University

Historically, African American women have been under-represented in engineering majors. So, they have fewer opportunities to be mentored and socialized by another African American woman in engineering. This study discusses the mentoring experiences of 14

VIRGINIA TICKLES

undergraduate African American females in engineering majors and their perception on the value of being mentored by African American women at a Historically Black College and University (HBCU). It also examines African American women's experiences

in STEM majors at HBCUs. The results of the study provide insight into a limited body of knowledge on how mentoring socializes undergraduate African American female students for success in STEM majors at HBCUs.



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M PAPER

### **1.2.1 CO-ORDINATION AND CONTROL: CONNECTING THE CAPABILITIES OF CHILDREN WITH/ IN AN EDUCATIVE STEM CONTEXT**

KRISTA FRANCIS  
University of Calgary

STEVEN KHAN

BRENT DAVIS

We observed children's actions in building robots and used these observations to reframe our understanding of how spatial reasoning might be conceptualized in ways that honor what children are capable of. Our main purpose is to argue that an enactivist perspective is useful for making sense of what children do and are capable of within the context of building a robot because of its deliberate attention to

sensori-motor coordination and environmental feedback. The combination of these, we argue makes for an educative task that is both diagnostic and developmental and requires a reconsideration of how spatial reasoning might be conceptualized in a STEM context. In this presentation, we use contrasting examples of a student actually fitting an L-shaped Lego piece as part of constructing a robot and

a frequently utilized psychological measure that purports to attend to the same spatial reasoning phenomena - rotation. Then we encourage the audience to discuss the implications for teaching spatial reasoning in STEM contexts by asking, 'How do we design educative tasks that are attentive to the complexity of spatial reasoning and its development with learners?'



S PAPER

**1.2.2 (TWO-WAY LEARNING) KISKIAUMATOWIN IN SUPPORT OF SASKATCHEWAN'S MULTI-VOCAL K-9 SCIENCE CURRICULUM**

SANDY BONNY

University of Saskatchewan

The contributions of Saskatchewan's Aboriginal peoples are underrepresented in STEM educational resources, undermining the renewed Saskatchewan Science Curriculum's explicit mandate to integrate Western and Aboriginal perspectives in K-9 classrooms. This paper describes two programs developed at the University of Saskatchewan that aim to support the renewed science curriculum's vision through interactional learning practices. (1) The University of Saskatchewan's Science Ambassador Program engages senior undergraduate and graduate students from science, engineering and the health

sciences in 4-6 week placements in remote Aboriginal community schools. These students 'make science fun and relevant' by pairing hands-on science activities with peer-mentorship and community engagement. The activities they present in science classrooms reflect evolving cultural understandings and enthusiasm for inquiry-based learning. (2) The Saskatchewan Cradleboard Initiative facilitates experiential learning projects related to Indigenous and place-based science in University-level courses, which generate multi-vocal educational media for youth in lieu of traditional academic submissions. Students are connected with

Aboriginal elders, knowledge keepers, community educators, and physical archival collections, and are encouraged to bring their own perspectives and journeys to the media they develop. Both programs are dynamic examples of kiskiaumatowin, a Swampy Cree word describing interactional learning that transforms both teacher and student (c.f. Dorion, 2010). Emergent resources share tacit anti-racist perspectives and normalize multi-vocality in the context of science teaching and learning. Successes and challenges identified within and by each program will be discussed.



## S PAPER

**1.2.3 ARGUMENTATION SCHEMES: A WINDOW ON INTERNATIONAL, INDIGENOUS AND WESTERN SCIENCES**

ROBERT ANTHONY  
University of Victoria

MIJUNG KIM

Argumentation is recognized as a fundamental feature of expressing scientific reasoning and is a feature that is deeply embedded in STEM science education practices. Some have proposed features for argumentation in science with global application to reflect the universal character of scientific reasoning. Others have claimed distinctive national and cultural features of science, in particular those who do not accept English as the global language of science, and national and cultural minorities such as Indigenous people. In this

paper we examine 2 sources for evidence regarding the global or local character of argumentation. First, two sets of papers related to epistemology, 5 papers describing Indigenous science and another 5 papers 'western'/universal science are analyzed using Walton's argumentation schemes to identify the argument structures used in indigenous and non-indigenous writing about science. Secondly, two small group discussions, one involving largely indigenous youth and the other involving non-Indigenous youth are analyzed to

reveal the argumentation strategies and patterns of argumentation. Evidence from published studies on argumentation in Korean and Chinese are also considered. The value of Walton's presumptive argumentation schemes for exploring the character of arguments in international, Indigenous and 'western' sciences is confirmed. This pursuit for understanding argumentation schemes will contribute to developing students' scientific reasoning and decision-making on STEM-related problem solving.

## S PAPER

**1.2.4 KOREAN ELEMENTARY STUDENTS' PERCEPTION ON STEAM LEARNING OPPORTUNITIES (STEAM LO)**

YUMIN AHN  
Seoul National University

WON-YOUNG JUNG  
EUN JI PARK

SEUNG-URN CHOE  
CHAN-JONG KIM

STEAM (Science, Technology, Engineering, Arts, and Mathematics) is a new trend of a convergence science education in Korea. As a learning method, it emphasizes creative design and emotional touch. Although many related educational research studies have been conducted and related policies have been planned and executed, students' perceptions on STEAM learning opportunities (STEAM LO) have scarcely been considered and explored. The major aim of this study is to explore Korean elementary students'

perceptions on STEAM learning opportunities. It is important because STEAM is a learner-centered approach, and students' perceptions influence greatly on their learning. This study consists of two parts. First, we conducted a survey to 452 elementary students to identify types of students' perceptions on STEAM LO. Totally 1,039 responses were collected, and analyzed using framework with 'place' and 'situation of learning.' As a result, students' perceptions were classified into four types. Second, Q-technique was applied

to verifying our findings logically and statistically. As a P sample, 50 students participated in this investigation with Q sample of prior responses. The data collected are currently being analyzed. Preliminary results showed that Korean elementary students tend to perceive arts, such as painting, singing, and writing, related to science content as STEAM LO. Students' perceptions on STEAM LO can provide fruitful information on the way to design and develop learning strategies and materials for STEAM.



## T PAPER

**1.3.1 A CAUTIOUS SECONDARY SCHOOL APPROACH TO THE T IN STEM**P JOHN WILLIAMS  
University of Waikato

MATHEW THOMAS

The Technology component of many STEM proposals is overlooked, but it is the position of this paper that for the STEM subjects to effectively integrate, the integrity of each discipline must be respected. There are many reasons to be cautious about promoting a

STEM approach in the secondary schooling sector, and this paper presents the results of research in a secondary technology classroom that may provide some clues about how integration might be effectively achieved.

## G PAPER

**1.3.2 WHAT ARE YOU LOOKING AT? GRADUATE-ENTRY PRE-SERVICE TEACHERS' PERCEPTIONS OF STEM PEDAGOGY**MARGARET LLOYD  
Queensland University of  
Technology

MICHELLE MUKHERJEE

In 2012, the authors conducted a study of pre-service teachers which aimed to determine what they "saw" when observing effective practice in STEM classrooms rather than what we thought or presumed they saw (Lloyd & Mukherjee, 2012). We asked participants from Early Years, Primary and Secondary cohorts to watch and comment upon selected exemplary videos of teachers using ICT (information and communication technologies) in Science. Our concern was with if and how pre-service teachers identified "good practice" in STEM and how this impacts on their own

technological, pedagogical and content knowledge. We believed that this was more than skills, "tips and tricks" or simple lesson plans. There is a disposition to be acquired by mimesis, an enculturation more than an apprenticeship and a deliberate adoption of ways of working and thinking in the STEM disciplines. In this paper, we continue this research aim by focussing on a 2013 cohort of pre-service graduate-entry students preparing to teach in the Primary (P-7) sector. Previous studies (see Anthony & Ord, 2009; Kember, 2011; Priyadharshini & Robinson-

Pant, 2003) show wide variance of prior disciplines and how graduate-entry students' notions of effective pedagogy are rooted in their prior discipline or workplace or their own schooling. Given growing interest and expressions of preference for graduate-entry teacher preparation, we believed that this cohort warranted further attention. We had also felt that the original methodology we had developed for the 2012 study which used the SOLO Taxonomy (Biggs, 1999) as its framework for analysis warranted further trialling.



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S PAPER

### **1.4.1 PREPARING STUDENTS FOR LABORATORY CLASSES AND REDUCING COGNITIVE OVERLOAD USING INTERACTIVE ONLINE PRE-LAB TUTORIALS**

TRACEY KUIT  
University of Wollongong

In Australian Universities core biology subjects can be taught to over 1000 students at any one time. The students may be studying a wide variety of degree programmes, such as science, nutrition, medicine, nursing and environmental science, and possess an array of learning styles and objectives. Many students will have limited prior knowledge of subjects such as biology, chemistry and mathematics and many have minimal laboratory experience.

Catering to these differences is a challenge for University educators and further, students in such subjects can become unmotivated and overwhelmed by the vast amount of new content and skills to be learnt and the pace at which such acquisition is required. In an attempt to address the issue of student engagement and to motivate students to take responsibility for their own learning and feel less overwhelmed whilst in group work laboratory classes,

we created interactive online modules for students to complete in their own time before coming to laboratory classes at university. The overall aims were: to provide an engaging interactive learning environment that would encourage students to learn independently and to provide tools to help students feel better prepared and less overwhelmed for group activities encountered in class. The student experience was evaluated through an online survey.

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E PAPER

### **1.4.2 CONNECTING ELEMENTARY AND ADVANCED MATHEMATICS IDEAS FROM A PERSPECTIVE OF TEACHER TRAINING**

MARGO F KONDRATIEVA  
Memorial University

This is a position paper based on several years of my personal experience of working with pre-service secondary mathematics teachers. My goal is to address the situation where teachers are unable to relate more advanced mathematical procedures with corresponding elementary ideas. To illustrate such a situation I consider treatment of parabola. I observe that deeper understanding could be

achieved by complementing the usual calculus approach with elementary geometrical methods. The majority of teachers in my study were not familiar with basic geometrical properties of parabola; for instance they did not know an elementary way to construct a tangent to a parabola. I argue that such deficiencies in teachers' subject knowledge may undermine their pedagogical development. In my opinion,

this issue ought to be explicitly addressed in teacher training programs.



## E PAPER

**1.4.3 UNDERSTANDING HOW MIDDLE SCHOOL STUDENT ENGINEERING DESIGN THINKING TRANSLATES INTO PRACTICE**

WAHYU HASAN  
Queensland University of  
Technology

LES DAWES

This paper investigates a longitudinal study involving engineering design activities conducted with middle school students encompassing a three year period (from seventh grade to ninth grade) introducing foundational engineering ideas, principles, and design processes, together with an understanding of the roles of engineers and engineering in society. Data was gathered from six design activities

over this period, all of which required the application of the engineering design process to a design and build challenge. Specifically, this paper focuses on the stages of the design process associated with the production of design sketches and the construction of the final model or artefact. This paper proposes to establish criteria representing the degree of sophistication of both the students' design sketches and their constructed

artefacts for each activity, leading to an understanding of how the students transfer their drawn designs to construction. Students' responses to the engineering design activities revealed a number of iterative design processes, where the problem goals, including constraints, served as monitoring factors in students' idea generation, planning and construction.

## S PAPER

**1.5.1 ANALYSING STEM 2.0 ACTIVITIES THROUGH THE PISA SCIENTIFIC LITERACY FRAMEWORK: FINDINGS OF UNIVERSITY STUDENTS' VOLUNTEERING EXPERIENCES IN A DEVELOPING COUNTRY**

VINESH CHANDRA  
Queensland University of  
Technology

ANDY YEH

Many developing countries have made significant progress towards the United Nations Millennium Development Goals (MDGs) on universal education for all primary school aged children. However, the quality of education in some of these is a concern. We in the developed world can engage with schools in developing countries to build this capacity through knowledge sharing. This investigation highlights the experience of Australian university students who engaged as volunteers in two Fijian primary schools to

teach science. Their focus was on science and technology or STEM 2.0 (Bybee, 2013). The underlying structure of the activities involved: (a) developing an understanding of the context and science content; (b) creating a model to facilitate understanding (technology), and (c) explaining the science knowledge gained through the model built using ICT. We used the PISA science assessment framework to analyse the participants' engagement. Our investigation showed that the primary school students were able to demonstrate their scientific

knowledge and competency that were relevant to the local context. In addition this outcome was complemented by classroom pedagogy, the models created, and the ICT used. Collectively these factors also impacted positively on students' attitudes. Through this analysis, we propose a model that can be used by volunteers to teach science and technology using ICT in a developing country. In the process the participants also developed their knowledge of global citizenship.





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S PAPER

### **1.5.2 A QUALITATIVE INVESTIGATION ON THE SCIENCE EDUCATION REFORM IN TAIWAN: EXAMINING THE TRANSITION INTO A CONSTRUCTIVIST SCIENCE TEACHING APPROACH IN RELATION TO THE MAINTENANCE OF A CONFUCIAN HERITAGE CULTURE**

YING SYUAN HUANG  
McGill University

This qualitative study examines how Taiwanese science education reform initiatives are being implemented. More precisely, the study looks at discrepancy between the reform and teachers' cultural beliefs, and whether these could lead to teachers' resistance during the implementation of the reform. Importantly, the reform discourse will be examined vis-à-vis Confucianism, particularly, the notion of cultural heritage preservation in Confucianist philosophy. Qualitative data were gathered from science education

policy documents and individual interviews with three policymakers in Taiwan. These data detail the national science education policy goals and reform initiatives with regard to the secondary science curriculum in Taiwan. In addition, individual interviews were conducted with ten Taiwanese in-service secondary science and technology teachers. Teachers' reflective journals were also collected. These data reveal in-service teachers' epistemologies and views on science education reform initiatives, as well as

their teaching approaches in relation to Confucianism. This study critically examines and portrays the complex interactions between teachers' epistemologies and their broader sociocultural environments. Findings suggest that both policymakers and teachers in Taiwan perceive intercultural contradictions between Confucianism and constructivist science teaching approaches as a critical obstacle to the implementation of the reform.



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T PAPER**1.6.1 TEACHING A STEM-ORIENTED, ICT-BASED PROGRAM ABOUT SOUND, WAVES AND COMMUNICATION: A PILOT STUDY**

NAYIF AWAD

Ben-Gurion University of Negev,  
Sakhnin College

MOSHE BARAK

In this article, we present the case of development a curriculum for interdisciplinary learning in science and technology, its implementation in junior high schools and evaluation of students' achievements and attitude. The 30 hours course (15 two-hour sessions) encompass subjects such as sound and waves, conversion of sound to electrical signal, amplification, sampling, and analog to digital conversion. Beyond teachers' short presentations, the students are engaged in problem solving and project-based learning, with strong emphasis on using information and computer technologies (ICT)

tools such as simulation and sound editing software. One can see that the course design was guided by the following principles: contextual learning; integrated learning of science, technology and computer sciences; extensive use of information and computer technologies (ICT); and combining teacher's instruction with project based learning. The research aimed at exploring students' achievements and motivation to learn science, technology and computers. The participants in the pilot study were 40 junior high-school students (7th grade, age 13). Data collection tools include:

achievement tests, attitude questionnaires, interviews with teachers and students, and analysis of the students' assignments and projects. The findings up to date indicate that the students managed to handle the subject fairly well and had good achievements in the final exam. The learners also succeeded in developing final projects relating to sound and communication systems, for example, "The human ear", design of a sound system, and Bluetooth, and 35 students (out of 40) presented their projects to the parents at the end of the course.



S PAPER

### 1.6.2 EXPERT-GUIDED CROWD-SOURCED LEARNING CONTENT: A PILOT STUDY IN A LARGE ENROLMENT INTRODUCTORY PHYSICS COURSE

SIMON BATES

University of British Columbia

We describe the implementation of and results from a pilot study to extend the pedagogy of the Flipped Classroom (FC) approach, by tasking students taking the course to become co-producers of learning content. We describe a pedagogical framework and associated procedures for using student-produced learning content extensively within FC courses, together with processes to evaluate and curate this content. Results from an initial small-scale pilot (Oct 2013, completed)

together with more extensive deployment in several sections of a large-enrollment introductory course in Physics (over 800 students, to follow Jan-April 2014) will be presented. We will present data illustrating aspects of student engagement, student perceptions of their experiences as co-producers of learning materials, and the evaluation of the quality of the materials they produce. This design is both novel and significant, as it tries to address one of the known limitations of the FC

approach: not all students acquire the intended familiarity with the content which is presented to them ahead of class time (due to various reasons, including but not limited to, poor study strategies, lack of metacognitive ability to 'know what it is they don't know' when reading an academic text, workload, etc.). The pedagogical design is transferable across a wide range of STEM disciplines and in courses that utilize a FC modality.

S PAPER

### 1.6.3 TEACHERS' RECOGNITION OF STEAM EDUCATION IN KOREA

HEEJIN NOH

Korea National University of Education

SEOUNG HYE PAIK

There is not enough research for the study of experienced teachers in STEAM, and the study of their recognition and requirement to STEAM. Objective of this study is that how teachers make STEAM education in classroom, and what is needed to spread out and expand STEAM. We did survey and analyzed total 135 experts - STEAM leader school member and STEAM teacher study group. We gave an intensive interview to one of those group members by school grade. Questionnaire types are Lecture type, Teaching form, Teaching method, Elements of curriculum,

Classroom hour and Requirement. Result of this study is a large proportion of teachers realize that schoolteachers do joint project or do team teaching is desirable. And lots of teachers understand team teaching is advisable rather than one instructor teaching. STEAM teaching is performed in various ways. Especially, lecture, experiment and making products take have been done. They said STEAM classroom hour should be at least one hour a week. This is a meaningful because this result has come from professionals having experience in STEAM

teaching. It is expected for STEAM to be expanded in Korea. However, connection to other subject and difficulty of cooperation with other field expert turns up as assignments which must have to overcome to planning and operation on new STEAM program. That is, the people who already have experience STEAM education consider STEAM as a right way, and this should be spread out continuously. The Effect of STEAM education gives positive feedback to experienced person group.



S PAPER

**1.6.4 LESSONS FOR THE FLIPPED CLASSROOM APPROACH IN A LARGE UNDERGRADUATE CHEMISTRY COURSE: EXAMINING EXAMS SCORES BEFORE AND AFTER “FLIPPING” THE BUFFERS MODULE**ANKA LEKHI  
University of British Columbia

Flipped classrooms typically refer to swapping classroom and homework activities, such as note-taking, lecturing, problem-solving and peer-led discussions. This is often done by using video lectures or other online materials to replace face-to-face lectures, freeing up class time for students to work on problems in groups or individually with the guidance of the instructor. However, the following question, critical to the effectiveness of this pedagogy has yet to be investigated with a clear answer: How might this pedagogy impact student

performance in undergraduate Chemistry education? To address this question, exam scores for similar question types taken from two consecutive years' final exam in a General Chemistry course taught through a traditional lecture and face-to-face-online blended formats respectively, were compared. In year 1 of the study (2011), the module on acid-base buffers was taught using a typical lecture style approach. In year 2 of the study (2012), the acid-base buffers module was taught using online materials where students

completed an online tutorial-type review and assessment module. The lecture time was spent discussing the questions which were identified to be the most difficult for students where students actively solved problems in class. The final exams in 2011 and 2012 had similar questions pertaining to the buffers module. The analysis of the scores and instructor's own experiences will generate insights into how the flipped classroom pedagogy might be used in large lecture science classes.

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S PAPER**1.7.1 GIFTED YOUTHS' SUGGESTIONS FOR CLIMATE CHANGE MITIGATION**SAKARI TOLPPANEN  
University of Helsinki

MAIJA AKSELA

This research analyzed the project works of 19 gifted international youth. The projects were done as part of an application process to an international youth camp and they focused on climate change mitigation. The analysis of the projects was done by content

analysis. The pre-findings show that students plan local, national and international projects, most of which focus on raising awareness on climate change. However, interdisciplinary collaboration was rarely present in the projects. The projects also focused on the

environmental and societal aspects of sustainable development, but economic aspects were rarely discussed. Implications of the results on Education for Sustainable Development and Action Competence will be discussed.



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S PAPER

### **1.7.2 A CURRICULUM INTERVENTION TO IMPROVE CHILDREN'S UNDERSTANDING OF MATHEMATICS AND SCIENCE CONCEPTS FUNDAMENTAL TO UNDERSTANDING CLIMATE CHANGE**

LAURA SUPER  
University of British Columbia

LINDA SIEGEL

ALEX SARRA-DAVIS

NA'AMA AV-SHALOM

SUZY VIRAGH

JENNIFER LUU

VRINDA OHRI

KRISTINE HUI

SHUTING HUO

JOANA PINTO

Climate change is an important scientific issue. The public is subjected to conflicting claims about climate change, especially global warming, and generally lack the scientific knowledge to critically evaluate these claims. One approach to this science literacy gap is to ensure that our children are taught the necessary scientific concepts in order to understand the issues. This study implements

a new science curriculum in grade 4 and 5 classes. We also sought to understand possible factors useful for predicting success in learning the curriculum, to potentially identify children with reading and mathematics difficulties, and to analyze their learning in comparison to typically achieving children. In 2013, we studied the effect of part of the curriculum in classes in Vancouver and North

Vancouver, British Columbia, Canada. For this part of our ongoing study, we found the following key results: grade 4 and 5 children can learn concepts underlying the science of climate change and global warming; and special needs (children with poor reading or poor math skills) students, on average, performed as well as the rest of the children.

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S PAPER

### **1.7.3 INTERGENERATIONAL JUSTICE, ENVIRONMENTAL EDUCATION AND OUR HOPES FOR FUTURE GENERATIONS**

DAVID BURNS  
Kwantlen Polytechnic University

STEPHEN NORRIS  
CHARMAINE LEUNG

BETTY YEUNG

It is often hoped that education will provide the next generation with the knowledge, skills and attitudes needed to prevent catastrophic environmental degradation. We will argue that, while such hopes

have their place, they also serve to distract attention from the necessary betterment of currently adult generations. We ultimately conclude that it is a mistake for science teachers to emphasize the

betterment of future generations at the expense of rigorous self-examination. Teachers today ought to ask more of themselves and, in so doing, will better serve their students.



## S PAPER

**1.7.4 UNDERGRADUATE STUDENTS' CONCEPTIONS OF LEARNING ENVIRONMENTAL SCIENCE AND THEIR LEARNING SELF-EFFICACY IN BEIJING**JING WANG  
Beijing Normal University

YAN DONG

JYH-CHONG LIANG

This study explored the relationships undergraduate students' conceptions of learning conceptions of learning environmental science and their learning self-efficacy. This study developed a questionnaire (called the Conceptions of Learning Environmental Science [COLES] inventory) based on previous instrument framework and students' interview about learning environment science which administered to 346

undergraduates in Beijing. It was found that this study confirmed a seven-factor structure through exploratory factor analysis: "memorizing", "testing", "increase of knowledge", "applying", "understanding", "seeing in a new way" and "experiment". Moreover, the results revealed that students' learning self-efficacy was significantly and negatively correlated to their "memorizing" conception and positively correlated to "applying",

"understanding", "seeing in a new way" and "experiment" conceptions of learning environmental science. In addition, the t test results also showed that the female students were more likely to have "memorizing" conceptions of learning environmental science. However, the male students tended to have "applying" and "seeing in a new way" conceptions of learning environmental science.

## G PAPER

**1.8.1 SUPPORTING INTERDISCIPLINARY APPROACHES TO STEM EDUCATION THROUGH SCIENCE FICTION**JANICE BOGSTAD  
University of WisconsinCHANGYI FU  
RONG ZHOU

YAN WU

Continuing with our discussion of method and theory through the use of science fiction texts which was initially presented in Beijing in 2012, three scholars present a session where they focus on the applicability of science fiction to teach science topics requiring

interdisciplinary thinking, such as climate change (Bogstad), review a short history of science fiction in science education in China, Japan and Russia (Wu), and report on a case study comparing differences in ability to explore new ideas and to develop critical thinking skills

as well as the understanding of the scientific spirit, technology, and engineering ethics between students who have had a science fiction course and those who have not (Fu).



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POSTER

**2.0.1 DEVELOPMENT OF MODEL TO IMPROVE CONTENTS, METHODS AND EVALUATION OF STEAM EDUCATION FOR MATHEMATICS AND OTHER SUBJECTS IN MIDDLE SCHOOL**

HO-KYOUNG KO  
Ajou University

SU-YOUNG CHOI  
MIHYUN YOO  
WOO-SANG OH

JENG-HYUN KIM  
KYEONG-RYEONG LEE

This research develops theme based STEAM programs and applies in elementary classes to examine the effects of STEAM programs on students' science learning interest, scientific attitude, and self efficacy. The participants of this work were two classes of

the 4th grade of C elementary school located in Gyeongnam. It was divided into two groups - an experimental group is composed of 25 students and a comparison group is composed of 25 students. We developed STEAM program based on the theme of paper art.

The results showed that theme based STEAM program showed positive influence in the elementary students' self efficacy. However, theme based STEAM program did not show statistical significance in student's scientific attitude and science learning interest.

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POSTER

**2.0.2 COMBINING SCIENCE WITH ART FOR INTER-DISCIPLINARY EDUCATION: THE CASE STUDY OF AN UNDERGRADUATE COURSE IN KOREA**

HUNKOOG JHO  
Dankook University

HYE-GYOUNG YOON

MIJUNG KIM

This study aims to show a unique way of inter-disciplinary approach to STEAM education in Korea. With an emphasis on sensitivity and creativity in STEM education, science education in Korea has included "Art" in its inter-disciplinary approach. This exploratory study shows the example of how science and art could be integrated and

taught as STEAM approach. From a historical viewpoint, the relationship between development of science and art has been reciprocal. Since the ancient era, science and art have had a cultural symbiosis and much work of arts provides many chances to learn science concepts effectively. In this study, we designed an

undergraduate course to foster students to have creative thought based on various disciplines. This presentation will show a good example of cooperation between the two disciplines and discuss how science and art contribute to inter-disciplinary education for the future.



## POSTER

**2.0.3 THE EFFECT OF CLASSROOM ENGAGEMENT ON STUDENT EXPERIENCE AND FINAL GRADE IN AN UNDERGRADUATE BIOLOGY COURSE AT MEMORIAL UNIVERSITY OF NEWFOUNDLAND**

ANNA HICKS  
Memorial University of  
Newfoundland

TRUDI JOHNSON

Especially during the first year in university absenteeism can have detrimental effects on grades, and we have witnessed this in our large university undergraduate biology classes. It has been suggested that altering teaching methods from lecturing toward student engagement can enhance learning, student participation, decrease absenteeism, and improve critical thinking and problem solving skills. In this research study we used a combination of engaging learning activities and classroom response system (clickers) to prevent absenteeism in one of three sections on an introductory

university biology course in Fall semester 2013. In one section the professor used student engagement methods (small group work, quizzes, clickers) during lectures, and two sections received traditional lectures without student engagement. This was a mixed method study using both quantitative and qualitative research methods. We used quasi-experimental design in the classroom to compare the two types of teaching. We collected pre- and post-test data, the course grades, lecture absenteeism rates and student engagement CLASSE survey. Qualitative methods were

used to interview students in focus groups about their experiences. Results show that students were less absent from the class that used engaging teaching methods. There were no differences in midterm exam, final exam, or in pre- and post-test grades. The student CLASSE survey indicated more interaction between faculty and students in the section that was taught using engaging methods. At the time of Abstract submission the student focus group interview results are under analysis, and these results will be discussed at the conference.





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POSTER

**2.0.4 INVESTIGATING THE ECOLOGICAL STRATEGIC CALCULUS LEARNING APPROACH ON ACADEMIC ACHIEVEMENT OF A COLLEGE STUDENT WITH LEARNING DISABILITY IN CALCULUS**

NEERUSHA BAURHOO  
McGill University

Mathematical literacy is mandatory in our daily lives (e.g. paying bills, understanding bank statements, analyzing mortgage rates). However, developing a comprehensive understanding of mathematics can be challenging for all students, especially for those with learning disabilities (LD). As indicated by the National Assessment of Educational Progress, students with disabilities (including those with LD) are significantly achieving lower academic scores as compared to their typically achieving peers across grade

levels in mathematics (National Center For Education Statistics, 2013). Several intervention-based strategies have been examined to support students with LD in mathematics. The present study examined the ecological strategic calculus learning approach in improving academic performance and minimizing other academic barriers experienced by college students with LD in calculus. The study followed the hybrid embedded mixed method design with a main quasi experimental single-case design. Data collection

involved academic scores from formal classroom-based assessments to measure academic outcomes as well as interview and reflective diaries to capture students' perspectives on academic barriers. Findings indicated that the ecological strategic calculus learning approach might be effective in improving academic outcomes and addressing few academic barriers reported by students with LD. Significance and contribution of the study are also discussed.

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POSTER

**2.0.5 EFFECTIVE PRACTICE OF STEM CURRICULUM RESOURCES INTEGRATION FOR CHILDREN IN INFORMAL ENVIRONMENT**

RUIHUI HAO  
Education Center for "Learning by Doing" Science Education Reform Pilot Program

STEM is an emerging practice and research paradigm of international science and technology education in recent years. How to fuse science, technology, engineering and mathematics into cohesive informal instruction becomes a new research focus. In order to explore the ways to integrate

curriculum resources from in and out of classes to implement STEM practices in the informal background, we have been executing a science education project called "Jim's workshop" for 3-12 year-old children, which is connected to current science education of China, follows

principles of science education, emphasizes inquiry-based learning, and is informed by leading science education patterns and experiences in the US, France and the UK etc.. This project includes a whole set of STEM activities, on an informal learning platform.



## T PAPER

**2.1.1 INTEGRATION OF STEM INTO THE CURRICULUM FOR TECHNOLOGY EDUCATION: USA CASE STUDY**

SZU-CHUN FAN

National Taiwan Normal University

KUANG-CHAO YU

This study sought to gain a holistic view of American high school STEM based curriculum programs for technology education. It employed a qualitative case study method to describe and explain the educational philosophy, curriculum/standards design, instructional methodology, and teacher education for delivering STEM education. A semi-structured

interview method was used and 15 USA technology education teacher educators were interviewed to collect their views and suggestions on STEM curriculum program design and instruction for technology education. Data will be coded and analyzed using both qualitative and quantitative approaches. The qualitative analyses will categorize, analyze,

and summarize the experts' viewpoints and suggestions; the quantitative analyses will use descriptive statistics to support the analysis of results. The results will be analyzed and conclusion made by May 2014. This study may lead to a better understanding of STEM concepts and principles used within a technology education curriculum design.

## S PAPER

**2.1.2 TRANSFORMATION IN EDUCATIONAL PRACTICES THROUGH STEM**

TONY SAHAMA

Queensland University of  
Technology

DEEPTHI BANDARA

The need for strong science, technology and innovation linkages between Higher Education Institutions (HEIs) and industries is a pivotal point for middle-income countries in their endeavor to enhance human capital in socioeconomic development. Currently, the University-Industry partnerships are at an infant stage in Sri Lankan higher education context. Technological maturity and effective communication skills are contributing factors for an efficient graduate profile. Also, expanding

internship programs in particular for STEM disciplines provide work experience to students that would strengthen the relevance of higher education programs. This study reports historical overviews and current trends in STEM education in Sri Lanka. Emphasis will be drawn to recent technological and higher education curricular reforms. Data from the last 10 years were extracted from the higher education sector and Ministry of Higher Education Policy portfolios. Associations and trend analysis of

the sector growth were compared with STEM existence, merger and predicted augmentations. Results were depicted and summarised based on STEM streams and disciplines. It was observed that the trend of STEM augmentation in the Sri Lankan Higher Education context is growing at a slow but steady pace. Further analysis with other sectors in particular, Industry information, would be useful and a worthwhile exercise.



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G PAPER

### 2.2.1 STEM FUNDS OF KNOWLEDGE OF CHILDREN IN THE HOME

SAMANTHA TAN  
University of British Columbia

JESSICA TANG

SAMIA KHAN

This research investigated STEM funds of knowledge of children in a “low asset” community in a major city in North America. An out-of-school program was developed to build upon these funds of knowledge. Briefly, funds of knowledge refers to historically accumulated and culturally developed bodies of knowledge and skills for household or individual functioning and well-being. STEM funds of knowledge are funds of knowledge that are related to science, technology, engineering or math gained through common, everyday activities. Household visits were

conducted to ascertain the STEM funds of knowledge of children in the homes. Data collected from consultations were subsequently analyzed using a process of collective coding by members from this community and researchers in science education and sociology. Drawing upon the codes, a STEM Funds of Knowledge elementary program was developed for fifty local families with the goal of incorporating children’s STEM funds of knowledge from their household into the lesson plans. Before the program, parent, teacher, and child questionnaires

were analyzed to identify the children’s STEM funds of knowledge and assess the impact of the program on enriching children’s STEM funds of knowledge. Our findings reveal that 1) a substantial amount of children’s STEM funds of knowledge are gained in their homes, 2) children’s STEM funds of knowledge include math, construction, usage of technology, plant biology, and environmental science, and 3) programs designed based on this process can be an effective way to integrate existing STEM knowledge from the home with new STEM knowledge.

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G PAPER

### 2.2.2 THE STEM ISSUE IN AUSTRALIA: WHAT IS IT AND WHERE IS THE EVIDENCE?

SARAH HOPKINS  
Monash University

HELEN FORGASZ  
DEBORAH CORRIGAN

DEBRA PANIZZON

In Australia, it is widely claimed that there is a shortage, in fact a ‘crisis’, with respect to the STEM workforce. In this paper, we

define STEM, present data on STEM participation rates, examine current concerns about the STEM workforce, and interrogate and

critique the interpretations of the expressed ‘crisis’ in the Australian context.



S PAPER

**2.2.3 THE PRACTICE OF STEM IN CHINESE SPECIAL SCHOOL**HUI LI  
Southeast University

Based on the work of science education, Thinktank: Handsbrain Education, Jiangsu developed STEM themes and implemented practices

ZHAO YE

in pilot special schools since 2010, organized teacher training, and tracked to guide teaching. The special children's ability advanced

JIAN ZHOU

obviously in various aspects after the STEM themes teaching.

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G PAPER

**2.2.4 A HORIZON OF POSSIBILITIES: A DEFINITION OF STEM EDUCATION**KRISTA FRANCIS  
University of Calgary

Over the last two decades, there has been an increased frequency in use of the term STEM in Canadian educational contexts. Indeed, we (the authors of this paper) came together as part of a designated STEM research project at our university faculty of education. As we started working with each other, we questioned how we fit into STEM and wondered how we were defining STEM education.

LYDIA BURKE

We did not embrace STEM's associated advocacy for global competitiveness and fulfilling workforce requirements. Nor did our perspectives align with any particular model of integration of STEM disciplines. Our concern was keeping the educational opportunities for children open for as long as possible. In this paper we present a definition of STEM education that aligns

MARIE-CLAIRE SHANAHAN

with our educational purposes for improving elementary STEM education. We illustrate this definition by describing the components of just one ongoing research initiative that supports our drive for a sustained, systemic, and specialized contribution to development in the field of STEM education.

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G PAPER

### 2.3.1 WHAT DIGITAL VIDEO TECHNOLOGY CAN DO FOR TEACHERS IN STEM

RUTH GUO

Buffalo State, State University of  
New York

STEPHEN GAREAU

The study described here took place in a graduate educational technology program at a northeastern U.S. state university. The study investigated what digital video technology can do for teacher education in STEM. The researchers address the

issues of both the possibilities and limitations of digital video technology for teacher education in STEM. Ethnographic case study was employed as a research approach to analyze the complex teaching practices and learning processes of STEM. Thus, digital

video technology plays double roles here: as a research tool and as an instructional resource. The paper also reports on possibilities and limitations with the use of digital video technology in the teaching and learning of STEM.

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G PAPER

### 2.3.2 INTEGRATING ICTS INTO TEACHERS' PRACTICE IN THE CLASSROOM USING SUPPORTED CONTINUOUS PROFESSIONAL DEVELOPMENT (SCPD)

MARIE KAVANAGH

University of Southern Queensland

This article discusses the Supported Continuous Professional Development (SCPD) approach used within an E-hotseat project as a method of supporting teachers use of Information and Communication Technologies (ICTs) in the classroom. The E-hotseat technique used is discussed as well as the SCPD

approach which involved a combination of techniques and ICTs. Findings indicated that teachers valued participating in SCPD activities. They felt supported and had greater confidence in trying new technologies. Teachers critically analysed the ICTs used and the stages and processes of the facilitation techniques. They

began discussing the selection of ICTs based on pedagogical decisions. All teachers asked to participate in the project again, an indication of the positive impact of SCPD and its potential to influence teachers' continued motivation to use innovative techniques.



### 2.3.3 ENGAGING STUDENTS (AND THEIR TEACHERS) IN STEM THROUGH ROBOTICS

CHRISTINA CHALMERS  
Queensland University of  
Technology

Robotics@QUT is a university outreach program aimed at building pre- and in-service teacher capacity to encourage interest in Science, Technology, Engineering and Mathematics (STEM) subjects with school children from low socio-economic status areas. Currently over 35 schools are involved in the outreach program. Professional Development workshops are provided to teachers to build their knowledge in implementing robotics-based STEM activities in their classrooms, robotics loan kits are provided, and pre-service teacher visits arranged

to provide the teachers with on-going support. The program also provides opportunities for school students to engage in robotics-based on-campus activities and competitions and is seen as a way to build aspirations for university. This paper presents an interim evaluation that examines the value of the Robotics@QUT program for the teachers, pre-service teachers and school students participating in the program. Surveys were administered to determine the participants' perceived benefits of being involved and their perceptions of the program. The

data gathered from the teachers showed that they had gained knowledge and confidence and felt that the Robotics@QUT program had assisted them to deliver engaging robotics-based STEM activities in their classrooms. The pre-service teachers' responses focused on benefits for themselves, for their future teaching careers and for the school students involved. The school students' responses focused on their increased knowledge and confidence to pursue future STEM studies and careers.

### 2.3.4 UNDERWATER WEB CAMERAS AS A TOOL FOR OCEAN STEWARDSHIP

MIKE IRVINE  
University of Victoria

MIJUNG KIM

In an attempt to engage students in enhancing marine awareness and learning marine science and technology, this paper proposes that underwater web cameras will be effective tools in accomplishing these goals. Through underwater web cameras, students and teachers can connect to marine environments in real-time by observing and engaging in inquiry-based learning collectively. The technology of an underwater web camera allows access to live video streams anywhere, any time of day and through all Internet capable devices, promoting further

student engagement outside of the classroom. This experience provides a more active presentation of marine environments when compared to a book or film. Research suggests that these forms of experiences provide an engaging presentation of marine environments and the motivational impact of using underwater web streaming to encourage students to pursue science careers. In addition, online web streaming can facilitate discussions between students and scientists at a distance. Students can hear and speak with researchers that are

underwater instantaneously, inquiring about the various marine environments they are observing. The educational importance of these kinds of interactions, promote participatory science and technology literacy, knowledge retention, interest in science careers and marine awareness. Underwater web cameras give students the opportunity to discover the richness of the ocean, promotes a strong integration of science and technology, and affords students a chance to practice ocean stewardship.



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S PAPER

### 2.4.1 CHINESE SCIENCE AND TECHNOLOGY MUSEUM EDUCATORS' ROLES AND NEEDS FOR PROFESSIONAL DEVELOPMENT

JIAO JI  
University of British Columbia

DAVID ANDERSON

XINCHUN WU

Understanding museum educators' roles and their needs for professional development (PD) is crucial for science and technology museums (S & T) to improve educational service. This exploratory survey study investigated 102 S & T museum educators' background, current working status and aspirations for

PD across China. Findings show that 1) Chinese S & T museum educators' work is complex; 2) Internal departmental discussion is perceived to be the predominant PD mode, while more external opportunities are desired; 3) Participants are interested in attending museum education courses and courses that can

provide credits toward master's degrees. This study as an initial step pushes S & T museums, S & T museum administrative institutions and universities to promote the professionalization of museum education work in Chinese S & T museum context.

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S PAPER

### 2.4.2 CHILDREN'S PERCEPTIONS OF SCIENTIFIC OBJECTS THROUGH 2D VS. STEREOSCOPIC PRESENTATIONS IN A MUSEUM

AARON PRICE  
Museum of Science and Industry

HEE-SUN LEE

Stereoscopic technology (3D) is rapidly becoming ubiquitous across research, entertainment, and informal educational settings. This paper presents the results of a National Science Foundation funded study into the use of stereoscopic visualizations for children's learning in science museums. 261 children were shown a series of 13 images in a display on the floor of a science museum. The

images were randomly displayed in either two-dimensional or stereoscopic format. They were asked questions about spatial properties of the images and asked to draw one of the images at the end of the test. Results show no difference in responses on the test between the 2D and stereoscopic display modes. In the drawing task, stereoscopic display did not have an impact on children's ability to recall

and reproduce simple properties, but it did have a positive effect on their ability to recall and reproduce more complex properties. Age, gender, prior spatial visualization ability and the novelty effect were all controlled for in the study. Results are interpreted through the lens of cognitive load theory and its impact on science visualization design.



S PAPER

**2.4.3 PLAY-BASED LEARNING FOR UNDERSTANDING PHYSICS IN MIDDLE SCHOOL.**

ELIZABETH HOLT

St. Peter's Lutheran College

St Peters Lutheran College had to design a work program for Middle School Science that would meet the criteria of the National Curriculum including the Physics strand. The program had to be delivered across Year 8 and 9; each year level is approximately 280 students. It is delivered by 8 to 10 teachers per year level. Only one of these teachers is a specialist Physics teacher; the remainder

have limited Physics knowledge. Designing a play based program, outside our normal text book has been critical. The work program needed a very high level of support for teachers and robust, easy to use equipment. The success of students was measured by their grades and uptake of Senior Physics. Students were successful with 99% of year 8 and 9 students passing the Physics strand and over

50% achieving a B grade or higher in 2012 and 2013. Students at St Peters Lutheran College go against the National trend of reduced uptake of Senior Physics, with 15% of students selecting Physics in the Senior Years. Play based learning has enhanced student enjoyment and understanding of Physics concepts.

S PAPER

**2.4.4 PROMOTING STEAM EDUCATION IN THE CONTEXT OF INFORMAL SCIENCE LEARNING: THE CASE OF NATURAL HISTORY MUSEUM**YOUNG-SHIN PARK  
Chosun UniversityHYO-SUK RYU  
JONGWON PARKYOUNGMIN KIM  
HAE-AE SEO

The purpose of this study was to explore what kinds of characteristics can be withdrawn when two science docents with whom the researchers had collaborated for 5 months developed STEAM program whose title was 'foot print is black box', and implemented it to the setting of one natural history museum in Korea. 'Science' could be achieved easily in the hall which is full of science exhibitions, 'Arts' and 'Mathematics' could be emphasized in the separate lecture room through the interaction

between two docents and visitors by creating a story of 'animals' foot prints' in handkerchiefs and by calculating the size of the animal or its walking speed abducted from the size of foot print each but 'Technology' and 'Engineering' had limitation to be implemented since there were not related exhibitions. The docents who participated in this study could only deliver the story related to 'T' and 'E' verbally in the lecture room. The format of STEAM embedded in natural history museum was that of SteAM

with the more emphasis of S, A, and M but less of T and E. Two docents participated in this study developed firm and structured understandings and practices of STEAM and visitors' responses to STEAM were very positive. It is suggested that authentic STEAM should be possible when implemented by the unit of the community based one and professional developed program for STEAM is recommended for docents to be expert.





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E PAPER

### 2.5.1 LINKING PEDAGOGICAL KNOWLEDGE PRACTICES AND STUDENT OUTCOMES IN STEM EDUCATION FOR PRIMARY SCHOOLS

PETER HUDSON  
Queensland University of  
Technology

LYN ENGLISH  
LES DAWES

DONNA KING  
STEVE BAKER

STEM education is a new frontier in Australia, particularly for primary schools. However, the E in STEM needs to have a stronger focus with science and mathematics concepts aligned to the presiding curricula. In addition, pedagogical knowledge practices such as planning, preparation, teaching strategies, assessment and so forth need to be connected to key concepts for developing a STEM education. One of the aims of this study was to understand how a pedagogical knowledge practice framework could be linked to student outcomes in STEM education. Specifically, this qualitative research investigated

Year 4 students' (n=19) involvement in an integrated STEM education program that focused on science concepts (e.g., states of matter, testing properties of materials) and mathematics concepts (such as 3D shapes and metric measurements: millilitres, temperature, grams, centimetres) for designing, making and testing a strong and safe medical kit to insulate medicines at desirable temperatures. Eleven pedagogical knowledge practices (e.g., planning, preparation, teaching strategies, classroom management, and assessment) were used as a framework for understanding how teaching may be linked to student outcomes

in STEM education. For instance, "planning involved devising a student booklet as a resource for students to understand the tasks required of them, which also provided space for them to record ideas, results and information. Planning involved linking national and state curriculum documents to the STEM education activities. More studies are required around pedagogical knowledge frameworks to understand what students learn when involved in STEM education, particularly with the inclusion of engineering education.



M PAPER

**2.5.2 RESTRUCTURING A PRE-SERVICE TEACHER MATHEMATICS EDUCATION COURSE TO DEVELOP MATHEMATICS CONTENT KNOWLEDGE (MCK) AND MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE (MPCK)**KEVIN LARKIN  
Griffith University

This paper examines key pedagogical and structural changes, made over two semesters, to a core pre-service teacher mathematics course such that it could successfully be taught in mixed (blended) rather than solely face to face mode. Using Transactional Distance Theory (TDT) as a conceptual framework, it outlines the impact of design changes on the development of Mathematical Content Knowledge (MCK) and Mathematical Pedagogical Content Knowledge (MPCK) by pre-service

teachers. It also examines the effect of the design changes on attitudes towards the learning of mathematics and the development of self-confidence concerning the teaching of mathematics. Pre-service educator feedback indicated a lowering of mathematics anxiety; improvement in their mathematical pedagogical content knowledge; a shift in perspective regarding mathematics; and an increased confidence in teaching mathematics. These findings have implications for universities

moving towards the increased use of online teaching in mixed-mode or blended courses. This article contributes to domain knowledge as blended learning environments in mathematics education have not been thoroughly investigated using TDT. It also contributes to the current educational discourse regarding the appropriateness of delivering mathematics education courses in blended modes.

T PAPER

**2.5.3 FROM UNKNOWN TO KNOWN: VIRTUAL WORLDS INTERACTIVE PEDAGOGY**HSIAO-CHENG (SANDRINE) HAN  
University of British Columbia

When education happens in a virtual world, the possibilities and restrictions are different from a real world educational environment. In one virtual world, The University of British Columbia's Open Sim: VIEW (Virtual Immersive

Education World), the students of this class created their own educational environments in which they demonstrated a 20-30 minute lesson on one of the following subject areas - math, music, language, and civic education. In

this article, the students share their experiences on the positive and negative aspects involved in creating their virtual worlds, as well as the knowledge and experiences gained from such a process.



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M PAPER

#### **2.5.4 SUSTAINED SCHOOL-BASED COACHING AS A MODEL OF PD FOR SECONDARY MATHEMATICS TEACHERS**

RICHELLE MARYNOWSKI  
University of Lethbridge

This paper reports on research implementing a sustained school-based coaching model of teacher professional development (PD). Secondary mathematics teachers were provided access to a mathematics teaching and

assessment expert as a school-based coach over the period of one and a half school years. The focus of the coaching was to assist teachers in enhancing their use of formative assessment strategies in their secondary mathematics

classes. This paper outlines some essential characteristics of the PD model of sustained, school-based coaching as noted by the participants.

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G PAPER

#### **2.6.1 BEYOND THE SUBJECT SILOS IN STEM - THE CASE FOR 'LOOKING SIDEWAYS' IN THE SECONDARY SCHOOL CURRICULUM**

DAVID BARLEX  
Brunel University (Emeritus)

FRANK BANKS

This paper considers how teachers of each of the school subjects science, mathematics and design & technology might adopt a positive approach to STEM by 'looking sideways' and taking into account in their own teaching what colleagues from each of the other subjects are teaching. The paper will use the invited comments of

three distinguished educators, one from each of science, mathematics and design & technology for an initial exploration of what this might involve. Then the paper considers two possible futures of STEM: the first in which teaching the subjects is independent one from another, the acronym to have a full stop between each of the letters as it

were - S.T.E.M; the second in which there is a dynamic and synergic relationship between two or more of the contributing subjects. Each future is considered in the light of comments from teachers in Israel, Argentina and Brazil. Finally the paper discusses the idea of 'looking sideways' for the development of teacher professional knowledge.



S PAPER

## 2.6.2 ALTERNATIVE POWERS: DE-FRAMING THE STEM DISCOURSE

 DAVID BLADES  
 University of Victoria

MATTHEW WEINSTEIN

SHANNON GLEASON

Internationally STEM has become a slogan for organizing new discourses and practices in science education. Our paper explores the role STEM could play in stimulating the invention, deployment, and development of alternate sources of electrical power; in particular, solar technologies versus the dominant carbon technologies of fracking and shale/sand oil extraction. Though a rehearsed dialogue presented in the form of a one-act play we use the discourse

of alternative power to reveal possibilities for reimagining STEM in new ways. Our deconstruction of alternative sources of energy does not advocate for any particular alternative; instead, we demonstrate how STEM as social engineering works to orient and organize school science education curriculum development in directions that reinforce and legitimize neo-Liberal assumptions of global competition and capitalist expansionism. Our

conversation interrogates how STEM as a discourse diminishes our understandings of the role of school science might play in shaping more livable worlds and futures. In contrast, our engagement also demonstrates the possibility of alternative pedagogies to resist the dominating discourses of national competitiveness. Our hopeful conversation thus suggests new roles for school science education outside and against the prevailing discourse of neoliberalism.

M PAPER

## 2.6.3 NEW CURRICULA AND MISSED OPPORTUNITIES: DEALING WITH THE CROWDED CURRICULUM 'STEMS' FROM 'BIG IDEAS'

 CHRIS HURST  
 Curtin University of Technology

The recent Common Core Standards for Mathematics and the Australian Curriculum: Mathematics represented opportunities to make significant changes to the teaching of mathematics at elementary and primary school level. However, whilst the documents in themselves are sound they have not departed much from previous curriculum documents in terms of key content and how it is organised. The familiar

linear progression from year to year is still the centrepiece of the organisation of the documents. In acknowledging the vital importance of the Common Core Standards for Mathematical Practice and the ACARA Proficiencies, it is suggested also that it would be better to re-think the nature of key content and to organise it for teaching in different ways to those which continue to be the norm in curriculum documents. The

solution rests in a framework based on the 'big ideas' of mathematics with an emphasis on the links and connections within and between them, as well as between them and real situations and other learning areas. There is a need for such connections to be made explicit for children and therefore it is necessary for teachers to hold their mathematical knowledge in different ways.



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S PAPER

### **2.7.2 HELPING PRESERVICE TEACHERS TO DEVELOP AN UNDERSTANDING OF INQUIRY-BASED SCIENCE INSTRUCTION: LINKING THEORY AND PRACTICE THROUGH AN AUTHENTIC EXPERIENCE**

LOUISE SUTHERLAND  
University of Sydney

The majority of prospective teachers begin their preservice teacher education with limited experience undertaking science research and have naïve beliefs about the nature and practice of science (Luft, 2001). As, teachers' understanding about the nature and practice of science is critical to their approach to teaching (Crawford, 2000), supporting

preservice teachers to refine their understanding of the nature and practice of science needs to be incorporated into preservice science teachers' education. This paper examines how a blended mode of instruction was developed and implemented in a preservice science teacher education program. Using an action research framework the refinement of

two key areas of the model, (i) supporting the development of preservice teachers abilities to conceptualise a research project and (ii) supporting preservice teachers ability to scaffold students research are discussed. The challenges and solutions of a blended mode of instruction in preservice science teacher education is considered.

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S PAPER

### **2.7.3 SCIENCE SEEN THROUGH A CAMERA LENS: A CASE OF STEAM PROGRAM OF UNIVERSITY-COMMUNITY COLLABORATION, CALLED 'SCIENCE PHOTO ACADEMY'**

JIYEON NA  
Seoul National University

JINWOONG SONG

JOON-YOUNG CHOI

As STEM was being received an increasing worldwide attention, in Korea STEAM was proposed as a grand slogan for integrated education by the government in 2011 with an intention of promoting students' curiosity and creativity. Although many researches and developments on STEAM (or STEM) have been made in Korea, many of those efforts still have focused on the relationship between S (i.e. science) and TEM

(i.e. technology, engineering and mathematics) rather than between S and A (i.e. arts). Science Photo Academy (SPA) is a community-based weekend science program for local middle school students from low-income families run by an affiliated institution of a local university. With an intention of combining scientific inquiry activities with artistic experience (photography), throughout its first two years, SPA has been initiated

and evolved in relationship with surrounding environments. This study reports tentative results of a case study on SPA mainly based on classroom observations and semi-structured interviews with participating students, teachers and its coordinators. It is hoped that this study could provide a better understanding of practical aspect of informal science education and meaningful implications for STEAM education in Korea.



## WORKSHOP

**2.8.1 A STEM IN THE STREAM: COMMUNITIES AND URBAN RIVER RECOVERY IN THE 21ST CENTURY**

JOHN AMES  
University of British Columbia

ELEANOR HENDRIKS  
LAURA SUPER  
SUSAN CHUNG

STANLEY KING  
VANESSA LEE  
ANDREW RISEMAN

Restoring heavily polluted rivers is of ecological, social, and scientific concern. This workshop uses the arts to educate about the interplay of ecological, social, and scientific players involved in urban stream stewardship, with a special case study of day-lighting of Still Creek. For this interactive workshop, participants will form two main groups: (i) the urban environment with two subgroups: a) the salmon, and b) the river eco-system supporting the salmon; (ii) the human community with three

subgroups: c) conservationists who study rivers, d) industrialists, and e) citizens (general public). In these groups, participants will demonstrate, through problem-based learning, how the general public (teachers, school children, etc.) and scientists can collaboratively better understand their ecological roles in impacting rivers, and riparian organisms, and as stewards protect these fragile ecosystems. The target audience are elementary school educators. The workshop will take place at

the University of British Columbia's Beaty Biodiversity Museum public courtyard. At the Beaty Biodiversity Museum participants will work using several art forms to embed science learning: performing arts (gesture-movement and choreography) and visual art (story-board sequencing and community draw). The objective of this workshop is to impart elements of form through the arts to convey meaningful content in science.

## POSTER

**3.0.1 AN ANALYSIS OF STEAM'S EFFECT ON MATHEMATICS AND SCIENCE GIFTED STUDENTS**

EUN KI BAN  
Gyeonggi Science High School for Gifted

STEAM education is highly encouraged in Korea to prepare for the future society which requires creative and integrated thinking. Gyeonggi Science High School for the Gifted has been designated as a STEAM research school and carries out various STEAM programs within the school curriculum. This study analyzes the effect of the STEAM program and

suggests a suitable STEAM lesson for gifted students. As a result of this study, C19 'integrated classes with various subjects', 'presenting a situation which covers the content of a whole program', 'utilizing diverse tools', and 'various learning outcomes' were highlighted fields in STEAM education and gained the highest scores. However, the current STEAM program was not

effective enough to gain high scores in student 'absorption', 'challenge' and 'passion'. Average students tend to stay interested in content that is familiar to them and enjoy learning related to their experiences, but gifted students seem to be less interested in those factors. Therefore, a special study on STEAM education for the gifted is highly required.



## POSTER

**3.0.2 "ARE THERE ANY WINNERS IN HIGH STAKES TESTING IN MATHEMATICS?" - AN INVESTIGATION INTO THE IMPACT OF HIGH STAKES TESTING ON THE TEACHING AND LEARNING OF MATHEMATICS IN AUSTRALIAN PRIMARY SCHOOLS.**

LINDA CRANLEY  
University of Notre Dame

In 2008, the National Assessment Program - Literacy and Numeracy (NAPLAN) commenced in Australian schools. Every year, all students in years 3, 5, 7 and 9 are assessed on the same days using national tests in numeracy. The results are reported nationally through summary and national reports. An individual report is provided to parents and caregivers for each student. The results show student's achievements against a national average and school scores are posted on My School

Website. The aim of the testing is to compare results of each cohort, over a two year period. The testing of mathematical standards across the nation, through the annual implementation of NAPLAN, invokes many questions about the potential that high stakes testing has for academic reform. The role of the teacher is instrumental in the results children achieve through high-stake testing. This presentation will report on whether instructional pedagogy has been affected by the implementation

of high stakes testing and the publication of results. The purpose of the investigation is to seek perspectives of NAPLAN on key stakeholders. These stakeholders have been identified as parents, teachers and children. This investigation will summarise the impact that this mandatory implementation of national testing in all Australian primary schools has had on the attitudes and pedagogies of the teaching and learning of mathematics.

## POSTER

**3.0.3 USING AVIATION AS A THEME TO INCREASE STUDENTS' INTEREST IN STEM EDUCATION**

RACHEL GRAF  
University of British Columbia

This case study investigates the use of aviation as a theme to promote the learning of science, technology, engineering and mathematics (STEM) subjects in the middle school grades. Two male homeschooled students studied aviation over the course of two years of school. For the second year, an integrated unit was designed with an emphasis on the completion of summative projects related to aviation. The unit also emphasized the use of the scientific method. Components of the unit included building an aviation history timeline, drawing

and designing parts for aircrafts, reading a pilot's manual and studying math concepts framed around aviation concepts such as force, speed and distance. The students began studying aviation in grades four and six, and ended the integrated curriculum unit when they finished grades five and seven. In this classroom microcosm it was possible to break down the components of learning to cater to the students' interests in aviation. To measure the students' interest in the lessons, a class interest rating system was used on a daily

basis. Both the students and the instructor engaged in journaling throughout the integrated unit. The instructor used anecdotal notes to assess student learning, as well as leveled grades and percentages. Overall, the greatest impact that the aviation unit had was on students' goals for completing further studies in STEM subjects as well as on their reading levels, which increased because they were reading high interest, low vocabulary texts which enhanced their reading skills.



## POSTER

**3.0.4 A STUDY ON THE PERCEPTION OF THE CLASSROOM RESPONSE SYSTEM (CRS) AND ITS EFFECT ON ACADEMIC ACHIEVEMENT**

JUNGSOOK OH  
Daegu University

This study examined the college students' perceptions of Classroom Response System(CRS) and its effects on their academic achievement. Participants were divided into an experimental group and a control group. Participants were given a review quiz with five to seven questions at the end of each class for one semester. Participants in the experimental group were asked to answer the

questions using CRS while their counterparts in the control group were to answer by raising their hands. The results of the study indicated that participants in the experimental group rated their level of satisfaction and participation higher than the participants in the control group did. There was statistically significant difference in their academic achievement between the two groups when their

final exam scores were compared. Particularly a percentage of correct answers for some review questions presented during the classes were significantly higher in the experimental group. This study empirically proved the effect of CRS use in academic achievement. Based on the findings, directions for future research are suggested.

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## POSTER

**3.0.5 PRIMARY PRESERVICE TEACHERS' CONCEPTUAL KNOWLEDGE OF THE MULTIPLICATION OF FRACTIONS USING AREA MODELS**

ELISE THURTELL  
University of Wollongong

Teacher knowledge is an essential component of quality teaching (AAMT, 2006; National Council of Teachers of Mathematics, 2000) and must be deep and connected to support effective teaching (NSW Department of Education and Training, 2003). Preservice teachers have been identified as a group who lack sufficient knowledge for the teaching of mathematics and, more specifically, for the topic of fractions (Ma, 1999; Newton, 2008; Ryan & McCrae, 2006). There

are several key understandings necessary for the effective teaching of fraction operations. Within the current study, the focus was on assessing preservice teachers' understandings of the effect of multiplying fractions, that is, finding a part of a part of a whole, and how they represent this. Exam responses were collected including algorithms, area models and written explanations, from four preservice teachers in their first year. Isometric questions were again collected in

their third year. These teachers were then interviewed about their responses, adding to the analysis of the conceptual knowledge they had of multiplying fractions. The third year responses indicated a deeper conceptual knowledge of the effect of multiplying fractions when compared with their first year responses. However, interview data highlighted areas of the preservice teachers' knowledge which were not necessarily as deep as their area models may have suggested.

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SYMPOSIUM

**3.1.1 INTEGRATIVE STEM AND THE EDUCATION PIPELINE**

STEPHEN PETRINA  
University of British Columbia

MARK SANDERS

KEN VOLK

This symposium aims to generate discussion and understanding of STEM in context of its educational “pipeline, pre-K” post-Doctoral. The focus is on interrelationships among the disciplinary pipes of science, technology, engineering and mathematics, and integrative STEM, or the integration and mixing of these disciplines in substantive ways at optimal siphons and turns throughout the pipeline. Persistence and retention in STEM is dependent on not only the quantity of courses but also the quality of experiences for students

throughout education. One of the arguments in this symposium is that integrative STEM affects the quality of experiences in ways that individual pipes cannot. Consistent findings indicate a crisis in the STEM pipeline wherein a vast demographic enters but only the drip of a few are retained or survive at the end, despite vast resources throughout. On the other hand, it is conceded that the individual STEM pipes are indispensable to education, economics, and the environment. One question is how to improve the quality of STEM

experiences for students while minding the quantity? Another question is to what degree do the arts and humanities configure into challenges of quality? The symposium profiles a culmination of research into integrative STEM education and follows with two relatively brief responses to the key report. In addition to responses to the key report, audience participation will be generated through a series of questions concerning integrative STEM and the pipeline.

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S PAPER

**3.2.1 VARIOUS WAYS OF USING AUGMENTED REALITY TECHNOLOGIES TO CHANGE THE WAY STUDENTS SEE THE WORLD**

MING-CHAO LIN  
National Taiwan Normal University

AR is used in mobile devices, has opened new doors in information achievement, learning and teaching. We try to let “Learning process itself take place on students by using AR technology. Before we change the way of students’ learning, we change the way of teachers’ (in the

future) teaching (Lin et al. 2012). Pre-service teachers were been asked to develop units with AR software, Aurasma, on “Integrating Information Technology into Teaching\_ course. We gather all pre-service teachers’ AR teaching units to classify according the way

they using AR technology and draw a conclusion to collect several types as sample for coming AR teaching setting as below: Related content \_illustration and Further information. The results are yet to come; we’ll finish the pilot study at April, 2014.



**S PAPER****3.2.2 WHAT GOES AROUND, COMES AROUND: HOOPING TECHNOLOGY FOR LEARNER ENGAGEMENT, MOTIVATION, PHYSICAL HEALTH, AND STEM LEARNING**

STEPHEN GAREAU  
Buffalo State, State University of  
New York

RUTH GUO

A hoop is a large, thin, circular often plastic ring that is twirled around the waist, limbs, or neck, for the purpose of fun, entertainment, exercise, and/or learning. Hooping has been a type of play and exercise from 500 BCE, up until the present day. In 1957, Australian bamboo 'exercise hoops' were adapted in the design and manufacture of 42-inch 'hula hoops' made of Marlex plastic. They became an instant fad across North America. Nowadays,

the activity is called 'hooping' (or 'hoopdance'"and not 'hula hooping'. During the past few years, the activity of hooping has seen a re-emergence in many regions of the world, particularly among young people. Also, with the advent of cloud computing and a plethora of mobile learning technologies, mobile learning "as a legitimate learning preference" is gaining prominence. The study described here was a pilot study. The purpose

of the study was to examine the mobile activity of hooping, particularly how it relates to K-12 student health, and well-being, and learning. The paper describes some of the benefits of hooping for (a) student engagement, motivation, and enjoyment, (b) student physical health and well-being, and (c) learning, particularly the learning of certain K-12, STEM-related principles of physics.

**T PAPER****3.2.3 CAMPUS SERVICE APPLICATION BASED ON AUGMENTED REALITY AND LOCATION AWARENESS**

PENGFEI SHI  
Beijing Normal University

SU CAI  
QIANQIAN YUAN

PEIWEN WANG

The campus service application is a tool which provides campus information for students, including offline and online mode. The former includes distribution of leaflets or posters, which has bad publicity since it is neither economical nor environmental, and unimpressive for students as well. The latter mainly includes campus online platform which contains large amount of information so that students cannot find information easily, in addition, students cannot

remember information with merely virtual presentation. Augmented reality could provide students a combination of virtual and real world, which gives students a sense of immersion, on the other hand, location awareness could provide campus information based on location information, which is convenient for students to search for information. This paper develops a campus service application based on augmented reality and location awareness to

make up for the defects of present campus service application. GPS, camera, WIFI, digital compass and gravity sensor are used as basic hardware for application, and software architecture is built on Android platform and Wikitude SDK. 40 Students have been selected for system testing and the experimental results show that the application could provide efficient information inquiry and better user experience.



## WORKSHOP

**3.3.1 DEVELOPING A MAKER CULTURE TO ENCOURAGE LEARNERS AS RESEARCHERS - A TOUR OF FIVE DIFFERENT MICROCONTROLLERS FOR STEAM EDUCATION.**

COLIN CHAPMAN

Caroline Chisholm Catholic College

It is intended that the participants will develop a platform and coding language agnostic approach to incorporating microcontrollers into authentic research opportunities in their teaching and learning life. The workshop will explore up to five different microcontrollers - Parallax Basic Stamp, Parallax Propeller, mbed, PICaxe and the Arduino. The microcontrollers are used to solve similar challenges simultaneously in order to invite assessment and critique of the pros and cons of

each platform and/or language, and the teaching opportunities that they may support. Authentic learner research opportunities present rich opportunities for Science, Technology, Art, Engineering and Mathematics Education. The workshop will unpack some recent learner produced technology projects for discussion. The approach used during the workshop will be a fragmentary model of teaching and learning that promotes participant

exploration of computer science, science, mathematics, art, engineering and technology habits, conventions, connections and design cycles with minimal direct teaching. We will explore the use of a range of cloud based tools that allow data processing, data sharing, data visualization, version control and collaboration. These tools will include Google products, Microsoft products, SketchUp, Xively, mbed, GitHub and social media.

## G PAPER

**3.4.1 THE EXTENT OF AWARENESS OF RESEARCH-BASED STEM LITERACY PROGRAMME AMONG NIGERIAN TEACHERS**

REBECCA ETIUBON

University of Uyo

STEM literacy programme is a plan of action for achieving a set of activities with specific goals for sustainability. A relevant and functional STEM literacy curriculum will help teachers gain mastery of subject concepts and acquire skills to enable them teach well and reduce the rate of under-achievement among students in STEM subjects. This paper, therefore, tried to determine the extent of awareness of research-based STEM literacy programme among Nigerian teachers. A survey research design was used. Three hypotheses guided the study. The population consisted of 420

STEM teachers drawn from 13 public secondary schools in Uruan Local Education Authority Zone of Akwa Ibom State. Simple random sampling technique was used to draw 120 (60 pre-service and 60 in-service) STEM teachers who formed the sample for the study. Instrument for data collection was a 20-item structured Questionnaire. The instrument was validated by two lecturers in Science Education Department of the University of Uyo. Instrument reliability was established using Cronbach Alpha reliability coefficient which yielded .80. The hypotheses were tested at .05 level of significance. Study

findings revealed that awareness of research-based STEM literacy programme is low and research-based STEM literacy programme is rarely utilized by pre-service and in-service STEM teachers. Scientific and entrepreneurial skills needed for teacher education are absent and rarely used in STEM literacy acquisition. Based on these findings recommendation amongst others was that curriculum designers should collaborate with STEM teachers to select contents, strategies, specific learning objectives to sustain qualitative and functional STEM education.



M PAPER

**3.4.2 LANGUAGE AND LITERACY IN MATHEMATICS: STEPPING STONES OR STUMBLING BLOCKS IN ACCELERATING JUNIOR-SECONDARY STUDENTS**EDLYN GRANT  
Queensland University of  
Technology

The authors have collaborated in the development and initial evaluation of a curriculum for mathematics acceleration. This paper reports upon the difficulties encountered with documenting student understanding using pen-

and-paper assessment tasks. This leads to a discussion of the impact of students' language and literacy on mathematical performance and the consequences for motivation and engagement as a result of simplifying the language in the

tests, and extending student work to algebraic representations. In turn, implications are drawn for revisions to assessment used within the project and the language and literacy focus included within student learning experiences.

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M PAPER

**3.4.3 BABY STEPS TOWARDS STEM INTEGRATION: POSSIBILITIES IN AUSTRALIAN HIGH SCHOOLS**VINESH CHANDRA  
Queensland University of  
Technology

STEVE LANG

Historically, synergy between academic disciplines has enabled mankind to solve and overcome significant problems and challenges over thousands of years. However, schools deal with the knowledge and skills that are embodied in these disciplines in clearly defined silos. This is more so in high schools than in primary schools because of the way they are structured and staffed. Science, Technology, Engineering and Mathematics (STEM) Education conveys different meanings to different people and in many instances little progress has been made past the acronym

stage. There is much to be gained by designing learning activities that harness the connections between these disciplines. Therefore, a real change is needed in schools. The primary analytical objective of this paper was to look for commonality and overlap between the content descriptions in mathematics and science syllabus documents of the Australian Curriculum. We focus specifically on the curriculum for students in Year 10 (15 year olds). While the documents are prescriptive in terms of the content, how the content is sequenced is left to the schools and

teachers. Through such analysis conversations can start between subject specialists in schools. Through these discussions, teaching units and timetables can be proposed, maintaining the status quo of the disciplines but harnessing the connections between them to facilitate student learning. This sets into motion the first baby steps towards STEM education - it is past the acronym stage and has the potential allow for integration with minimum disruption to school routines and resources.

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T PAPER

### 3.5.1 COLOR-BALL: A GESTURE-BASED VOCABULARY GAME TO PROMOTE CHILDREN'S STUDY

GAOXIA ZHU  
Beijing Normal University

SU CAI

YING KAN

Early childhood is a critical period for language learning, so it is for English. The difference of language features and lacking of language environment are both obstacles when Chinese children learn English. Vocabulary, as the basic element of sentence, is what children should first master. Many studies have shown that games

have positive effect on children's study. In this paper, we designed and developed a vocabulary game based on gestures in which children can operate the words by natural interaction. The game combines sounds, animations and gestures together which will fully mobilize the enthusiasm of young children to learn words. Comparing

the effect of Color-Ball game with traditional cards instruction, experiment result shows that there is marginally significant difference between the two forms; Children have positive attitudes towards this game and experience in the game plays a significant role.

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G PAPER

### 3.5.2 WHAT DOES A STEM CURRICULUM LOOK LIKE AT THE PRE-K LEVEL?

TODD MILFORD  
University of Victoria, Griffith  
University

The belief that Science Technology Engineering and Mathematics (STEM) literacy is an important skill for nations to promote and develop within their populations is common in educational policy documents (Amgen, 2012; Gonzalez & Kuenzi, 2012; National Research Council, 2011a). STEM education is an interdisciplinary approach to learning where content is coupled with real world lessons as students apply science, technology, engineering and mathematics in a context that makes connections between various aspects of their

lives (Lantz, 2009). The National Research Council (NRC) (2011a) has identified three broad goals for STEM (i.e., an increase in advanced training and careers in STEM fields, an expansion of the STEM-capable workforce and an increase in scientific literacy among the general public). Although systematic empirical research on how to achieve these broad goals is lacking, one possible path is through the use of effective educational practices applied to STEM. This paper proposal details the actions of a group of Early Childhood

Educators (ECE's) to design and provide a STEM curriculum with a group of 18 four and five-year-old girls over the course of a full school year. Through an action research paradigm, the procedures that the ECE's employed in designing, implementing and refining their STEM curriculum are documented and analyzed. It is anticipated that the results of this study can be used by other schools interested in implementing such a program as well as for the ECE's themselves to reflect on and better deliver their program in future iterations.



T PAPER

### **3.5.3 STEM EDUCATION FOR SUSTAINABLE DEVELOPMENT: A SOCIOTECHNICAL ANALYSIS**

TONY SAHAMA  
Queensland University of  
Technology

DEEPTHI BANDARA

It is debated that for sustainable STEM education and knowledge investment, human centered learning design approach is critical and important. Sustainability in this context is enduring maintenance of technological trajectories for productive economical and social interactions by demonstrating life critical scenarios through life critical system development and life experiences. Technology influences way of life and the learning and teaching process. Social software application development is more than learning of how to program a software application and extracting

information from the Internet. Hence, our research challenge is, how do we attract learners to STEM social software application development? Our realisation processes begin with comparing Science and Technology education in developed (e.g., Australia) and developing (e.g., Sri Lanka) countries with distinction on final year undergraduates' industry ready training programmes. Principal components analysis was performed to separate patterns of important factors. To measure behavioural intention of perceived usefulness and attitudes of the

training, the measurement model was analysed to test its validity and reliability using partial least square (PLS) analysis of structural equation modelling (SEM). Our observation is that the relationship is more complex than we argue for. Our initial conclusions were that life critical system development and life experience trajectories as determinant factors while technological influences were unavoidable. A further investigation should involve correlations between human centered learning design approach and economical development in the long run.

E PAPER

### **3.6.1 TEACHING AND LEARNING DIGITAL CONTROL THROUGH REAL-TIME IMPLEMENTATION**

YANG CAO  
University of British Columbia,  
Okanagan

Teaching digital control course, it is found that students are often struggling with understanding the connection between the underlying mathematics for various control algorithms and their implementation. In particular, the effect of the control algorithm on system seems to be a mystery. Matlab simulation is able to help students better understanding the

control system and building up confidence in the effectiveness of the controller. However, simulation alone is not able to get rid of questions such as "is it really going to work on real system?" or "how is it going to work in real-life?". Quanser Rotary experiment set-up is an ideal platform to examine the difference between simulation and experiment. This paper describes

the integration of Quanser solution into the digital control course offered in the School of Engineering at University of British Columbia Okanagan and gives examples on real-time implementation of digital control algorithms. In particular, implementation of LQG will be demonstrated. The impact on teaching and learning will also be discussed.



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T PAPER

### 3.6.2 STUDENTS' ATTITUDES TOWARDS USING OF E-SCHOOLBAG FOR LEARNING IN CHINA

YI SHANSHAN  
Beijing Normal University

FENG-KUANG CHIANG

With the advancement of education informatization process, experimental schools are becoming more and more in which E-schoolbags are invited into classrooms. As the direct users, students' attitudes towards E-schoolbag are important. This study focuses on students' attitudes towards E-schoolbag

and the influencing factors using quantitative research method. 86 students participate in this study. Each of these students uses one Tablet PC in class. The result of this study shows that most students are active in using Tablet PC in daily class instruction. E-schoolbag won't increase students' learning stress. And sex is not the main factor

that influences students' attitudes towards E-schoolbag significantly. Through this study, we hope to provide a reference to the design and development of E-schoolbag in the future. What's more, we hope to inspire the use of E-schoolbag in classroom more efficient and more effective.

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T PAPER

### 3.6.3 DESIGN AND DEVELOPMENT OF THE E-SCHOOLBAG PERCEPTIONS SCALE (EPS) FOR K1-12 STUDENTS

JUAN ZHENG  
Beijing Normal University

FENGKUANG CHIANG

In association with the application of E-schoolbag, it is significant to trace the K1-12 students' E-schoolbag perception for instruction towards E-schoolbag project. However, the research for the moment is concentrated on the tools of E-schoolbag. The perceptions of the students had been paid little attention. Therefore, the aim of this study is to develop and validate E-schoolbag

perceptions scale (EPS) for K1-12 students. Both qualitative and quantitative methods are used in this research. After the first round revise by primary teachers and experts, a proposed 30 item (6 factor) was piloted with 86 student. Subsequently, quantitative analysis was used to established the validity and reliability of the scale using the 86 sample. Applying the exploratory factor analysis as the

second round revise, the results of the study supported a 26 -item (5-factor) EPS in Likert format. And the Cronbach's coefficient of the five new factors were 0.97, 0 .95, 0.92, 0.94 and 0 .92, respectively.





G PAPER

**3.7.1 AN EXPLORATORY STUDY ON THE IMPACT OF WOODFUEL USE AND PLANNING STRATEGIES FOR ITS SUSTAINABILITY IN WESTERN KENYA**FESTUS BERU  
University of EldoretP OPATA  
G SIMIYU  
SELLINE OOKOPETER OKEMWA  
S WAFULA  
SAMSON NASHON

This paper reports on an exploratory study that investigated and proposed strategies sustaining woodfuel supply in a high woodfuel dependent Sabatia District in Western Kenya. The study was inspired by a concern for the potential social and ecological impacts such as forest degradation, loss of biodiversity as well as health issues resulting from the overdependence on woodfuel. Using a cross sectional study design and employing a questionnaire complemented by interviews and focus group discussions the impact of woodfuel use on environment and development of planning strategies for sustainable Woodfuel use in the district were

investigated. The questionnaire was administered to 240 randomly selected participants. Selected representatives participated in a follow up focus group discussion. In addition efforts by the local jua Kali to alleviate the impact by developing more efficient charcoal stoves were examined to enrich the data corpus. Analysis of the resulting data indicated that woodfuel use is closely linked to the rampant soil erosion in the area due to the use of the three-stone-hearth facility, and creation of treeless landscape, loss of biodiversity and, increased health issues. Emergent from the interview and focus group discussions was the need to involve local populations

especially the local jua kali artisans in designing the planning strategies for sustainable woodfuel use, demonstration of efficiency and availability and affordability of alternative domestic energy sources coupled with vigorously mounted awareness campaigns and the serious impacts of the continued high rate of woodfuel use on the environment and future generations. The study educates both for the public and institutional settings, given the increased concern for global warming phenomena worldwide as well as contribution to awareness of the positive impacts resulting from reduced carbon print.





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S PAPER

### **3.7.2 THE DEVELOPED INQUIRY-BASED SPIRAL CURRICULUM TO PROMOTE THE RADIATION LITERACY AS STS AND SUSTAINABILITY EDUCATION**

HISASHI OTSUJI  
Ibaraki University

Recent tragic natural disasters such as the Indian Ocean earthquake (Dec. 26th, 2004) or the Great East Japan Earthquake (Mar. 11th, 2011) made us recognize that all human beings are allowed to live on the earth under the unattainable power of the nature. Especially in terms of the education for the sustainability, the nuclear power plant accident at Fukushima threatened our sustainability of current life style. Not much focus on the education of the radiation literacy and energy resource had been paid before the accident, and existing

programs were mainly provided to enhance the understanding of scientific concepts, without paying much attention to the literacy and decision-making ability. In the effort of overcoming the tragedy, new orientation of such curriculum is expected to be developed. This study (1) proposes a spiral curriculum, related to radiation literacy, through which learner can get enough basis of understanding and can sharpen their inquiry ability, which leads to decision making as citizen in democratic society, and (2) reports the effect of the

curriculum, after conducting a few lessons situated in the curriculum. For elementary level, we proposed inquiry activities of spectrum of sun light using prism and of invisible light (Ultraviolet) using black light and UV beads in grade 3. For junior secondary level, we conducted the self-measurement of "invisible environment such as carbon dioxide and radiation dose. Students recognized by themselves that their school is safe, and complained that they have been left behind without giving proper teaching after the tragedy.



## G PAPER

**3.7.3 ZERO WASTE EFFORTS AT THE UNIVERSITY OF BRITISH COLUMBIA: EXAMINING WASTE GOALS, PROCESSES AND OPPORTUNITIES TO EDUCATE CAMPUS COMMUNITY**

LATIKA RAISINGHANI  
University of British Columbia

IVANA ZELENKA

KWESI YARO

This study employed auto-ethnographic and phenomenological frameworks to describe the experiences of UBC graduate students, volunteering to promote Sort it Out initiative of UBC's Zero Waste Sustainability Action Plan that aims to achieve waste reduction on campus. The efforts include promoting appropriate sorting of the waste by improving recycling and composting efforts by informing and educating campus community and providing better bins with clear and effective signage. The investigation included observing, guiding and educating people through informal brief

interactions about disposal of waste in appropriate bins through Sort it Out and Info Booth in busy campus locations and residences. Collected data were analyzed using interpretive frameworks of behavior change theory namely Social Practice and Community Based Social Marketing. The early analysis reveals: widespread ignorant waste disposal behaviors at the individual and collective level; the need for establishing and promoting behavior change strategies that might constantly inform and guide campus community in appropriate waste disposal; creating awareness at the

individual as well as on a community scale is critical given the high levels of contamination, or mis-sorting of the waste items; and information and education have a strong role to play in changing mind-sets and behaviors. This research attempts to promote awareness and encourage best waste disposal practices to ensure zero waste at UBC. It has laid a foundation for similar studies to examine issues that might affect the introduction of a behavior change strategy and improve waste management in other contexts in Canada and elsewhere.

## SHOWCASE

**3.8.1 FOCUSING ON STEM PERSPECTIVES IN TEACHER EDUCATION**

ISHA DECOITO  
York University

SABRINA LORENZ  
HYE KYONG SON

ROBERT JORDAN

A major goal of the STEM agenda is to improve the proficiency of all students in STEM, regardless of whether or not they choose to pursue STEM careers or postsecondary studies. The ability to understand and use STEM facts, principles, and techniques are highly transferable skills that enhance an individual's ability to succeed in school and beyond, across a wide array of disciplines. Teaching in ways that inspire all students and deepen their

understanding of STEM content and practices is a demanding enterprise. To be effective, teachers need content knowledge and expertise in teaching that content, but the research suggests that science and mathematics teachers are particularly underprepared for these demands. The lack of preparation is reflected in a lack of comfort by teachers in teaching the required content, specifically weak initial teacher preparation. This mixed-methods study focuses

on science teacher education, and through the development of STEM projects, findings reveal that teacher candidate's interest and engagement in STEM increased, and their understanding of STEM education and learning of STEM concepts were positively impacted as they designed curricula addressing STEM education. This presentation showcases three of the STEM projects developed by teacher candidates in science education.



## SHOWCASE

**3.8.2 ADDRESSING THE CHALLENGES TO STEM EDUCATION IN RURAL IDAHO**

MELINDA HAMILTON  
University of Idaho

Idaho faces unique challenges addressing STEM skills gaps with a relatively small population spread across a large geographical region. Much of the population is located in isolated rural communities and a large percentage of the student population is comprised of low income, first generation college goers, or underrepresented minorities. With support from the Micron Foundation, The University of Idaho (UI) is conducting research that seeks to explore STEM

attitudes, scientific literacy, and educational outcomes in Idaho. As part of a five-year, longitudinal study we are collecting and analyzing data from parents, students, teachers, and community members across the state. Findings from this research were used to develop and implement three pilot innovations to address specific challenges. The goal of this showcase is to highlight results and discuss interventions that address the complex factors that shape interest in STEM at the

community level, and STEM learning and academic performance at the K-12 level. During this 90-minute Innovation Showcase we will discuss the relevant findings from the research, demonstrate the pilot innovations with suggestions for implementing similar approaches in classrooms and in other communities, and discuss the potential impacts of these innovations on STEM outcomes.

## WORKSHOP

**3.9 DEVELOPING 21ST-CENTURY MINDS WITH VERNIER PROBEWARE**

VERNIER INTERNATIONAL INC

Developing 21st-Century Minds with Vernier Probeware: Are you preparing future science teachers for the expectations of the 21st-Century science classroom? Explore state-of-the-art probeware solutions that help teach core science topics in physics, chemistry, biology, Earth science and environmental science. Educators receive hands-on training with Vernier's new LabQuest2, LoggerPro software

and the Connected Science System, and a suite of commonly used probes and sensors.

Pre-registration is required to attend this workshop, limited to 32 participants per workshop.

The registration sheet is at the registration/information desk in ESB Lobby.



## G PAPER

**4.1.1 GOING THE DISTANCE: DESIGNING A PROSPECTIVE LONGITUDINAL EVALUATION FOR THE WOMEN IN SCIENCE AND ENGINEERING MENTORING PROGRAM AT UBC'S OKANAGAN CAMPUS**

STEPHANIE MCKEOWN

University of British Columbia,  
Okanagan

It is widely accepted that women are underrepresented in STEM careers and encounter systematic difficulties in career longevity and advancement in many industries in North America. Research suggests that quality mentoring is one of the most successful avenues by which to increase the number of women entering scientific careers after graduation. Within university settings, quality mentoring relationships provide opportunities for students to be supported in academic and social

settings, which benefit students by increasing their self-esteem and by providing them with a better understanding of the educational climate. In addition, mentors are role models for students and can aid students in understanding the expectations for professional performance. This study evaluates the effectiveness of a structured triad-mentoring program at UBC's Okanagan campus, using a prospective longitudinal design. This paper session will provide an overview of the design of the

prospective longitudinal study, a summary of the results to date that includes a discussion on the usefulness of rubrics for analyzing these data, and a discussion on the use of a modified focus group approach and its benefits for program review. This study contributes to the discourse on mentoring for STEM students and offers new insights on measuring the impact of a mentoring program on the experiential learning outcomes of students.

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## S PAPER

**4.1.2 THE TOWER BUILDERS: THE NEED TO PLACE ETHICAL CONSIDERATIONS AT THE FOREFRONT OF STEM AND STSE EDUCATION INITIATIVES**

ASTRID STEELE

Nipissing University

Taking as illustrative a science lesson in a pre-service teacher class, the authors consider the roles of the increasingly influential, heavily funded STEM (science, technology, engineering

and mathematics) and the STSE (science, technology, society and environment) education initiatives. The foci of both initiatives are discussed, as are their disparate ontological foundations. Habermas'

knowledge theories, in conjunction with several contrasting ethical perspectives, are posited as a way of considering STEM and STSE, with implications for strengthening science pedagogy.

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## S PAPER

### 4.1.3 GENDER AND SOCIO-ECONOMIC GAPS IN SECONDARY STUDENTS' INTEREST IN SCIENCE-RELATED TERTIARY EDUCATION: THE CASE OF ISRAEL

SVETLANA CHACHASHVILI-  
BOLOTIN  
Ruppin Academic Center

MARINA MILNER-BOLOTIN

The study aimed at investigating factors affecting Israeli secondary students' interest in pursuing science-related tertiary education (SRTE). Specifically, the study seeks to examine the effects of student academic performance in advanced secondary science courses (AdSecSC), their gender, and parental education level, on their decision to pursue SRTE. To do it, we administered a survey to 2458 secondary students from public schools (68% of grade 11-12 student population) in the fifth largest Israeli city. The results of the analysis indicate that (a)

enrollment in at least one AdSecSC significantly increased students' interest in pursuing SRTE; (b) there is a significant gap in the AdSecSC enrollment between the students whose parents hold or do not hold a post-secondary academic degree, but there is no significant difference in the enrollment of boys and girls in AdSecSC; (c) there are significant differences in students' interest in pursuing SRTE by gender and by parental education; (d) enrollment in at least one AdSecSC did not decrease the gender gap in pursuing SRTE, nevertheless it diminished the

impact of parental education on it. These results have noteworthy educational implications: if we want to attract more students from various family backgrounds to SRTE, it is crucial to engage them in advanced secondary science studies. However, in order to attract more girls into science, engaging them in secondary science-related studies is necessary, but insufficient: despite the academic success in secondary science, girls often opt not to pursue science-related degrees, which increases the gender gap in tertiary science-related studies.

## G PAPER

### 4.2.1 ANCIENT WISDOM FOR A SHARED PLANET: REGENERATING INDIGENOUS TRADITIONAL ECOLOGICAL KNOWLEDGES

PAT O'RILEY  
University of British Columbia

PETER COLE

Increasingly, schools educate students to fit into 'the global economy' while downplaying the ecological impacts of unregulated economic growth and the traditional ecological knowledges (TEK) of Indigenous Peoples. TEK have long been dismissed by the mainstream as being naive and primitive, but there is growing realization that ignoring these knowings in favour of rationalist-Enlightenment-scientific knowledges has been shortsighted. By devaluing and dismissing TEK, there is a double loss: a) of diversity of experiential and

embodied knowledges for dealing with challenges facing life on earth, and, b) loss of nonessentialized traditional Indigenous knowings and practices to maintain localized cultural sustainability.' Indigenous youth, seeing their cultural knowings devalued, diminished and dismissed in school, take on mainstream notions of what constitutes validity and excellence, abandoning their cultural teachings. An ecologically- and socially-just future requires a range of voices, knowledges and practices, including TEK, to negotiate the complexities of a

balanced relationship between humans and other-than-humans on a shared planet. Our research with the fishing/ hunting/ gathering-based St'at'imc of British Columbia and the agricultural-based Kichwa-Lamista of the High Amazon in Peru advances culture as a crucial constituent of cultural-ecological sustainability. Together, the two international field sites offer rich knowings, practices and ecotechnologies that can offer possibilities for more livable, sustainable futures for all.



G PAPER

**4.2.2 AFRICAN KNOWLEDGE ON ENDOD (PHYTOLACCA DODECANDRA) AND ITS POTENTIAL FOR MEDICINAL USES IN KENYA**SELLINE OOKO  
Masinde Muliro UniversityJ. OKEYO  
OSANO ODIPO  
F. OLALFESTUS BERU  
PETERSON OMBOGO  
PETER OKEMWA

Berries from *Phytolacca dodecandra* L'Herit (Endod in Amharic) are natural Saponin, and have been traditionally used as detergent and traditional medicine for centuries in Africa. Extracts from parts of endod plant have been found to have molluscicidal, larvicidal and antimicrobial activities. The plant is a readily available source of antiseptic agent to control waterborne microbial infections. A Knowledge, Attitude and Practices (KAP) survey conducted in Western Kenya provided information on African

knowledge, attitude (perception), community practices, distribution and the potential for increased production and use of endod for indirect control of faeco-oral infections. A specially developed structured questionnaire was administered to a purposive sample of participants who had some knowledge on endod and who at least knew one of its ethno medical uses. The study revealed that the local communities have some knowledge on endod. The plant is mainly used as herbal medicine for treating various ailments including

treatment of fungal skin diseases and deworming of domestic animals. In addition, it is used to clandestinely procure abortion. Most people have positive attitude towards its use mostly because it is efficacious as herbal medicine. It is argued that understanding medicinal value of plants such as endod, is one way of inspiring local research innovation in herbal medicine with a view to improving their safety or reducing the amount of toxicity before encouraging their use.



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S PAPER

### **4.2.3 EXPLORING TRADITIONAL TECHNOLOGIES TO CONTEXTUALIZE LEARNING: SCIENTIFIC AND MATHEMATICAL PHENOMENA EMBEDDED IN KOSRAEAN FOOD PREPARATION AND PRESERVATION**

LATIKA RAISINGHANI  
University of British Columbia

This paper reports on an exploratory study that utilized ethnographic and phenomenological frameworks to investigate scientific and mathematical aspects embedded in Kosraean food preparation and preservation. The investigation involved interacting with the pre-service and in-service elementary teachers, observing preparation of traditional food during college community events, visiting local peoples' homes and having hands-on cooking and food preservation experiences with them, and talking to community elders about the

traditional ways of food preparation and preservation. Collected data were analyzed using interpretive frameworks that employed ethno-science/mathematics perspectives complemented by contextual learning theory. The findings reveal: 1) the richness of Kosraean food preparation and preservation practices in scientific and mathematical concepts, ideas, and thinking 2) scientific and mathematical aspects embedded in traditional food technologies that could be utilized to proffer a model for culturally responsive contextualized science and

mathematics instruction in Kosrae schools 3) how exploration of scientific and mathematical aspects in traditional food practices opens up a contextualized, culturally responsive space for teachers and native learners to engage in teaching and learning of science and mathematics as subjects that relate to their everyday real-life experiences. This research stands as a founding exemplar to initiate and sustain similar pedagogical dialogues to create culturally responsive contextualized learning experiences in other disciplines, and contexts including Canada.



## SHOWCASE

**4.3.1 SISTERS OF THE ACADEMY: FOCUSING ON BLACK WOMEN IN STEM**

VIRGINIA TICKLES  
Sisters of Academy

Sisters of the Academy (SOTA) Institute is an organization of Black women whose mission is to facilitate the success of Black women in the Academy. SOTA's signature programs are the (1) Research BootCamp®, (2) Writing Retreat, (3) Intensive Grantsmanship and Mentoring Workshop, and most recently the (4) Science Technology Engineering and Mathematics (STEM) Initiative. SOTA has proven success through targeted programs reaching African American women in STEM in the academy. Our programming and initiatives represent our mission by

EZELLA MCPHERSON  
LAKERRI MACK

supporting women in matriculation of graduate studies, research publications, promotion and tenure process, and grant funding acquisitions through mentoring and professional support. Pairing novices with experts through our mentoring programs and initiatives truly expands the depth of the organization and members. Recently SOTA has collaborated with STEM focused scholars and programs at colleges and universities of our current partnerships but we are also seeking new partnerships to magnify our outreach in higher

DEVONA FOSTER PIERRE

education and our communities. The purpose of this workshop is expose the STEM community to SOTA's innovative ongoing and emerging STEM initiatives for mentoring and preparing African American women for STEM fields. This workshop is important in providing others with the knowledge and tools necessary to conceptualize similar programs in their spaces and to increase SOTA's network of opportunities and impact. Additionally, it is important to strengthen the leaky pipeline for black women STEM professionals.

## SYMPOSIUM

**4.4.1 USING COLLABORATION TO INCREASE STEM ENGAGEMENT FOR GIRLS**

KAREN PETERSON  
National Girls Collaborative Project

In this interactive, dynamic session, facilitators will lead activities and discussion to demonstrate the National Girls Collaborative Project (NGCP) model for sustainable collaboration among cross-sector stakeholders. Collaboration is a key strategy for leveraging resources and strengthening the capacity of professionals to provide high-quality activities to K-12 girls in science, technology, engineering, and mathematics (STEM). Collaboration is an interactive process intended to enable

BRENDA BRITSCH

professionals across projects and communities that share goals to generate and carry out creative solutions and strategies that maximize benefit beyond that which one project or community could accomplish. It is critical to leverage key resources, such as STEM expertise and experience working with girls, to provide these high-quality STEM opportunities and to avoid reinventing the wheel or expending unnecessary (and often unavailable) funds. Participants will learn about the

KAREN BOULDIN

proven model, tools and resources developed by the National Girls Collaborative Project to strengthen practitioner efforts to engage and support girls and women in STEM programs. Having reached more than 7.7 million girls across 40 states since 2002, NGCP best practices in collaboration, resources and opportunities for engagement will be shared and experienced via hands-on activities and networking opportunities.





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SYMPOSIUM

**4.5.1 BECOMING A TEACHER: EMBRACING STEM (K - 6) TEACHER EDUCATION**

MARY STORDY  
Memorial University of  
Newfoundland

SUSAN RYAN  
TODD WOODLAND

IAN CREWE

This symposium will describe a highly innovative STEM-focused post-degree Bachelor of Education program (K-6) currently under development at Memorial University of Newfoundland. The first of its kind in the country - perhaps globally- this initiative, located in Canada's most easterly province, is intended to help foster greater capacity in STEM Education for pre-service kindergarten to grade six generalist teachers. Discussion of STEM education and its relevance to schools indeed is not new; however most of the current focus in North America

centres on junior high or high school classrooms. The intent of the Becoming a Teacher: Embracing STEM (K-6) Program is to shift the focus to the elementary ages. While the intended learners for the program are pre-service teachers, upon completion of this highly integrated, inquiry based field oriented STEM -focused degree program, such new teachers will be the impetus to creating a new generation of STEM learners for the province and country. The focus of this symposium is to outline the various components of the program, to describe the learning

framework, and to discuss some initial possibilities and challenges in program development. In particular, an interdisciplinary approach will be highlighted to show the ways in which STEM can be used to enhance student engagement and knowledge in all subject areas for K-6 classrooms. The panel will discuss how the program is informed by pedagogical practices of inquiry, creativity, critical thinking, problem solving and collaboration as well as the importance of developing collaborative school-university partnerships.



M PAPER

**4.6.1 THE NATURE OF ABACUS IS ONE KIND OF WORKING MEMORY TRAINING: A FUNCTIONAL MRI AND BEHAVIOR STUDY.**

JOHN Y.S. CHENG

National Taiwan Normal University

CHUN-YEN CHANG

With aid of educational neuroscience, we can take a different perspective on the traditional Chinese tool for calculation. The aims of our unique longitudinal study are to evaluate the relatively short term effect of six-months abacus-based mental calculation (AMC) training on the functional connectivity network, and to investigate the possibility of AMC training effect transfer to the untrained working memory task. Abacus experts have demonstrated extraordinary

potential of mental calculation in the past cross-sectional studies. Non-experts show activity in the prefrontal and perisylvian areas, while experts, with long-term training of at least three to five years, show more activation over premotor and parietal regions. The trained children advanced 9.11 percentile on the WISC-IV exam's working memory subsection (from 81.19 to 90.30,  $p = 0.037 < 0.05$ ). Resting state MRI revealed increased connectivity between the left inferior frontal area and the left

inferior parietal lobe. The combined results suggested six months of AMC training can generalize to untrained working memory exams, and a midway paradigm shift can be expected along the fronto-parietal circuitry within the relatively long time required to become an expert. Compared to the common practice of task repetition, AMC is not only an arithmetic operation, but an appropriate and interesting tool to improve working memory capabilities by exercising visuo-motor and visuo-spatial skills.

M PAPER

**4.6.2 ENHANCING MATH AND PHYSICS EDUCATION FOR HIGH SCHOOL IN ISRAEL**

SARA HERSHKOVITZ

Center for Educational Technology  
- Tel Aviv

The first Virtual High School (VHS) in Israel was established in September 2012 in order to provide the opportunity for more students,

especially in outlying areas to learn advanced math and physics. The model of teaching and learning in the VHS, students' achievements,

and the perception of the school will be described.



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M PAPER

#### **4.6.3 PROFESSIONAL LEARNING COMMUNITY: A CASE STUDY - MATHEMATICS IN THE VIRTUAL HIGH SCHOOL**

YANIV BITON

Center for Educational Technology  
- Tel Aviv

In the last two decades, the model of professional learning communities has developed in education systems all over the world in different ways. This study characterizes a special learning community of teachers, tutors,

students, and developers who work in the Virtual High School in Israel. Examination of the communication methods chosen by the community to create a conversation: recording synchronized meetings, communal documents, social networks,

WhatsApp, email, etc., reveals different characteristics of the community. This paper focuses on two sub-communities: the teacher sub-community and the teacher-tutor sub-community, and presents examples.

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G PAPER

#### **4.7.1 LEAN STARTUP PRINCIPLES AND STE(A)M IMPLEMENTATIONS: A CASE STUDY APPROACH TO THE APPLICATION OF BUSINESS INNOVATION PRINCIPLES TO EDUCATIONAL INNOVATION**

CHRIS METCALFE  
Scots College

MICHELLE FERGUSON

This paper engages the problem of institutionalised obsolescence in school curricula through the application of business innovation models. Rapid change in STEM-related industries and knowledge communities and the lack of alignment between secondary, tertiary and industry-

based learning models produce disconnected secondary course approaches which do little to motivate and attract students, or address the needs of the end clients of the educational process. It is posited that schools can learn from post-Fordist approaches to business innovation, such as the

'Lean Startup' framework. This paper introduces the principles of lean startups, re-interprets them for secondary education, and provides a case study of the implementation of the principles in a private boys' grammar school in Sydney, Australia (The Scots College).



T PAPER

**4.7.3 A INTEGRATED CURRICULUM DESIGN STRATEGY TO SCAFFOLD ONLINE TRAINING FROM THE PERSPECTIVE OF KNOWLEDGE BUILDING**

JINJU DUAN

Beijing Normal University

In this article, we articulate five principles of design based on Biggs' 3P model and illustrate their application in an information technology course for online training. In this way, we provide a practical framework for others wishing to enhance their course design. To apply the five principles,

we created a learning environment consisting of a broad range of learning contents, resources and activities which were structured and sequenced with an integrated design strategy. By providing a framework of learning content, resources and activity about online training, we sought to progressively

enhance the sophistication of our learners' knowledge building and transfer, with the aim to find out the curriculum design embedded activity strategy accord to knowledge building in order to promote the knowledge transfer effectively.

T PAPER

**4.8.1 STEM NATURAL PARTNERS PROJECT - LEARNING FOR SUSTAINABILITY**

SUSAN MCLAREN

University of Edinburgh

In the context of the convergence of various Scottish Government policies, this paper discusses approaches taken by Moray House School of Education (MHSE), with a view to preparing student teachers appropriately with the content knowledge, the creativity and the confidence to embed Learning for Sustainability(LfS) and STEM into their planning, teaching and learning. Previous studies highlight the slow enactment of education policies pertaining to Learning for Sustainability in education practice generally. Design and Technology

curricula in Scotland have, specifically, required teaching and learning related to sustainability since 1993. Scoping surveys indicate common confidence and knowledge issues that seem to be hindering implementation of any change. Several models to address these issues have been explored; this paper illustrates only one, STEM Natural Partners Project - Learning for Sustainability. Although student teachers at MHSE from the STEM disciplines are represented as our natural partners, the case reported takes,

as its major focus for discussion, Design and Technology education students who will be working in secondary school sector, i.e. with young people aged between 11-18year olds, in their broad general education stage, and their specialist senior phase certificate classes. Evaluative responses from students and partners, are discussed. The impact and value of the venture for all partners involved are reviewed for a valid appraisal to be presented, and recommendations for future are considered.



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E PAPER

### **4.8.3 ENGINEERING EDUCATION AND SUSTAINABLE DEVELOPMENT: A MIXED METHODS APPROACH**

MATT WRIGHT  
University of British Columbia

SUSAN NESBIT

THOMAS FROESE

An industry survey was conducted in late 2013 to develop an understanding of sustainability practitioner expectations of new graduates. The survey tool was developed through an exploratory sequential mixed methods approach. The survey received numerous responses from Civil Engineering organizations across the province of British Columbia, Canada. Canadian Engineering programs have been integrating

sustainable development content into the curriculum for almost 10 years. In tandem, there have been considerable efforts taken to align engineering objectives set forth by the professional Engineering community. However, there has been an absence of collaboration with the engineering profession to inform curriculum development, especially in regards to sustainable development. Additionally, there is not a comprehensive

understanding of sustainable competencies for each engineering discipline. To address the gap in understanding of sustainable development between industry and academia, a common language must be developed. The use of a knowledge-skills-attitude (KSA) framework allows both industry and academia to engage in meaningful dialogue to inform curriculum and professional development.



## SHOWCASE

### **4.9.1 TEACHER INQUIRY IN K-6 STEM: THE IMPACT OF TEACHER-DRIVEN AND INQUIRY-BASED PROFESSIONAL DEVELOPMENT ON TEACHING AND LEARNING IN K-6 STEM**

KAREN GOODNOUGH  
Memorial University of  
Newfoundland

RENE WICKS  
TOM WALSH  
KEITH POWER

NANCY HEALEY  
STEPHANIE COLLINS  
JENNIFER KENDELL

Memorial University of Newfoundland's Faculty of Education has implemented Teachers in Action: Professional Development in STEM Education (K-6), focused on studying the impacts of teacher engagement in innovative and relevant professional learning. Through this initiative, the Faculty partners with the Education Ministry, school districts and schools, to create professional development opportunities for teachers in K-6 STEM education. Teacher collaborative teams design their

own professional development projects, which are teacher-driven and inquiry-based; meet the needs of teachers and their students; and are collaborative, ongoing, and embedded in classroom practice. The University provides support through the provision of resources and release time. The Teachers in Action team facilitates face-to-face sessions at key stages throughout the year, maintains ongoing communication, and works with teachers in their schools. In this show case session, teacher teams will share their experiences

about the processes of designing professional development that is embedded in the principles of teacher inquiry and collaborative action research. They will also share key findings based on the implementation of their projects. The Principal Investigator and her team from Memorial University of Newfoundland will share observations and key findings about the Teachers in Action initiative, with a particular focus on how it impacts teaching and learning in the STEM curriculum areas.

## POSTER

### **5.0.1 USING SCIENCE FICTION FILMS ON STIMULATING JUNIOR HIGH SCHOOL STUDENTS' CREATIVE PERFORMANCE IN CREATIVE MOTOR VEHICLE**

KUEN-YI LIN  
National Taiwan Normal University

This study examines how science fiction films (SFF) inspire the creative performances of junior school students in the creative motor vehicle learning activity. To achieve this, a quasi-experimental method comprising a non-equivalent pre and post-test was used to conduct

teaching experiments with 163 seventh grade students in seven classes. According to the results of the descriptive statistics and ANCOVA, the following conclusions were made: (1) SFF positively promote students' creative performances in the design

process; (2) SFF positively promote students' creative performances in making the product; (3) students with different cognitive styles have no different creative performance in creative motor vehicle.



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POSTER

### 5.0.2 AN ISOLATED MASS MODEL FOR INTUITIVE ELECTRO-MECHANICAL ANALOGIES

LEO STOCCO  
University of British Columbia

In the well-known electro-mechanical analogy used to transform between electrical and mechanical systems, mass is replaced by a grounded capacitor. This is sufficient for converting a mechanical system into its electrical

equivalent, but does not allow any electrical system to be modeled by a mechanical equivalent. A two-terminal isolated mass element, previously proposed by the author, simulates a capacitor in the general case and can be used to build a

topologically identical mechanical equivalent of any electric circuit. It is the missing link of perhaps the most powerful technique available for building student intuition on the analogous behaviour of electrical and mechanical systems.

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POSTER

### 5.0.3 THE DEVELOPMENT OF STEM PROJECT-BASED LEARNING IN INTELLIGENT CLASSROOM

CHIEN-YU LIN  
National Taiwan Normal University

HSIEN-SHENG HSIAO

The STEM Project-Based Learning focuses on student-centred learning by using the Intelligent Classroom environment. The Intelligent Classroom environment which integrates information technologies, network technologies, digital learning materials and instructional methodologies,

could raise the effect of STEM Project-based Learning and bring up students' high level abilities. Moreover, the teacher in this learning process plays as a learning facilitator who provides students with adaptive assistance because students would suffer the problem of using the individualized learning

technology during the different learning progressing. Therefore, this research proposed a model of implementing STEM Project-Based Learning in the intelligent classroom, which including hardware, software platform, and an example of instructional design.



## POSTER

**5.0.4 OPTIMIZATION OF COORDINATED TRAFFIC SIGNAL TIMING: A GENETIC ALGORITHM APPROACH**

FAREEZA KARIMUSHAN

Independent Learner

Improvement of traffic signal timing and coordination between traffic signals are regarded as important factors in increasing traffic flow efficiency by reducing traffic delay, queue and travel time. One area of studying the traffic network system is the simulation of different aspects of road traffic in an attempt to understand and reduce traffic congestion and emission. The present

research is divided into two part:(i) Development of a mathematical model to simulate the average delay of vehicles in coordinated signalized intersections on one-way West Cordova street in downtown Vancouver, British Columbia, Canada (ii) Optimization of coordinated signal time setting in the intersections of Cambie, Abbott, Carrall, and Columbia by applying genetic algorithm with the

aim of minimizing traffic delay in the intersections, in the context of the activation of pedestrian crossing signal. The study attempts to develop a system of simultaneous linear equations to represent traffic flow into each intersection and investigate the application of evolutionary algorithm in solving linear equations.

## POSTER

**5.0.5 METHODOLOGICAL IMPLICATIONS FOR MOLECULAR MAKING: APPLICATION OF LIQUID-PROCESS IN MATERIAL PREPARATION AND PRODUCTION**

BO HUANG

University of Illinois at Urbana-Champaign

A new model, based on statistical thermodynamics and kinetics theories, is introduced to simulate the physical properties of different metastable states in liquid. In a statistical thermodynamic view, a physical state is fixed in equilibrium as long as the macroscopic variables of the system are determined, such as temperature [T], pressure [P] and particle number [N]. However, according to the kinetic route of development, while this physical state illustrates the most probable and stable microstates distribution, there are many more metastable states that the system could fill

MING HUANG

in on the way of approaching its equilibrium. Since the state-of-the-art theory cannot fully explain or predict the final physical state, we thus introduce, in this work, a new "molecule cluster model to simulate the situation afore mentioned. A liquid system is composed of various clusters, in which a specific number of molecules are bounded by weak interactions within the clusters. In different physical states, however, the distribution of these molecule clusters varies in terms of the number, the type and the proportion of molecules. We point out that, to determine the physical

state of liquid in equilibrium, macroscopic physical properties, including volume, dielectric constant, refractive index and optical rotation, are required. In our experiments, different kinetic routes (e.g., temperature, mixing sequence, etc.) are designed for the same system under final specific conditions. We conclude that micro-kinetic modeling is the technological base for the industrial engineering of new material. This raises methodological implications for molecular research and production.





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M PAPER

### **5.1.1 NUMERACY . . . SCIENTIFICITY: IDENTIFYING, LINKING AND USING THE 'BIG IDEAS' OF MATHEMATICS AND SCIENCE FOR MORE EFFECTIVE TEACHING.**

CHRIS HURST

Curtin University of Technology

Recent curriculum documents such as the Common Core Standards for Mathematics and the Australian Curriculum: Mathematics continue the practice of presenting content in a linear and compartmentalized manner and appear not to accentuate the links and connections that are present in the 'big ideas' of mathematics. Both documents seem to pay lip service to the 'big process ideas' or proficiencies which should be the vehicles for

developing and making explicit links between and within the 'big content ideas'. To some extent, the same criticism could be levelled at the recently developed Australian Curriculum Science although that document at least embeds key process ideas as one of the three strands called Science Inquiry Skills. However, it is suggested here that it may be beneficial to re-think the nature of key content and to organise it for teaching based on the 'big ideas' of mathematics and

science, emphasizing the links and connections within and between them. In attempting to deal with the 'crowded curriculum', teachers would do well to consider similarities between 'big mathematical ideas' and 'big scientific ideas' and to make connections explicit for children. This paper begins by considering a model for numeracy and suggesting that its scientific equivalent might be termed 'scientificity'.

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S PAPER

### **5.1.2 IMPLEMENTING A CONTEXTUALIZED SCIENCE CURRICULUM AND INSTRUCTION: WHAT DO TEACHERS AND STUDENTS HAVE TO SAY?**

WINSTON MASSAM

University of British Columbia

Contextualized science curriculum and instruction entails teaching science through learners' everyday environment. The intention is to help learners find meaning in context by connecting what they learn in school science with the phenomena they encounter in their everyday local contexts. In the present 'ongoing' study, an instructional model is designed such that lessons are developed from the mandate science curriculum and taught through learners'

everyday local environment. We implement these lessons by taking students from classroom to their real-world local contexts and then back to classroom to share what they learned from the real-world. The intention is to see that learners are able to get the opportunity to actively engage in learning, challenge ideas and concepts, reflect on, and make connections between the knowledge they learn in school and their everyday experiences. In doing so, we believe

that this is the best way that school science could be made active, participatory, meaningful, and engaging, but more importantly; the way to help learners see that science is relevant and useful for their lives during and after school. We present in this paper, the initial teachers' and students' views and perceptions regarding this way of high school science teaching and learning.



## M PAPER

**5.1.3 DEVELOPING NUMBER FACT KNOWLEDGE FOR DIFFERING CONTEXTS**

JENNY YOUNG-LOVERIDGE  
University of Waikato

BRENDA BICKNELL

This paper focuses on selected findings from a study that explored the use of multiplication and division contexts with 34 five- and six-year-old children from diverse

cultural and linguistic backgrounds. Although children had considerable knowledge of number facts, they did not always apply them to problem-solving situations. The

magnitude of the numbers did not necessarily determine the difficulty level for achieving automaticity of recalled facts.

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## E PAPER

**5.1.4 CONTRIBUTION OF INDUSTRY-BASED STUDENT LEARNING PERFORMANCE FOR THE STEM EDUCATION**

TONY SAHAMA  
Queensland University of  
Technology

GUNNAR ANDERSSON  
HONG WU  
MATHIAS WILICHOWSKI

PIERRE-OLIVIER LOMBARTEIX  
VALENTÍN MIGUEL EGUÍA

We hypothesized that Industry based learning and teaching, especially through company assigned student projects or training programs, is an integral part of science, technology, engineering and mathematics (STEM) education. In this paper we show that industry-based student training and experience increases students' academic performances independent to the organizational parameters and contexts. The literature on industry-based student training focuses on employability and the industry dimension, and neglects in many ways the academic dimension. We observed that the association

factors between academic attributes and contributions of industry-based student training are central and vital to the technological learning experiences. We explore international initiatives and statistics collected of student projects in two categories: Industry based learning performances and on campus performances. The data collected were correlated to five (5) universities in different industrialized countries, e.g., Australia N=545 projects, Norway N=279, Germany N=74, France N=107 and Spain N=802. We analyzed industry-based student training along with company assigned student projects

compared with in comparisons to campus performance. The data that suggests a strong correlation between industry-based student training per se and improved performance profiles or increasing motivation shows that industry-based student training increases student academic performance independent of organizational parameters and contexts. The programs we augmented were orthogonal to each other however, the trend of the students' academic performances are identical. An isolated cohort for the reported countries that opposed our hypothesis warrants further investigation.

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S PAPER

### **5.2.1 A CASE FOR INTEGRATING PEER INSTRUCTION AND LEARNING CATALYTICS IN THE INTRODUCTORY PHYSICS LAB**

NATASHA HOLMES  
University of British Columbia

D BONN

This document proposes a paper to present how Learning Catalytics, a web-based peer instruction technology, has been used to enhance teaching and learning in an introductory physics lab

course. While peer instruction is often described as a useful tool for large lecture settings, we make a case for its use in small lab sections due to the opportunities for fuller engagement, assisting

data collection, providing feedback, and developing scientific inquiry behaviours. We will describe some examples of its use in the lab and some of the results that have been extracted.

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S PAPER

### **5.2.2 DEVELOPMENT OF AN INSTRUMENT ASSESSING FRESHMAN STUDENTS' UNDERSTANDING OF DATA ANALYSIS IN THE PHYSICS LABORATORY**

IDA KUKLIANSKY  
Ruppin Academic Center

HAIM ESHACH

This study describes the development of the Laboratory Data Analysis Inventory Instrument (LDAII). This tool is designed to assess the skills and knowledge of freshman students concerning data analysis required in their first physics laboratory. Being a student-centered instrument, its statements includes actual students' misconceptions identified in observations in freshman's laboratory classes, interviews with students, students experiment reports, interviews with experienced laboratory instructors, as well as misconceptions found in the literature in the field.

Seven experts participated in the validation process of the LDAII. The final version of LDAII consists of 31 statements relating to the following 4 objectives: A) Understanding central tendency measures, B) Understanding error [statistical (random), and equipment (systematic) errors], C) Interpreting graphs and understanding the relation between graphs and the experiment's goals, D) Understanding how to fit a regression line to the measurements. The pilot sample included 77 participants from three different academic institutions representing not only

three different forms of science education, but also three different levels of experience was used to test the instrument. The Cronbach's Alpha coefficient arrived at was 0.698. This value is acceptable for such a diagnostic test. The results revealed a significant difference between the averages of the group of students having less laboratory experience and the two other groups ( $p=0.001$ ). The LDAII is a valid and reliable tool that can be used to assess understanding of data analysis required in the introductory physics laboratory.



S PAPER

**5.2.3 INVESTIGATING THE EFFECTS OF PEERWISE & PEER INSTRUCTION PEDAGOGY ON THE DEVELOPMENT OF PEDAGOGICAL CONTENT KNOWLEDGE OF PROSPECTIVE PHYSICS TEACHERS**MARINA MILNER-BOLOTIN  
University of British Columbia

ALEXANDRA MACDONALD

HEATHER FISHER

This study investigates the effects of technology-enhanced pedagogies, such as Peer Instruction and PeerWise, used in a secondary teacher education methods course on prospective physics teachers. In the first year of the study we identified a gap between the prospective physics teachers' experiences of science education as students, and the pedagogies they were expected to implement as teachers. The purpose of the current study is to explore the effects of modeling these technology-enhanced pedagogies implemented in secondary physics methods courses on prospective physics teachers' pedagogical and

content knowledge. The central pedagogy implemented in the study is Peer Instruction, which works with Classroom Response Systems (clickers). It has been proven effective in both secondary and post-secondary physics education contexts. However, the key to successful implementation of Peer Instruction is not the technology, but the teacher's ability to ask powerful questions that challenge learners' misconceptions. Designing pedagogically effective questions should be at the heart of teacher education. Prospective teachers have to practice authoring, answering, and evaluating conceptual questions,

as well as implementing them into their lessons. We addressed this challenge by augmenting traditional Peer Instruction pedagogy with PeerWise, an online tool that allows students to author multiple-choice questions, provide detailed explanations, as well as answer, evaluate, rate, and comment on multiple-choice questions created by their peers. This is especially valuable for prospective physics teachers who are developing their pedagogical skills. This study employs a mixed-methods design that includes classroom observations, interviews, think alouds, and quantitative data from PeerWise.



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S PAPER

### **5.2.4 THE ISOTOPE PROJECT: REVEALING INSERVICE TEACHER TENSIONS OF TEACHING THROUGH A STEM-BASED APPROACH.**

RICHARD HECHTER  
University of Manitoba

Modern pedagogy in science education is punctuated with Science, Technology, Engineering, and Mathematics (STEM) approaches. As a result, both novice and veteran teachers are being asked to shift teaching and learning strategies to incorporate STEM elements into their classroom. While teacher education programs are now integrating STEM approaches into teacher training and preparations, this modern approach is not necessarily reaching veteran teachers. On this premise, the ISOTOPE (Integrating Science Outcomes, Technology Orientations, and Pedagogical Experiences) Project was

designed to include experienced inservice teachers in STEM-based professional development. The purpose of this paper is to report findings of a pilot study aimed to investigate the transformative perspectives of participant inservice science teachers of the ISOTOPE Project who have not learned their discipline through STEM approaches, yet are beginning to teach using this framework. Qualitative data was collected from participants (n=24) of the ISOTOPE Project, during the one year, three phase outreach activity and workshop event series designed for rural and northern inservice science teachers

to explore the STEM-based framework for contextualizing and promoting integrated, meaningful, and authentic science learning experiences. Results indicate that new models and approaches for science teaching that focus on linking theoretical underpinnings with pragmatic applications are required to more efficaciously match relevant and modern technologies appropriately within the science classroom. Implications of this study will inform professional development programs, curriculum development, and professional learning communities.



S PAPER

**5.3.1 EXPLORING UNDERGRADUATE STUDENTS' METACOGNITIVE TRANSFORMATIONS IN AN ORGANIC CHEMISTRY COURSE**ASHLEY WELSH  
University of British Columbia

This paper describes the development and preliminary analysis of a study exploring undergraduate students' metacognitive transformations in an introductory organic chemistry course designed for biological science majors. Students consistent struggle with learning organic chemistry served as an impetus to pinpoint the factors influencing how (and if) students

plan, monitor, control, and evaluate their learning strategies over the course of a semester. A survey instrument administered at the beginning and end of the course revealed a drop in students' ability to: connect with the material; monitor, evaluate, and plan their learning; and be confident in their capability to succeed in the course. One-on-one interviews were conducted with 26 students

to expand upon the survey results and to present the critical events or catalysts that students describe as triggering change (or lack thereof) in their learning strategies and metacognition. This study offers a window into the supports and barriers influencing students' metacognition and provides insight for curriculum, pedagogy and advice to enhance student learning.

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S PAPER

**5.3.2 THE STUDY HABITS OF STUDENTS ON INTRODUCTORY STATISTICS COURSES: INVESTIGATION AND INTERVENTION**GAITRI YAPA  
University of British Columbia

BRUCE DUNHAM

Despite recent advances in statistical education, there is little existing research on either the study habits of students on introductory statistics courses or how interventions may bring about improvements in study

skills in statistics. Here findings are presented on student responses to post-course interviews and mid-course surveys regarding study habits on introductory statistics classes. In addition, an intervention is suggested that may help students

with ineffective study habits: details of a so-called study skills workshop are provided, including its rationale and aims, evidence of student conduct within such workshops, and the likely impact on student performance.

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S PAPER

### **5.3.3 THE ROLES OF INSTRUCTION AND METACOGNITION IN ENHANCING SELF-REGULATED LEARNING IN A HIGH SCHOOL CHEMISTRY COMPUTER-BASED LEARNING ENVIRONMENT**

CM LAM

Hong Kong Institute of Education

Computer-based learning environments (CBLEs) offer both opportunities and challenges for self-regulated learning (SRL). Research has shown that metacognitive monitoring and control are important for self-regulatory processes and are predictors of academic learning in CBLE. However, research also shows that many students lack metacognitive awareness and do not spontaneously initiate metacognitive activities. The majority of previous interventions focusing on students' SRL were conducted in one-off studies that did not provide learners with sufficient opportunities to practise SRL. The current study

utilised a 16-session intervention programme to encourage students to use SRL when studying high school chemistry in a CBLE. The programme taught cognitive and metacognitive strategies and explicitly prompted metacognitive reflection. The following questions were investigated: (i) How does direct instruction affect students' SRL? (ii) How does metacognitive reflection affect learners' cognitive and metacognitive learning strategies? and (iii) What are the effective learning strategies for this CBLE? Two high school chemistry classes (n=74) participated in this study, which was based on a quasi-experimental non-equivalent control group design. Online

multiple-choice questions based on public examinations were designed to assess student performance. Quantitative data from pre- and post-assessments using the Motivated Strategies for Learning Questionnaire were collected to identify any changes in SRL strategies. Qualitative data of pre-post semi-structured interviews and think-aloud protocols from selected participants were also collected to identify the cognitive and metacognitive strategies that are deployed during learning. The results of this study shed light on the effect of direct instruction and metacognitive reflection on SRL in CBLE.



## SHOWCASE

**5.4.1 INCREASING INSTRUCTIONAL INTERACTION THROUGH ADAPTATION OF LOCAL PLAY FOR RECOGNITION OF NUMBERS AND SHAPES BY PRIMARY SCHOOL PUPILS**

THELMA EKUKINAM

University of Uyo

This paper demonstrates the adaptation of local plays into relevant instructional games for teaching recognition of shapes and numbers. Review of related literature has revealed the fact that the teacher led instructional interactions is the only form of interaction in the public primary schools and as such pupils lack opportunity for practice and application of knowledge gained. Thus, a pre-test and post-test,

non randomized experimental design was adopted for the study. The population comprised four thousand, one hundred and sixteen (4,126) primary one pupils in Ikot Ekpene Local Government Area of Akwa Ibom State while two hundred and thirty-six primary one pupils formed the sample for the study. An instrument, 'Adapted Instructional Game Package' (AIGP) was used to collect data. A t-test statistical analysis revealed

significant difference in the post-test performance of pupils exposed to both strategies for both games but also indicate that pupils in the experimental group benefited more than pupils in the control group with higher t-cal values respectively 4.92 & 5.37 against 1.98 as the t.cri value. Local plays are recommended as useful resources for learners' maximum participation and interaction during lesson delivery.

## S PAPER

**5.5.1 AFFECTING ATTITUDE TOWARDS SCIENCE, HIGH SCHOOL AFRICAN AMERICAN STUDENTS**

CHARLES ANDERTON

Mississippi State University

KEITH KOENIG

DEBRA PRINCE

CADE SMITH

Racial minorities, women, and people with disabilities are underrepresented in the fields of Science, Technology, Engineering, and Mathematics (STEM). Attitude towards science has been shown to be a reliable predictor of science achievement. Project-based learning (PBL) has been shown to increase attitude and cognition of a topic. Therefore, this study focused on improving the attitude of high school African American students towards science through PBL. The sample selected consisted of approximately 100 African

American high school students (age 14 to 18 and a 65% to 35% female to male ratio) enrolled in JROTC (Junior Reserve Officer Training Corp) from Louisiana, Alabama, and Mississippi. A quasi-experimental research design which consisted of pre and post intervention measures of participants' attitudes towards science was utilized in this study. The intervention was separated into two parts: 1) a residential, immersive STEM and leadership PBL camp and 2) a fall six week long STEM PBL outreach. The Test of Science Related Attitudes

(TOSRA) was used to measure the participants' attitudes towards science. Results of preliminary data analysis suggest that participants of the summer camp intervention improved their attitude of science on six of the seven scales measured by the TOSRA. Results of data analysis examining the change in science attitudes following the fall outreach intervention found an increase in four with a significant increase in two of the seven scales of the TOSRA. Analysis is ongoing and continuing to provide insightful and worthwhile conclusions.





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G PAPER

### **5.5.2 THE IMPORTANCE OF SCIENCE FICTION AND OTHER STEM-RELATED MASS MEDIA IN YOUNG PEOPLE'S DECISIONS TO ENROL IN UNIVERSITY STEM COURSES**

TERRY LYONS

University of New England

FRANCES QUINN

This paper presents Australian results from the Interests and Recruitment in Science (IRIS) study with respect to the influence of STEM-related mass media, including science fiction, on students' decisions to enrol in university STEM courses. The study found that across the full cohort (N=2999), students tended to

attribute far greater influence to science-related documentaries/channels such as Life on Earth and the Discovery Channel, etc. than to science-fiction movies or STEM-related TV dramas. Males were more inclined than females to consider science fiction/fantasy books and films and popular science books/magazines as having

been important in their decisions. Students taking physics/astronomy tended to rate the importance of science fiction/fantasy books and films higher than students in other courses. The implications of these results for our understanding of influences on STEM enrolments are discussed.

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G PAPER

### **5.5.3 GATEWAYS TO ENGINEERING: A SYSTEMIC STEM INITIATIVE TO ADDRESS CAREER PATHWAYS IN ENGINEERING**

JAMES WATTERS

Queensland University of  
Technology

HITENDRA PILLAY

STEPHEN HAY

Providing learning experiences that raise students' interest in science, technology, engineering and mathematics (STEM) is of major concern to governments worldwide. Various agencies external to schools have developed programs to raise student interest. The Formula One in Schools program is one such program that involves an international

competition among more than 30 countries. The paper examines how the F1 in schools program has been embedded in the formal school curriculum. As part of a study of industry-school partnerships, we have examined to what extent the program provides an engaging learning environment. Drawing on a socio-cultural analysis of student and teacher experiences we show

that participants have acquired complex integrated knowledge and skills within a social and functional context. The approach challenges contemporary approaches to teaching STEM and provides models of practice that generate and sustain high levels of motivation and interest.



G PAPER

**5.5.4 WHAT'S IN IT FOR ME? MAKING THE CASE FOR PAID STUDENT PLACEMENTS IN COMPUTER SCIENCE**SALLY SMITH  
Edinburgh Napier University

COLIN SMITH

Recognising the need for skilled computer science graduates, the university funding body in Scotland, the Scottish Funding Council (SFC) is supporting a Scotland-wide student placement project, e-Placement Scotland, to create 750 new paid student placements across Scotland. Uniquely the project is employer-led, with an infrastructure designed to maximise applications for roles from students and minimise employer recruitment overheads. The project team is based at Edinburgh Napier University working with ScotlandIS, the trade body for computing in Scotland.

Making a case for the benefits to students from undertaking a placement is the easy part. Making a case to employers to increase the number of paid placements available to students will ensure sustainability of placements for students in the years ahead. Utilising an action research approach, the project team are conducting a parallel study to analyse the effects of its actions and inform its on-going work. Through employer demand, a wide range of placement models have emerged, including the traditional one year placement, shorter placements and, increasingly, part-time

placements undertaken alongside university study. The project found overall that the predominant model is the three month summer placement. The study shows that students in the penultimate year of an undergraduate CS course are the most successful in their applications. The paper highlights that a region-wide approach is beneficial, but in the absence of a regional placement hub the paper analyses the data in terms of generating a message for employers, with a view to answering their question "What's in it for me?".



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S PAPER

### **5.6.1 THE ROLE OF SCAFFOLDING AND THE FACILITATOR IN THE DELIVERY OF PROBLEM-BASED LEARNING ON AN UNDERGRADUATE INTERDISCIPLINARY SCIENCE DEGREE PROGRAMME**

SARAH GRETTON  
University of Leicester

At the Centre for Interdisciplinary Science (University of Leicester, UK) we have developed an undergraduate programme in Natural Sciences in which the core sciences (biological sciences, chemistry, physics and earth sciences) are taught entirely by Problem-Based Learning (PBL) through modules that address inherently interdisciplinary problems. The modules are taught sequentially each over a five week period, and each module is

based around usually one or at most two related problems. We have found that the extended nature of the research tasks presented by the problems presents various challenges including surface learning, lack of pre-session preparation and an inappropriate division of learning within groups. To address these issues we introduced a number of interventions to scaffold the student activities including less frequent but longer facilitation sessions,

pre-session tasks (recommended reading, questions for discussion and detailed learning objectives) and assigned weekly questions. We also introduced facilitation by dedicated trained, subject specific teaching fellows, rather than employing ad hoc graduate teaching assistants, to provide continuity over the programme. We report on the implementation of these interventions and provide quantitative and qualitative evaluation of these interventions.

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T PAPER

### **5.6.2 THE EFFECT OF STRATEGY USE AND SCAFFOLDING ON LEARNING IN AN EXPLORATORY LEARNING ENVIRONMENT**

NIKKI YEE  
University of British Columbia

ADRIANA BRISENO-GARZON

IDO ROLL

While the effect of scaffolding on learning has been studied extensively, little is known about its effect on students' strategy use. This study focuses on the relationships between level of scaffolding, self-reported strategies, and learning, in a virtual simulation environment. Participants in the study were asked to report cognitive and metacognitive strategies they

had used when completing an activity that was either Scaffolded or relatively Unstructured. Prior knowledge, together with these strategies, acted as predictors of an assessment of future learning in a backwards multiple regression. Results suggest that prior knowledge is a significant predictor of learning for both levels of scaffolding. In the Unstructured

group, less planning but more scientific reasoning correlated with future learning outcomes. No such relationships were found with the Scaffolded group. These results may help instructors to more effectively plan activities according to curricular objectives and student needs.



S PAPER

**5.6.3 ENHANCE STUDENTS LEARNING THROUGH AUTONOMY SUPPORT IN A LARGE GENETICS LABORATORY COURSE**

JINLU WU

National University of Singapore

Laboratory education can play a vital role in developing learner's autonomy and scientific inquiry skills. In an innovative mutation-based learning (MBL) approach, students were instructed to redesign a teacher-designed standard experimental protocol by a "mutation method" in a Molecular Genetics laboratory course. Students could choose to delete, add, reverse or replace certain steps of the standard protocol to explore questions

that interest them in a given experimental scenario. They wrote experimental proposals to address the rationale and the hypothesis for the "mutations", conducted experiments in parallel according to both standard and mutated protocols, then compared and analyzed results to write individual lab reports. Various autonomy-supportive measures were provided in the entire experimental process. Analyses of student work and feedback suggest that

students using the MBL approach 1) spend more time discussing experiments 2) use more scientific inquiry skills and 3) find the increased autonomy afforded by MBL more enjoyable than students following regimented instructions in a conventional 'cookbook' style laboratory. Furthermore, the MBL approach does not incur an obvious increase in labor and financial costs, which makes it feasible for easy adaptation and implementation in a large class.

G PAPER

**5.7.1 THE EXPLORATION OF LEARNING BEHAVIOR ANALYSIS AND EVALUATION MODEL IN UBIQUITOUS LEARNING ENVIRONMENT - TAKING LCS FOR EXAMPLE**

HAIPENG WAN

Beijing Normal University

With the deepening development of philosophy and practice in ubiquitous learning, it has become a common way of learning. However, with the features of context, personalization and socialization, ubiquitous learning brings challenges to the learning evaluation. How to realize the

data collection in various contexts and how to assess the quality of social interaction and personalized recommendation in ubiquitous learning have become a problem in learning effect evaluation. This essay starts with the connotation, characteristics of ubiquitous learning and then designs a learning

behavior analysis and evaluation model and the corresponding verification experiment based on the U-learning platform LCS, which can be used to realize the evaluation of knowledge acquisition and social interaction for the in-depth practice of ubiquitous learning evaluation in future.



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G PAPER

### 5.7.2 COLLABORATION FOR STUDENT SUCCESS IN STEM FIELDS: A NOVEL APPROACH

AFRIN NAZ

West Virginia University Institute of  
Technology

In this project, titled "Collaborations for Student Success in STEM fields (CSS-STEM)", we introduce an innovative project designed by the faculty members of College of Engineering at University of West Virginia Institute of Technology (WVU TECH) with the help of local high school teachers to place a strong emphasis on addressing the current and anticipated shortfall of STEM professions. The project was sponsored by NASA K-12 grant. The core of this project is a two-day workshop to provide

professional development training with the aim to improve high school teachers' STEM knowledge and skills. In the summers of 2012 and 2013, two consecutive workshops were held at WVU TECH for high school teachers. During these workshops, along with multiple training sessions, the university faculties and high school teachers held extensive discussions over a wide range of topics related to STEM education in West Virginia high schools. In addition, a range of follow-up activities are scheduled

after the Summer STEM workshop, in order to help the participating high school teachers transfer their knowledge and skills to their classrooms. Our post-workshop survey indicates that most of the participants find the workshop productive in addressing the state educational content standards, identifying innovative teaching methods/tools, and building network among university educators and high school teachers.

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G PAPER

### 5.7.3 DEVELOPMENT AND ASSESSMENT OF A CONTINUING EDUCATION COURSE IN QUANTITATIVE LITERACY FOR HIGH SCHOOL STEM TEACHERS

CRAIG MCCLURE

University of Alabama at  
Birmingham

As a part of a program funded by the Alabama Math, Science, and Technology Initiative, a 5-week unit on quantitative literacy was developed and piloted for area high school teachers. In this program, grade 8-12 teachers of biology, chemistry, and physics were introduced to quantitative literacy, its importance in society, and how student development of

quantitative skills can be supported in the classroom. At the beginning and end of the unit, a survey was administered to evaluate changes in the teachers' attitudes toward quantitative literacy, their ability to foster quantitative skills in the classroom, their ability to assess student quantitative skills, and their ability to identify areas in their discipline in which students would

benefit from improved quantitative skills. In this paper, studies supporting the development of student quantitative literacy will be presented, along with a description of the course and survey used for evaluation. Results of the evaluation and future directions in supporting quantitative literacy in secondary education will be presented.



## S PAPER

**5.7.4 APPLICATION OF INSTRUCTIONAL TECHNOLOGY FOR ASSESSMENT OF INSTRUCTIONAL OBJECTIVES IN TEACHING-LEARNING OF BASIC SCIENCE AND TECHNOLOGY**

IDONGESIT UDOSEN  
University of Uyo

Students' disinterest in learning of science courses at the secondary school level cannot be remedied if effective teaching methods are not employed at the basic education level. The study aimed at determining the difference between pupils' performance in Basic science and technology test based on allotted time and standard of performance for each behavioural objective by the teacher during classtime activities. The study was an experimental design. The population comprised all teachers in Akwa Ibom State. The

sample was based on the criteria of selection of schools under study. One of the schools was kept as a control group while another was kept as an experimental group. The intact classes in School A(control) had 215 pupils while School B (Experimental) had 192 pupils. The lesson notes were researcher-designed for both control and experimental groups. The teachers in the experimental group were then exposed to a pre-demonstration of the lesson plan on Magers' components of time as a constraint and

standard of performance for setting behavioural objectives. The finding revealed that there was significant difference between pupils' performance in BS&T test in experimental group as the calculated t- value (24.45) was higher than the critical value (1.97), thus the null hypothesis was rejected. It is recommended among others that if as in most instances 35 minutes are allowed for a lesson, the teacher may consider a time chart of 20 minutes for instruction and 15minutes for evaluation.

## G PAPER

**5.8.1 A MODEL OF SHARING STEM RESOURCES WITH LINKED DATA--TAKING LCS AS AN EXAMPLE**

GUOZHU DING  
Beijing Normal University

This research attempts to introduce a model of Knowledge Point-based Linked Data to share STEM resources, and it is going to take LCS system as an example to

show how to subdivide subjects included in STEM into different knowledge points, link them using semantic association techniques and solve problems related to the

subjects. Knowledge points will be marked in different languages so that people in different regions speaking different languages can share STEM resource.



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S PAPER

### **5.8.2 DEVELOPMENT AND APPLICATION OF A GUIDED PROJECT-BASED LEARNING PROGRAM OF STEM RELATED TO LED AND CELL-PHONE SENSOR**

YOUNGMIN KIM  
Pusan National University

In Project-based learning, sometimes the complex and unfamiliar concepts are too difficult for young scientists to understand, so they used to be bored with the lesson, and the project will be unsuccessful from the beginning of the process (Huggand Wurdinger, 2007). And, when students conduct a project-based learning, usually they get information related to the project theme from website being so easy, but they do not recognize that many of the resources available online usually contain even erroneous or biased information. Therefore, for the effective project-based approach should be the inclusion of instructional support

to guide and assist the students. The purposes of this research are to develop and apply a teaching model, which is called Guided Project-based Learning Model (GPBL-M), and learning program for effective project-based learning, and to investigate how students accomplish the processes in the model. The GPBL-M consists of 5 steps, which are selection of theme, planning of inquiry of the theme, implementing of the plan, concluding of the inquiry and presenting results. The participants were two small groups of students (3-5 students in each group), two lectures, and one research assistant. The research results are

as follows. First, finishing the project, they felt excitement of achieving the aim, and their self-confidence and feeling of competence has been much improved. They showed positive attitude and perception toward the project learning about science. Second, by the guided project-based learning, students had a useful chance to practice their ideas on the subject by interacting and communicating with their peers in the groups. In addition, they perceived the difficult scientific concepts precisely through discussion with the peers and with the teacher.

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T PAPER

### **5.8.3 THE STUDY OF THE EFFECT OF SMARTPHONE-BASED VISUAL INTERACTION IN U-LEARNING PERFORMANCE**

WANG QI  
Beijing Normal University

In the past 10 years, educational software and websites based on smartphones have been springing up with an incredible speed. However, smartphone-based learning still doesn't meet our expectations for some reasons. One important problem is how to design the visual interaction

of learning software. The visual interaction, affected by colors, layouts and operation interaction, plays an important role in memory and learning performance. This paper conducted an experiment on 40 under-graduate students using the two mobile clients of Learning Cell platform. The

two clients have different visual interaction levels. The new client has a better visual interaction. Experiment result showed that the new client performed better. User friendly visual interaction does have positive significant effect on ubiquitous learning performance.



## T PAPER

**5.8.4 THE DESIGN AND APPLICATION OF THE MOBILE EDUCATIONAL RESEARCH ACTIVITY BASED ON QR-CODE**

 ZHI ZHOU  
 Beijing Normal University

 AXI WANG  
 LING CHEN

FENG-KUANG CHIANG

Educational research activity is one of the important ways to promote teachers' professional development. Traditional methods cannot be satisfied with the needs of teachers' professional development completely. Meanwhile, there are also some typical problems in face to face discussions about teaching seminar, such as it's unable to

record lectures process timely; it's unable to view the peer evaluation timely; fail to find the appropriate teaching resources, strategy and so on. To solve the problems above, this study, which is based on Learning Cell platform, utilizes the advantages of the QR-code technology, design and develop the mobile research activity based on the QR-code. This paper conducted

an experiment on 17 English teachers working in 9 primary schools taking part in the mobile research activity based on the QR-code. The result demonstrated when using QR-code to conduct the face to face discussions about teaching seminar, it can rapidly promote teachers' professional development.

## SYMPOSIUM

**5.9.1 DESIGN AND ENGINEERING COGNITION AND DESIGN-BASED RESEARCH**

 STEPHEN PETRINA  
 University of British Columbia

 FRANC FENG  
 MIRELA GUTICA  
 PETER HALIM  
 YU-LING LEE

 PJ RUSNAK  
 YIFEI WANG  
 JENNIFER JING ZHAO

This symposium aims to generate discussion and understanding of design-based research (DBR) in design and engineering cognition. Seven empirical reports exploring design and engineering cognition or using DBR give the symposium depth and structure: Studies of 1) thirty tweenage girls in designing a mother's day game, media, and robots; 2) fifteen elementary

students testing a new educational video game; 3) nineteen young adults within an immersive virtual environment; 4) four teen students on the design of games; 5) twenty-four nursing students involved in a simulated learning environment; 6) Conceptual paper exploring technology and the "design" in DBR; and 7) Methodological paper connecting DBR with design

and engineering cognition and ethical know-how. Arguably, new technologies along with a return of DIY or maker culture invite or configure everyone to employ inventive practices or "designerly ways of knowing. Design now marks interaction with new technologies, making DBR increasingly important and relevant for STEM.





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SHOWCASE

**5.10.1 BRIDGING THE GAP IN STEM: COMBINING BUSINESS, INDUSTRY AND EDUCATION RESOURCES TO CREATE DYNAMIC K-12 TEACHER STEM PROFESSIONAL DEVELOPMENT**

ANNE SEIFERT

Idaho National Laboratory, Idaho  
i-STEM Director, Boise State  
University, Idaho State University

LOUIS NADELSON

SANDIE NADELSON

A STEM literate society is critically needed to feed highly technical workforces of businesses and industries today and into the future. The demand for workers with STEM education is increasing and there is a shortage of people pursuing STEM careers. Teachers are critical change agents and working with teachers is an excellent way to engage K-12 students in STEM, to increase a STEM literate citizenry, and arm them with needed skills. We have

developed a research-based STEM teacher professional development model (PD) building K-12 teachers' capacity in STEM teaching and learning that brings education and workforce together to support and enhance STEM Education. Our research provides insight into multiple facets of teachers seeking place-based integrated STEM PD. In this workshop, participants will engage in hands-on activities as they learn how to impact STEM Education and how our model can

be easily replicated in any location. We also propose to address STEM pipeline development through advanced STEM Education, share our developed and implemented instructional research products, instruments and tools, and share our STEM PD model of which participants can replicate and scale nationally and internationally to enhance teacher's capacity to prepare a STEM literate citizenry and the future STEM workforce.

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SHOWCASE

**6.1.1 PROJECT SOS (SCIENCE OF SUSTAINABILITY): DEVELOPMENT AND DELIVERY OF A UNIQUE MODEL FOR STEM EDUCATION**

KATHERINE DAWES

Palouse Discovery Science Center

CHRISTINE BERVEN

VICTORIA COATS

DANA DAWES

ANNE KERN

PATRICIA MCNAMARA

KATHLEEN RYAN

This session will review the development and delivery of a unique model for an informal science educational outreach program focused on science and sustainability. Session participants will explore hands-on activities created as part of a National Science Foundation-funded Pathways research project (DRL-1223290) entitled "Project SOS: Making Connections Using the Science of Sustainability. The project brings together rural, underserved youth and families

in northern Idaho and eastern Washington to explore STEM concepts important in sustainable building design. The project team developed a collaborative regional network of resources to create this informal science education program that combines: (1) interactive exhibit prototype activities about the physics of conduction, convection, and radiation; (2) a cooperative learning (Johnson, Johnson & Holubec, 1998) problem-solving challenge in which youth become "experts

in the areas of heat transfer, teach their team members what they learned, and apply this knowledge to improve the energy efficiency of a model house, and; (3) simple tools and instructions that prompt participating youths to apply their new knowledge to making their own homes more energy-efficient and sustainable. In this session we will discuss tools and techniques developed to accomplish program goals, successes and challenges, and current findings regarding the effectiveness of the program.



## S PAPER

**6.2.1 MEASURING SHORT TERM EFFECTS OF SELF-REGULATORY PROMPTS ON PROBLEM-SOLVING ABILITIES IN INTRODUCTORY GENETICS**

HEATHER FISHER  
University of British Columbia

MARINA MILNER-BOLOTIN  
IDO ROLL

DEBORAH BUTLER  
ALEXANDRA MACDONALD

Problem-solving skills are crucial for student success in undergraduate STEM courses, such as genetics, yet few students in these courses have developed problem-solving skills. This precludes many students from continuing STEM studies. As such, it is necessary to ensure these skills are actively developed during students' early undergraduate careers. This study focuses on the first step in the problem-solving process, orientation, which requires students to orient themselves to a new problem by engaging in behaviours such as interpreting what the problem is asking and identifying relevant information.

This is a key step in the problem-solving process and is a stumbling block for many students. This study, conducted in an introductory genetics course, employed a quasi-experimental design consisting of three conditions. All students (N=434) participated in a problem-solving tutorial with five problems and a quiz. In the control condition, students completed a traditional tutorial. In the two experimental conditions (problem-solving facilitated and self-regulation supported) students completed a modified version of the tutorial. The experimental conditions provided differing levels of prompts

to facilitate the development of problem-solving skills and self-regulatory behaviours. Tutorial problems and quiz solutions will be evaluated to assess students' abilities to engage in self-regulatory behaviours during problem-solving. We will explore whether having prompts supports students development of these behaviours, both while prompts are present and in subsequent, unprompted questions. The results of this study will help bridge research on self-regulation with the STEM education practice by proposing a model that aims at developing self-regulatory skills for problem-based courses.



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S PAPER

## 6.2.2 TRANSLATIONS OF INDUSTRY-BASED STUDENT LEARNING AND ACADEMIC PERFORMANCES

TONY SAHAMA  
Queensland University of  
Technology

Industry based learning and teaching, especially through industry assigned student projects or training programs, is an integral part of science, technology, engineering and mathematics (STEM) education. Available experimental evidences demonstrate that industry based learning outcomes are correlated with outcome based learning (OBL). In this paper we show Australian experiences such that industry-based student training and experience increases students' academic performances independent to the organizational parameters and contexts. We observed that the association

factors between academic attributes and contributions of industry-based student training are central and vital to the technological learning experiences. The data collected were correlated to science and Engineering study areas in Australian context with completed 545 OBL projects (N=545). In comparisons, we explore international initiatives and statistics collected of student projects in two categories: Industry based learning performances and on campus performances. We analyzed industry-based student training along with company assigned student projects compared with in comparisons to

campus performance. The data that suggests a strong correlation between industry-based student training per se and improved performance profiles or increasing motivation shows that industry-based student training increases student academic performance independent of organizational parameters and contexts. The programs we augmented were orthogonal to similar partnered University students however, the trend of the students' academic performances are identical. An isolated cohort for the reported countries that opposed our hypothesis warrants further investigation.



S PAPER

**6.3.2 PHYSICS TEACHERS' BELIEFS AND INTENTIONS ABOUT THE USE OF FORMULA IN MOTION CONTEXT**ZAHRA PARVANEH-NEZHAD  
Deakin University

SAMSON NASHON

The nature and characteristic of motion tasks involved in real life situation and the use of different math formula. Students' misconceptions occurring during physics problem solving is due to interpreting mathematical terms (in a physics problem) using everyday language interpretations, not mathematical interpretations. These notions highlight the necessity of exploring physics teachers' thinking and beliefs about the use of formula particularly in

motion topic. A qualitative approach incorporating a case study design was chosen. Two different data sources derived from a Problem Centred Questionnaire (PCQ); and a Problem Centred Interview (PCI) were used. Data processing of teachers' oral and written comments was conducted based on two main categories: Student Thinking and Disciplinary Thinking. In this paper teachers' thinking and beliefs about the use and understanding of the formula were

categorised in terms of the extent of their attention to Student Thinking and Disciplinary Thinking. However, it was found that teachers did not have strong beliefs to consider the use and understanding of the formula as the important factor when teaching motion task. The implication of this paper is to develop the physics teachers' and pre-services teachers' commitment to teaching and understanding of the use of formulae in their physics instructional planning.

S PAPER

**6.3.3 THE DEVELOPMENT OF PHYSICS TEACHER AGENCY IN THE CHINESE CURRICULUM REFORM CONTEXT: A NARRATIVE APPROACH**GUOPENG FU  
University of British Columbia

This study explored how secondary physics teachers exercised their collective agency in the process of adopting and adapting to a nation-wide curriculum reform in China. Through an ethnographic approach and drawing on Social Cognitive Theory, physics teacher's collective agency was explored and interpreted. The results

revealed that collective agency was a mediating bridge through which the discrepancies between reform mandates and teacher's pedagogies and curriculum interpretations were negotiated. Further, collective agency helped teachers to cope with uncertainties generated by the reform and offered mental supports.

Moreover, the reform mandates undermined the traditional power hierarchy within teachers and thus stimulated teachers' collective agency. The study demonstrates the interdependent relations between collective agency and reform environment and has implications for theory, practice, curriculum, and research.



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S PAPER

### **6.4.1 OPENING REAL SCIENCE: INTRODUCING AUTHENTIC SCIENTIFIC METHODOLOGY INTO MATHEMATICS AND SCIENCE TEACHER PREPARATION**

JOANNE MULLIGAN  
Macquarie University

Opening Real Science (ORS) is a unique collaboration between leading teacher educators, scientists, mathematicians and ICT designers to bring, relevant, authentic science into Australia's classrooms. By engaging pre- and in-service teachers with the concepts and practice of Real Science, and with real scientists and mathematicians, the project will enable them to teach mathematics and science as they are practised:

as dynamic, forward-looking and collaborative human endeavours. The project will drive a major improvement in the quality of mathematics and science learning by delivering innovative teacher education modules and a unique professional experience model to build the competence and confidence Australian teachers need to inspire and equip their own students to ask and investigate motivating questions in science

and mathematics. Authentic, inquiry-based approaches support diverse student populations by encouraging students to select topics relevant to their own experiences and aspirations. Partner universities already enrol 25% of Australia's pre-service education students but open access resources will extend the project's benefits to all teachers. This paper provides an overview of the project scope and methodology.

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G PAPER

### **6.4.2 ENHANCING MATHEMATICS AND SCIENCE TEACHER EDUCATION IN REGIONAL AUSTRALIA: ITERATIONS, INTERACTIONS AND MODULES**

GEOFF WOOLCOTT  
Southern Cross University

This presentation outlines a three-year project funded across six regional universities in eastern Australia to enhance mathematics and science teacher education. The project research and implementation uses iterative processes to trial and develop modules for teacher education and other university curriculum. Trial iterations draw together, through targeted interactions, the strengths of university mathematicians,

scientists, and specialist educators in collaborations directed at grounding pre-service teacher education in contexts that are part of daily life in regional Australia. The trial iterations utilise also enhanced feedback where pre-service teachers learn to self-analyse critical affective states recorded while they were teaching. This feedback is directed at improving pre-service teacher performance through an investigation of the

contribution competence, gained through the interactions with specialist educators, scientists and mathematicians, to pre-service teacher confidence. Both trials and module development and implementation will involve also the following research initiatives: a formative evaluation of the project; and, an investigation of mentoring of current project pre-service teachers by past project pre-service teachers



## S PAPER

**6.4.3 AN INVESTIGATION OF SECONDARY STUDENTS' ENGAGEMENT IN A SCIENCE INQUIRY THROUGH A STUDENT-SCIENTIST PARTNERSHIP**MICHELLE LASEN  
James Cook UniversityCLIFFORD JACKSON  
AMY BEAVANBRYN JOHNSON  
ROBERT CALLIN

In 2011, Year 9 science extension students at a regional Australian secondary school participated in a 'full scientific inquiry' (US National Academy of Sciences, 2000), wherein they undertook plant growth trials to investigate the capacity of biochar, a fine-grained charcoal, to enhance the nutrient quality of compost. The inquiry was planned and guided by their teacher and a scientist, who aimed to afford high-performing, junior secondary students an opportunity to work alongside a 'real scientist' and experience the 'thinking and doing of science' (Hume & Coll,

2010). Qualitative data emanating from semi-structured interviews with nine students, as well as the teacher and scientist, revealed high levels of student engagement in the inquiry focus, given potential benefits of biochar as a combined system for soil improvement and carbon sequestration. Students reported working with greater accuracy and purposefulness as inquiry results were not predetermined and were to inform pilot research for the scientist's doctorate. Quantitative data analysis revealed that students who participated in the biochar

inquiry outperformed their science extension-level peers who did not participate in the inquiry, in both a state-wide science test and overall science grades. Findings of this study highlight positive outcomes to have resulted from the student-scientist partnership. At a time when the school science curriculum is failing to engage the majority of young people (Lyons, 2006), there is need for further research to evaluate the effectiveness of this strategy in enhancing student engagement and achievement in science in the compulsory years of schooling.

## SHOWCASE

**6.5.1 FLIPPING CALCULUS: WHY, HOW, AND WHAT**FEI XUE  
University of Hartford

JOHN WILLIAMS

Flipping is a teaching method in which the primary delivery of content is moved outside of classroom via videos and the homework such as problem sets is shifted into the classroom. In this session we will introduce our department's project of flipping Calculus I at the University of Hartford. It includes the motivation for this project, the benefits, the challenges and

the lessons we learned from our two-year exploratory study. Many technologies used in the project, such as video making software, iPads, Clickers (instant response system), and WeBWork (online homework system) will be presented. In addition we will discuss a newly designed classroom with round tables and multiple projects that played an important role in

this project. Finally, encouraging statistical results, in particular the comparison of flipping and non-flipping sessions under the same instructors during the same semester, and the subsequent grade comparisons of Calculus II will be provided. Students' attitude survey and focus group interview summary will also be discussed.



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E PAPER

### **6.6.1 ELECTRICAL AND COMPUTER ENGINEERING UNDERGRADUATE STUDENT PERCEPTIONS OF THEIR ACHIEVEMENT OF ENGINEERING GRADUATE ATTRIBUTES**

CHRIS CAMPBELL  
University of British Columbia

STEVEN WILTON

ANDRE IVANOV

This paper presents findings of a survey of undergraduate student perceptions of competence with respect to 12 engineering graduate attributes (Engineers Canada, 2012) at UBC's Electrical and Computer Engineering (ECE) department. Findings from the finalized survey instrument will be presented and implications for curriculum improvement efforts and ECE's accreditation process will be discussed. The survey development process is described in a separate paper proposal. While Hinkin (1998) advises that only data from finalized surveys allows for valid inferences to be made, preliminary

data hints that: i) 3rd year electrical engineering students report greater competence than 4th year students in all but two attributes, ii) all years report a high degree of competence with communication, teamwork, professionalism, and lifelong learning with no lack of confidence in any attribute, iii) 4th year co-op students report less confident in their competence compared to non co-op 4th year students with the exception of investigation, design, and economics/project management. Although no inferences can be made from this 2013 data, (ii) is interesting: even 2nd year students

reported confidence in their work-ready engineering competence, raising the possibility that students underestimate what is required post-graduation. Also interesting is (iii), which suggests that co-op students have come to know what they do not know while non co-op remain less realistic about their work-readiness. Finally, (i) is interesting because 3rd and 4th year students have experienced different ECE curricula, making one wonder what trends across years the 2014 findings will suggest about students experiencing the same curriculum.



## G PAPER

**6.6.2 UNIVERSITY STEM SCHOOL ENGAGEMENT - SUPPORTING GRADUATE CAPABILITIES**

MARIA BARRETT  
Queensland University of  
Technology

This paper will examine a school engagement program - the Extreme Science and Engineering Program (ESEP) - at Queensland University of Technology, Brisbane, Australia. The program acts to demystify the university experience and build aspiration for tertiary studies in the fields of science, technology, engineering and mathematics (STEM) for school students from low-income backgrounds. The ESEP employs undergraduate and postgraduate university student ambassadors as workshop presenters for the program's in-school and on-campus activities.

The student ambassadors are also required to present their own personal accounts of their study choices, career aspirations and university experience at the STEM Futures events that form part of the program. This paper will discuss the use of university student ambassadors for such an outreach program and the impact of their involvement in the program, particularly in terms of developing graduate capabilities associated with post-graduation employability. The personal transformations, including sense of professional identity, that have also occurred

as a result of working with school students will also be considered. The formal evaluation that has recently been implemented to provide an evidence base for the impact of the program on the student ambassadors will be discussed and results of the analysis of 2013 survey data will be presented. The paper will conclude with consideration of a work integrated learning ambassador model to ensure sustainability of the ESEP beyond the current funding period.

## S PAPER

**6.6.3 BUILDING PEDAGOGICAL BRIDGES BETWEEN SECONDARY AND TERTIARY BIOLOGY: A MULTI-INSTITUTIONAL, NATIONAL ENDEAVOUR**

KAREN BURKE DA SILVA  
Flinders University

GERRY RAYNER

While the quality of student learning, sequencing and structure of curricula and validation of educational standards have been the subject of considerable government and agency scrutiny over the past decade, in both secondary and tertiary domains, there remains a considerable gulf between secondary and tertiary education systems in terms of both curricula and modes of teaching practice. In a biology-focussed project, academics from four Australian universities

collaborated in the collection, analysis and interpretation of national benchmarking information regarding the content, structure, and teaching modes of first year biology subjects offered at 37 Australian universities. Analysis indicated that while a high proportion of these subjects were very high enrolment, many students lacked prior learning in biology, which generated particular stressors for teaching and support staff. Additionally, considerable resources were allocated to

meaningful practical activities, which although highly regarded by students, were not being assessed in ways that could accurately determine student proficiency or their ability to think critically. The project, titled 'Transitions in Biology' has provided a model for future national benchmarking of science and related STEM disciplines, and set the foundation for ongoing and future meaningful and productive dialogue between secondary and tertiary educators.





E PAPER

### 6.7.1 STIMULATING CREATIVE IDEAS OF FRESHMEN STUDENTS THROUGH DESIGN COURSE

HAIFA EL-SADI

Wentworth Institute of Technology

RICHARD ROBERTS

ALI MOAZED

This paper shows a real example of the creativity of freshmen students in a Mechanical design course at the Wentworth Institute of Technology. The freshmen take mechanical design during the first year. The students use stages for mechanical design, define the problem, gather information, find

alternative solutions and take decisions that are the required at different stages of problem solving during design analysis. Team of students use design stages in the analysis of mechanical design projects. The results indicate that the design course including design stages help the students to improve

their motivation for collaboration and their performance and creativity in design analysis. The timeline representations of design process help the students to gain comprehension about their own design process. This design course also explores the creativity of the freshmen.

T PAPER

### 6.7.2 AN ANALYSIS OF INSTRUCTIONAL DESIGN FOR STUDENTS OF EDUCATIONAL TECHNOLOGY IN TERTIARY INSTITUTIONS IN NIGERIA

EDEM NTUK

National Association of Educational

Media and Technology

This analysis was completed in the context of an ongoing design project for 200 level students offering Educational Technology in the Public Teacher Training Tertiary Institution. I implemented a design using problem-based learner-

centered learning cycles (PBL). Analysis of Logistic Regression identified a model that analyzes the characteristics of learners in areas of pre service teachers' perceived knowledge of technology integration and technology

competencies, and independent samples T-Test to evaluate the kind of Instructional Design that can be used in teaching Educational Technology.

T PAPER

### 6.7.3 INTERPRETING STUDENTS' UNDERSTANDING OF CHOKING IN CHILDREN THROUGH WEB-BASED LEARNING EXPERIENCES

J. DOUGLAS ADLER

University of British Columbia

SAMSON NASHON

SANDRA SCOTT

JEFFREY LUDEMANN

Choking is defined for the study reported in this paper as foreign body aspiration or ingestion. This paper reports on a study in which an interactive animated website: "Be Smart ... Don't Choke <http://m2.edcp.educ.ubc.ca/dontchoke> was developed and deployed for grade 5 students to experience,

understand and interpret the meaning of choking in children. Using interview format, the students' understanding of choking before and after experiencing an animated website were probed. Analysis of the interview data revealed that the students: 1) defined choking in terms of their

own personal experience with it; 2) perceived choking in terms of eating habits and violation of good eating manners; and 3) experienced and expressed cognitive conflict between their held perceptions of choking and website experience of choking in terms of what chokes and who gets choked.



## WORKSHOP

**6.8.1 MAKING LEARNING VISIBLE IN UNDERGRADUATE RESEARCH EXPERIENCES**

SUSAN HOWITT  
Australian National University

This workshop will cover the approach and outcomes of a two year project funded by the Australian Government Office of Learning and Teaching, TREASURE (Teaching Research: Evaluation and Assessment Strategies for Undergraduate Research Experiences). Our aim in this project is to enhance learning in undergraduate research experiences (UREs) by (a) encouraging students to think

about the nature and practice of science, (b) providing an opportunity for students to reflect on the disciplinary and generic skills they are developing, and (c) assisting supervisors to provide targeted feedback by letting them know what their students are thinking. The workshop will use student learning of the nature of science as an example of the findings. If students focus on experimental results as the main

outcome of their project, they may be less inclined to see the practice of science as part of their learning. The focus on results is encouraged where the URE is part of the degree and assessed, usually, with a scientific report (as is becoming common in research-based elite degrees). We will show how structured reflective logbooks can scaffold student learning and re-focus attention on the nature and practice of science.

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## M PAPER

**6.9.1 TO ENGAGE OR NOT ENGAGE - HOW IS THE QUESTION!**

PAMELA HAGEN  
University of British Columbia

In this presentation, results, theoretical framework, and methodology are presented from a qualitative case study that utilizes the Imaginative Education theory (Egan, 1997, 2005) to

examine student engagement as a counterbalance to disengagement. The study investigated six intermediate students' perspective of learning during a shape and space unit of mathematics. Through

combining affective responses and imagination, stepping stones were provided to increase engagement and the development of cognitive understanding.

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M PAPER

### **6.9.2 USE OF GENETIC DECOMPOSITIONS TO SCAFFOLD THE DEVELOPMENT OF A STRUCTURALLY SEQUENCED CURRICULUM FOR MATHEMATICS ACCELERATION**

DAVID NUTCHEY  
Queensland University of  
Technology

EDLYN GRANT

TOM COOPER

The authors have collaboratively used a graphical language to describe their shared knowledge of a small domain of mathematics, which has in turn, scaffolded their re-development of a related curriculum for mathematics

acceleration. This collaborative use of graphical language is reported as a simple descriptive case study. This leads to an evaluation of graphical language's usefulness as a tool to support the articulation of the structure of mathematics

knowledge. In turn, implications are drawn for how the graphical language may be utilized as the detail of the curriculum is further elaborated and communicated to teachers.

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M PAPER

### **6.9.3 TRIGGERING WHAT YOU HAVE: BRICOLAGE AS A MATHEMATICAL WAY OF THINKING FOR MIDDLE SCHOOL STUDENTS**

ALAYNE ARMSTRONG  
University of British Columbia

This naturalistic case study investigates the problem posing patterns, that emerge as four small groups of Grade 8 students in the Lower Mainland of British Columbia work collectively on a structured mathematics task. Bricolage is characterized as a mathematical style of thinking, particularly for middle school students who have limited experience with mathematics, and do not have a large variety of algorithms at

their fingertips, nor exposure to formal proofs. The results show how, although the groups share common experiences and resources, each group follows very independent paths in terms of what they choose to draw on and what path they develop as they work towards a solution. Bricolage, is an emergent process through which groups define the boundaries of their understanding of the task, and then pose problems

that push these boundaries in order to explore and develop possible solutions to the task. As group work is necessarily public, with members striving to share their understandings and ideas with each other, observation of collective behavior can provide an indication of how the negotiations involved in the process of bricolage proceed.



## SHOWCASE

**7.1.1 PREPARING STEM-CENTRIC ELEMENTARY TEACHERS**

ELISSA HOZORE

Maryland State Department of  
Education

Participants will engage in a content-rich integrated STEM-centric lesson while examining tools and techniques which guide the development, implementation and assessment of STEM-centric elementary classrooms. In Maryland, STEM is used as a vehicle for delivery of deep and integrated content instruction. Resources will be shared that have

been developed for statewide professional development and teacher preparation programs to guide teachers and teacher candidates in creating STEM-centric classrooms. One of Maryland's priorities is to enhance the STEM preparation, and aptitudes of elementary and early childhood teachers. Maryland was the first state to develop certification

in elementary school STEM for both pre-service and practicing teachers as well as to develop STEM Standards of Practice. The resources developed to support the implementation of preparation programs and the STEM Standards of Practice will be explored while engaging in an integrated STEM activity.

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E PAPER

### **7.2.1 FEMALE ENGINEERING STUDENTS' EXPERIENCE WITH STEREOTYPE THREAT: A NARRATIVE INQUIRY**

STACIE GREGORY  
Uah State University

Due to the social context of engineering classrooms, the dearth of females in engineering may be attributed to stereotype threats (STT). Literature is replete with examples of the contributing role of STT to learning and performance decrements for stigmatized students in highly evaluative situations. Over 300 empirical studies exist illustrating the deleterious effects of STT on students' performance and persistence. However, the acceptance of stereotype threat as more than a laboratory phenomenon, necessitates an in-depth, authentic understanding

of how stigmatized groups experience being socially devalued and negatively stereotyped. This study utilizes narrative inquiry, a qualitative research method devoted to exploring what meaning people construct of life's events. Data from semi-structured interviews and journal reflections is triangulated to capture how female engineering students experience STT. What meaning this stigmatized group constructs of the events which trigger STT, in addition to situations which protect them from it, is analyzed thoroughly. The voices of these students offer reliable data that will lead to more

impactful intervention strategies to offset the detrimental effects of STT. This study lays the foundation for the creation of online video modules for engineering courses facilitated by gender and culturally relevant role models and designed in environments with identity-safe physical cues. Given the current trend in online learning and the increased interest in "flipping the classroom," such videos could potentially be implemented into engineering classrooms and serve as interventions to increase the persistence of female students in engineering education.



E PAPER

**7.2.3 MEASURING UNDERGRADUATE ELECTRICAL AND COMPUTER ENGINEERING PERCEPTIONS OF THEIR ENGINEERING COMPETENCE - AN OVERVIEW OF A SURVEY DEVELOPMENT PROCESS**CHRIS CAMPBELL  
University of British Columbia

STEVEN WILTON

ANDRE IVANOV

This paper describes the development of a survey instrument to measure undergraduate student perceptions of their competence with respect to 12 engineering graduate attributes (Engineers Canada, 2012) at the University of British Columbia's Electrical and Computer Engineering (ECE) department. These attributes are defined as disciplinary knowledge (e.g., knowledge base, problem analysis, design) and non-technical knowledge, skills, and dispositions (e.g., individual/teamwork, professionalism, impact of engineering on society/the environment). This survey is to be used by ECE to understand the

coverage of the graduate attributes that their undergraduates perceive they have achieved, which will inform curriculum improvement efforts and the current accreditation process. The survey development process is described: Item generation, first survey piloting (n=183), item refinement/reduction, second survey piloting, and replication/final validation (Hinkin, 1998). Validity evidence collected for the first survey draft is: i) internal consistency ( $\hat{\alpha}$ ) of 0.966, ii) three factors extracted account for 47% of variance, iii) three factors extracted have internal consistencies of 0.944, 0.923, and 0.909, and iv) the item-total

correlations of the items ranged from 0.388-0.709. The second pilot of a revised 42-item survey in early 2014 (n=200+) is expected to garner additional validity evidence (AERA, APA, & NCME, 1999): Based on improved response processes, improved internal structure, and hopefully corroboration with other data sources. The finalized survey instrument and the validity evidence garnered from its development will be presented. A separate paper proposed for this conference will present the findings from the final survey piloting and discuss their relevance to curriculum improvement and accreditation.

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S PAPER

### 7.3.1 FACILITATING SCIENCE METHODS THROUGH AN INQUIRY FOCUSED APPROACH

J. DOUGLAS ADLER  
University of British Columbia

SANDRA SCOTT

This paper discusses a study which examined how elementary science methods instructors integrated inquiry focused themes into existing course experiences. Following a practitioner-inquiry

research design, data was collected through researcher observations of student and instructor experiences, during an elementary science methods class. The study's findings were used to develop

a model for a science methods course that incorporates trans-disciplinary themes, and ways of knowing that align with the inquiry-focused goals of the UBC teacher education CREATE programme.

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S PAPER

### 7.3.2 THE PRACTICE OF INQUIRY-BASED TRAINING MODE ON PROMOTING PRIMARY SCIENCE TEACHERS' TECHNOLOGY AND ENGINEERING LITERACY IN CHINA

XIA FAN  
Education Center for "Learning by  
Doing" Science Education Reform  
Pilot Program

ZHAONING YE

Science, Technology, Engineering and Mathematics (STEM) education plays an essential role in promoting innovation and socio-economic growth. However, in many parts of the world, STEM education is seriously lagging behind. Specifically, STEM education in China is still in pedagogical practice state, a beginning stage, and lacking of teaching resources, shown especially in primary schools. Therefore, it is necessary

to cultivate more excellent teachers who are responsible for STEM curriculum design and developing resources. This paper firstly gives a brief description of STEM and its importance. Then, we point out the difficulties in carrying out STEM education in China. To remit this situation, the inquiry-based training mode is introduced, which can promote primary science teachers' Technology and Engineering Literacy in China, by

showing a vivid example used in the National Science Teachers Training Program called "LED Change! Change! Change!". The last part, some effective strategies will be suggested in this inquiry-based teachers training mode.



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E PAPER

### **7.4.1 THE DISJUNCTURE OF LEARNING AND RECOGNITION: CREDENTIAL ASSESSMENT FROM THE STANDPOINT OF CHINESE IMMIGRANT ENGINEERS IN CANADA**

HONGXIA SHAN  
University of British Columbia

To better recognise foreign qualifications, many OECD countries have promoted liberal fairness epitomised by universal standards and institutional efficiency. This paper departs from such a managerial orientation towards recognition. Building on recognitive justice, it proposes an alternative anchoring point for recognition practices: the standpoint or everyday experiences

of immigrants. This approach is illustrated with a qualitative study of the credential recognition practices of the engineering profession in Canada. From the standpoint of Chinese immigrants, the study identifies a disjuncture between credential recognition practices and immigrants' career stage post-migration. Taking this disjuncture as problematic, it further pinpoints recognition issues such as

redundancy and arbitrariness, a narrow focus on undergraduate education, and a deficit view of training from other countries. While some of these issues may be addressed by improving administrative procedures, others demand a participatory space allowing immigrants to become partners of assessment, rather than merely its objects.

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E PAPER

### **7.4.2 CASE STUDY OF CHINA'S ENGINEERING EDUCATION MODEL AND EMPLOYMENT IN STEM OCCUPATIONS**

LIJUI XU  
Tsinghua University

This paper aims at analyzing China's engineering education model and employment in STEM occupations and providing relevant development strategies. By means of careful field observations, in-depth interviews and case study, the problems and suggestions of China's engineering education have

been shown. The facts and findings lead to the following conclusions: Expanding STEM interdisciplinary courses and reforming curriculum settings; improving teacher's STEM practical ability and replenishing STEM teachers; focusing more on professional practice embraced with STEM occupations closely and

deepening cooperation between universities and enterprises; giving full play to the characteristics of engineering industry; strengthening subject consciousness of industry-university-research alliance; enhancing engineer's society status and building regional innovation system.





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S PAPER

### **7.5.1 PRE-SERVICE TEACHERS AND THEIR BELIEFS ABOUT TEACHING AND LEARNING SCIENCE: THE IMPACT OF A SCIENCE METHOD COURSE ON SCIENCE TEACHING EFFICACY**

JACINTA PETERSEN  
Curtin University of Technology

Science in the Australian elementary school context can be described as being in a state of renewal with the recent implementation of the Australian Curriculum: Science and the corresponding development of curriculum resources. Despite this curriculum renewal, the results of elementary students in science have remained static. Science in Australia has been identified as one of the least taught subjects in the elementary school curriculum. The role of the teacher, therefore,

is paramount, and teacher self-efficacy in teaching science is significant in order to understand the motivation to teach science in the primary school context. Social cognitive theory and self-efficacy have been explored widely in the area of science education, and this proposal outlines the implications of this research for science teacher education. Research has explored the impact that tertiary education and practical experience, including the role of the science teacher educator and mentor teacher,

can have on preservice teachers, in relation to either increasing or calibrating science teaching efficacy beliefs. Longitudinal research that explores science teaching efficacy is significant due to the correlation between teaching self-efficacy and performance. This paper will present initial findings from this longitudinal research relating to how preservice teachers perceive the teaching and learning of science before and after the completion of a science methods course.

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S PAPER

### **7.5.2 BECOMING A SCIENCE TEACHER - THE DEVELOPMENT OF PRE-SERVICE TEACHERS IDEAS ABOUT TEACHING THROUGH AN INQUIRY BASED APPROACH**

LOUISE SUTHERLAND  
University of Sydney

There has been a paradigm shift taking place in science education from more didactic teacher centered strategies to more student-centered inquiry pedagogies as illustrated by The Australian National Curriculum: Science. Teachers' understanding of the nature of science (NoS), their beliefs about student learning and teaching all impact on their

pedagogical approach. This paper reports on initial results of a longitudinal study into the role teachers' previous experiences, their knowledge about the NoS and beliefs about teaching and learning play in the development of their approaches to the teaching of science. A case study that describes the beliefs and experiences of pre-service teachers in their first year of

teacher education will be presented and compared. Particular attention will be given to the interactions between competing sets of beliefs about the nature of science, and teaching and learning held by the individuals, and how these may hamper the practice of teaching science through inquiry based instructional methods.



S PAPER

**7.6.1 HOW TO MAKE THE CLASSROOM MORE ACTIVE: THE TYPES AND FEATURES OF SILENCE IN ELEMENTARY SCIENCE CLASSROOM**JIYEON NA  
Seoul National University

JOON-YOUNG CHOI

JINWOONG SONG

Nation's future is connected with the effectiveness of science, technology, engineering, and mathematics education. In this context, STEM education is often considered a way that determines whether the country is able to solve its problems. However, many students are reluctant to enter schools of natural science or engineering, and similar phenomena are observed in Korea. While Korean students attain a high level of scientific academic achievement in international comparison studies such as PISA

and TIMSS, their attitude, interest, self-contentment, and preference related to science are low. They also maintain a silence and do not actively interact with teacher or students during science lessons. Hence, the purpose of this study was to investigate and identify the types and features of silence in science classroom. In the first part, researches related to silence in education and communication fields were reviewed. In the second part, a classroom of fourth-grade in an elementary school was observed for two weeks. The data

were collected through interviews and observation. It was found that students' silence is caused by various internal and external factors such as students' grade, development level, gender, race, class, cultural background, and social class. This study investigates types and features of science classroom silence through science classroom observations. The researchers hope that this study helps science educators who are concerned with students' active participation in science class.

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S PAPER

### **7.6.2 CHANGES IN TEACHERS' BEHAVIOUR IN SECONDARY SCIENCE EDUCATION: IMPLEMENTING A STANDARDS-REFERENCED NATIONAL CURRICULUM**

CARMEL DIEZMANN  
Australian Catholic University

There is substantial attention worldwide to the quality of secondary school teaching in STEM in Education. This paper reports on the use of Outcome Mapping (OM) as an approach to guide and monitor change in teacher practice and a visual tool, shaped as a Star, to benchmark and monitor this behaviour. OM and the visual tool were employed to guide and document three

secondary teachers' behaviour as they planned, implemented and assessed a science unit in the new Australian standards-referenced curriculum. Five key outcome markers in the teachers' behaviour were identified together with progress markers "cumulative qualitative indicators" leading to these outcomes. The use of a Star to benchmark and track teachers' behaviours was particularly

useful because it showed teacher behaviour on multiple dimensions simultaneously at various points in time. It also highlighted priorities in need of further attention and provided a pathway to achievement. Hence, OM and the Star representation provide both theoretical and pragmatic approaches to enhancing quality in STEM teaching.



S PAPER

**7.6.3 THE ENRICHMENT OF STEM EDUCATION: A PRACTICE OF INQUIRY INSTRUCTION AND EDUCATIONAL TECHNOLOGY**XINXIN FAN  
University of Queensland

DAVID GEELAN

WEI LIANG

The purpose of the study was to assess Year 10 students' conceptual understanding, inquiry skills, and confidence in learning after participating in a technology-supported inquiry learning intervention in physics education. Inquiry instruction has been considered as a hallmark of science education and it is also regarded as a key learning approach in other STEM fields. This study reported the effects of the use of inquiry

instruction using computer-based interactive simulations in physics classrooms. We used pre and post tests of conceptual understanding, pre and post surveys of students' development of inquiry skills and pre and post surveys of student confidence to collect data and measure changes in students' conceptual understanding, inquiry skills and confidence in learning. The results revealed statistically significant gains ( $p < .01$ ) in

conceptual understanding, inquiry skills and confidence in learning by students in the experimental group when compared with their peers in the control group. Moreover, results of the study also indicated that female students in the experimental group significantly improved their confidence in learning and increased their concept knowledge of selected topics.

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S PAPER

### **7.7.1 ESD (EDUCATION FOR SUSTAINABLE DEVELOPMENT) AND DISASTER PREVENTION IN JAPAN:AFTER THE 2011 OFF THE PACIFIC COAST OF TOHOKU EARTHQUAKE**

TATSUYA FUJIOKA  
Shiga University

This presentation will survey the coastal inland seas of Japan, focusing on “environment” and “disaster” as keywords for considering the future of the relationship between the natural environment and human activity. The 2011 off the Pacific coast of Tohoku Earthquake gave us a big shock. However, in Japan, 1995 Hyogo-ken Nanbu Earthquake had a great impact on the science education. In addition, we have experienced several serious natural disasters from 1996 to 2010. In this paper, we noted that

the disaster occurred just before the new national curriculum in Japan would start, and lately, United Nation have presented with education for disaster prevention. Especially, we should take notice of the significance of International Strategy for Disaster Risk Reduction (ISDR) and Hyogo Framework for Action (HFA) which cooperated with Education for Sustainable Development (ESD). The history of the Japanese archipelago can be viewed as the history of its coastal waters. Entirely surrounded by the sea, Japan has one of the longest

coastlines of any country in the world, despite its relatively small land area. Moreover, it is valid to consider her coastal waters and rivers as a single unit. This paper begins with a description of the natural environment of the disaster-prone Japanese archipelago. Next, it discusses science and technology, environmental problems and environmental education within the framework of the historical environment and sociocultural veins that were shaped by that environment and natural history.



S PAPER

**7.7.2 THE CHARACTERISTICS OF STEAM PROGRAM OF CLIMATE CHANGE ISSUE THROUGH PBL (PROJECT BASED LEARNING) APPROACH**YOUNG-SHIN PARK  
Chosun UniversityJONGWON PARK  
HYO-SUK RYUHAE-AE SEO  
YOUNGMIN KIM

The purpose of this study was to provide exemplary STEAM education by developing STEAM program with the application of a few theories which the researchers assume are useful and by implementing it to the classroom with the help of a teacher who is STEAM expert. The researchers developed the STEAM program with the content of climate change by PBL approach and implemented it into the SMARTCLASS. The results of this study were as follows; first, the STEAM program of climate change consists of three stages explicitly and implemented successfully in

the smart class room. Second, five components of STEAM program has been communicated explicitly, interdisciplinary, and successfully. Third, STEAM program of climate change developed the explicit learning objectives which students need to meet to be scientific literate citizen. Overall, students' responses were very positive to science learning through STEAM education according to objectives indicated above. In conclusion, first of all, there needs to be flexible curriculum to be implemented into the classroom. The curriculum of STEAM education must be

considered to be run flexibly as the combination of science class and creative experiential activity at schools. Second, we need to produce the STEAM expert to run program successfully by providing teacher professional development program. Third, STEAM education must be run as the unit of community based science learning. Lastly, there need to be more support for 'smartclass' where teachers could run the STEAM program effectively and successfully.



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SYMPOSIUM

**7.8.1 INTEGRATED PROJECT-BASED CURRICULUM INNOVATIONS IN BIOLOGICAL SCIENCES  
AND SCIENCE EDUCATION AT SIMON FRASER UNIVERSITY**

ALLAN MACKINNON  
Simon Fraser University

CINDY XIN  
LYNN QUARMBY

IVONA MLADENOVIC  
SHAWN BULLOCK

This symposium session consists of four presentations based on curriculum and pedagogical innovations at Simon Fraser University involving active learning strategies, integrated project-based learning, and interdisciplinary studies in the sciences, and in science education. The presenters represent SFU broadly, from the Faculties of

Science and Education and from a university-wide Teaching and Learning Centre (TLC). The projects discussed in the symposium included a flipped classroom project in first-year calculus; a team-based learning project in second-year biochemistry and molecular biology; an on-line journal for first-year biology students' research into applications of biology to their

everyday lives; and an integrated, interdisciplinary minor "Science, Technology, Society, Environment" program for intending secondary school teachers. Each of the four presentations will discuss the rationale, challenges, successes and lessons learned in developing and implementing these program innovations at SFU.

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M Paper

**7.9.1 ON INSTRUCTOR EXPERIENCES IN THREE FLIPPED LARGE MATH UNDERGRADUATE COURSES**

CINDY XIN  
Simon Fraser University

JAMIE MULHOLLAND  
VESELIN JUNGIC

HARPREET KAUR

This is a study of instructors who undertake the flipped classroom pedagogy and how it impacts instructional practice in terms of material preparation, classroom delivery and interactions with the students, time commitment and their changing role as teachers. Qualitative data were collected through weekly after-class debriefs with instructors, extensive classroom observations throughout the semester, and end-

of-semester instructor interviews. These were supplemented by data collected from surveys of students' perceptions of their flipped classroom experience. Our findings include: Significant time investment, technical skills, and planning are required of instructors to produce decent quality video lectures that students would watch and perceive as beneficial for their learning; preparing for in-class activities also requires

a great deal of time and effort; instructors' view of the importance of covering content is replaced by that of uncovering the content so that students are able to apply concepts in solving problems; preparing clicker questions that address conceptual understanding is critical in our model of flipped classroom; the changed role of the instructors in the flipped classroom is both challenging and invigorating.



S PAPER

**8.1.1 ANALYZING UNDERGRADUATE STUDENTS' ATTITUDES AND BELIEFS ABOUT PHYSICS:  
INFLUENCE OF GENDER AND YEAR OF STUDY**ALEXANDRA MACDONALD  
University of British ColumbiaMARINA MILNER-BOLOTIN  
JAMES CAROLAN  
HEATHER FISHERSAMSON NASHON  
SANDRA SCOTT

Today's society is heavily dependent on knowledge and innovation in science, technology, engineering and mathematics. Despite the importance of these fields, females have remained a minority in physical sciences programs and careers. This gap in participation is particularly evident in physics, where only 21% of B.Sc. degrees are awarded to women each year. Numerous attempts have been made to address this issue, yet the gender gap persists. Factors such as stereotypes, peer

expectations, assessment type, and learning environment have been identified to impact female and male students differently. This study explores one of these factors - undergraduate students' attitudes and beliefs about physics - by analyzing quantitative data collected from 2008-2013 at a large Canadian research university. The Colorado Learning Attitudes about Science Survey (CLASS) was administered to students enrolled in first, second, and fourth year physics courses during this period.

This study will analyze student responses to explore how their attitudes differ by gender and by year of study. This analysis will provide important insights into the attitudinal characteristics of undergraduate students at various stages of their physics programs. This information will help educators develop a deeper understanding of the current states of affairs in postsecondary physics departments, opening the door for dialogue about making the field more inclusive.

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S PAPER

### 8.1.2 EXPLORING GRADE 6 GIRLS' ATTITUDES AND INTEREST IN STEM

ISHA DECOITO  
York University

STEPHANIE FLORENCE  
DANIELLA DI LUCIA

PHILIP MYSZKAL  
TASHA RICHARDSON

The under-representation of women in STEM fields has its origins in early grades, since the supply pipeline for university graduates in science and engineering begins early on in elementary school, when children are exposed to and formulate opinions about mathematics and science. Self-efficacy studies in STEM maintain that girls' confidence in their academic abilities drops dramatically from elementary to high school. This decline is particularly significant in girls and young women's belief in their math

and science abilities. If confidence is in decline starting from the transition from elementary school to secondary school, there comes a point where intervention needs to take place in order to maintain the female student population on the STEM educational track. This paper focuses on data collected as part of a larger mixed-methods study exploring the impact of outreach workshops on students' attitude and interest in STEM education. Preliminary findings from S-STEM surveys indicate that no remarkable differences were

observed in gender comparisons across attitude and interest in science, science career aspirations, and science self-efficacy scales. However, in terms of math and engineering scales, findings indicate that grade 6 girls are less likely to be interested in math and engineering than boys. The findings are statistically significant with boys scoring higher than girls on the math and engineering interest scales. This data will be triangulated and elaborated upon at the STEM conference.



## S PAPER

**8.1.3 A LOOK AT STUDENT ATTITUDES AND MEASURED PERFORMANCE AFTER A NEW STEM INITIATIVE'S FIRST YEAR**THOMAS MEAGHER  
Owatonna Public Schools

This study explores how students perceive learning after completing the first year of a new K-8 STEM initiative in a rural public school system in the Midwestern United States. This study emphasizes survey data collected from over 500 students' enrolled in grades 4-7 at three different school buildings. Findings from this study investigate students' perceptions of their abilities at science, math, engineering, collaborative learning, and innovation. This survey tool attempts to gauge how students perceive their own learning through the lenses of access and equity

of STEM teaching and learning. Results from this study break down data by gender and ethnicity and compare how students of major ethnic groups perceive STEM learning. Lastly, standardized test performance from the same year is used for triangulation of how students performed on external assessments after one year of being enrolled in a public STEM school. This study is the first phase in developing a long-term longitudinal study of the impacts of STEM teaching and learning on students of major ethnic groups and gender. Pearson Chi-

square analysis of scaled survey responses demonstrate significant differences in student attitudes towards science and engineering careers delineated along lines of gender and ethnicity. Students show positive attitudes towards the academic fields of science, engineering, math or classroom collaborative learning, but follow with lower positive views of future careers in STEM fields. Standardized test results also demonstrate significant differences in student performance among major ethnic groups across students in this study.

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## WORKSHOP

**8.2.1 USING SCRATCH TO TEACH ROBOTICS ENGINEERING AND MULTIMEDIA GAME DESIGN**MARK LOCKETT  
Southport School

What would happen if you were to build a LEGO model and use it to control a 'Sprite' in a computer game? This 2 hour workshop uses the LEGO Wedo Robotic system

and the multimedia programming language Scratch. Participant will build a simple LEGO model that incorporates a tilt and distance sensor. The LEGO model can then

be used to control a computer game sprite in a 'Frogger' style game.

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SHOWCASE

**8.3.1 STEM 'FOUNDATIONS': DIMENSIONS OF SCIENCE LEARNING IN EARLY CHILDHOOD**

JANE KLOECKER  
American Museum of Natural  
History

ILANA APRIL  
CAITLIN COE

NATALIE TAHSLER

As many have observed, young children's powers of observation and persistent curiosity are well suited for inquiry into the natural world. Research suggests that an early start in science - especially when linked with parent involvement - establishes a foundation for later learning in school and beyond. There is urgent demand to offer high-level programs for early childhood, in order to provide a foundation for children's lifelong interest in STEM and to foster a more engaged and

scientifically literate citizenry. But what do we mean by the word "foundation"? What does it look like? Compared to science education for older children, science education for the early years remains relatively unexplored territory. Drawing upon fifteen years of experience engaging the youngest learners and their families, this presentation will examine the premise of STEM "foundations." The Science and Nature Program at the American Museum of Natural History offers weekly classes to children ages 3

through 11. Distinctive features of the program include direct parent participation, multiple sessions, hands-on investigations, and explorations of Museum halls. Our presentation will showcase age-appropriate curriculum - reflecting the Museum's scientific disciplines - that encourages the development of scientific "habits of mind." Using a range of assessment methods, we will provide insight into the dimensions of early childhood science learning.



## WORKSHOP

**8.4.1 LOST IN TRANSLATION: CONNECTING BIOLOGISTS AND MATHEMATICIANS TO FURTHER UNDERGRADUATE STUDENTS' QUANTITATIVE SKILLS**

DEBORAH KING  
University of Melbourne

KAREN BURKE DA SILVA

KELLY MATTHEWS

Modern biology has become an increasingly quantitative science, involving large amounts of data analysis. Graduates with skills in mathematics, statistics and computer science are in desperate demand across all fields of bioscience, including molecular biology, bioinformatics, ecology, medicine and biotechnology. However, there is increasing concern, shared by educators and employers alike, about the mathematical proficiency of life sciences students, particularly at the undergraduate level. To address these deficiencies,

undergraduate science curricular reform efforts have focused on building students' quantitative skills; that is, the ability of students to apply mathematical and statistical thinking and reasoning in a science context. However, emerging research has revealed numerous challenges inherent in collaborative, cross-disciplinary curriculum reform. One such challenge is the language barrier between mathematicians and life scientists, which inhibits a shared understanding of required content and desired learning outcomes. Facilitated by a cross-disciplinary

academic team, this interactive workshop will articulate some key problems encountered in subject development, and explore models for cross-disciplinary approaches to enhance life sciences students' mathematical capacity, including the dissemination of unit syllabi developed by the authors and curricular models from a national quantitative skills in science project. Participants will engage in discussion, share relevant experiences, and gain access to resources.

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G PAPER

### **8.5.1 BUILDING A COMMUNITY OF LEARNERS WITHIN THE STEM HIGHER EDUCATION CLASSROOM**

SHAUN NYKVIST  
Queensland University of  
Technology

MICHELLE MUKHERJEE

Building rich and authentic learning experiences in the STEM classroom, is a challenge for many educators within Higher Education. While many Higher Education Institutions have embraced the need to transform current teaching and learning practices and include a range of online tools, this has often been met with some resistance and approaches that do not always recognize the academic who are a critical component to the success of the transformational process. Over the last decade the Internet

has evolved from being a tool used by a few dedicated educators to one that is being used by the majority of educators. However, what is important is how this great resource is used in teaching and learning to allow students to build knowledge. The ability for students to construct knowledge and engage in higher order thinking skills is at the heart of educational practices, and building a community of learners has the potential to support these practices, especially within STEM education. This paper

explores the relationship between students and an academic teaching in a technology rich STEM learning environment and their adoption of social community and shared tools. In particular the paper reports on the critical components that make a successful community of learners and the educational tools and approaches that were successfully used to enhance the student learning experience in a STEM classroom.



T PAPER

**8.6.1 101 TECHNOLOGY FUN: EMPOWERING GIRLS AS TECHNOLOGY INNOVATORS AND ENTREPRENEURS**PJ RUSNAK  
University of British Columbia

Although today's girls are the most avid technology users of any generation, they are significantly under represented in its creation and innovation. Academic and industry research from the past 30 years documents that many girls are continuing to distance themselves from technology fields, careers, symbolism, and ideologies (AAUW, 2000; Ashcraft, Eger & Friend, 2012; DuBow, 2011; Hafkin, 2006; Turkle, 1988; Wajcman, 1998, 2004). This means that girls are not developing the confidence, literacies, and tools that are necessary to fully benefit from

and participate in advancing our technologically dependent society. Hence, the design-based research setting of this study, a "101 Technology Fun" summer camp, was created by the How We Learn (Media and Technology Across the Lifespan) team to offer girls a confidence-building environment for exploring the power of technology through hands-on design, invention, and imagination. Thirty co-researchers (girls ages 10 to 13) participated in the "girls only design studio" (University of British Columbia campus) with exciting learning labs in game design,

movie making, and robotics. Co-researchers were supported in their roles as technology designers to create and solve real-world design problems; to take risks and experiment with new ideas; and to pursue their technology-related interests in entrepreneurial and sustainable ways. Findings offer successful strategies for engaging girls as the makers and innovators of technology on their own terms not merely as consumers, child-users, or "surrogate boys or men" (Farmer, 2008; Kearny, 2006).

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M PAPER

### **8.6.2 CHALLENGES IN EMBEDDING NUMERACY THROUGHOUT THE CURRICULUM IN THREE QUEENSLAND SECONDARY SCHOOLS.**

MERILYN CARTER  
Queensland University of  
Technology

KLENOWSKI VALENTINA  
CHRISTINA CHALMERS

PETA-ANNE MCNAUGHT  
MALCOLM CARTER

The new Australian Curriculum and national standardized testing have placed the teaching of numeracy across the curriculum at the forefront of what Australian schools must do. However, it has been left to schools to determine how they do this. Although there is a growing body of literature giving examples of pedagogies that embed numeracy in various learning areas, there are few studies of cross-curricular numeracy from the management perspective. This paper responds to the research question: How do selected Queensland secondary schools interpret and apply the Australian Curriculum requirement

to embed numeracy throughout the curriculum? A multiple case study design was used to investigate the actions of the senior managers and mathematics teachers in three large secondary schools located in outer Brisbane. The numeracy practices in the three schools were interpreted from a social constructivist perspective. The study found that in each school key managers had differing constructions of numeracy that led to confusion in administrative practices, policy development and leadership. The lack of coordinated cross-curricular action in numeracy in all three schools points to the

difficulty that arises when teachers do not share the cross-curricular vision of numeracy present in the Australian Curriculum. The managers identified teachers' commitment, understanding, or skills in relation to numeracy as significant barriers to the successful implementation of numeracy in their school. Adoption of the Australian Curriculum expectation of embedding numeracy across the curriculum will require school managers to explicitly commit to initiatives that require persistence, time and, most importantly, money.



## WORKSHOP

**8.7.1 INSPIRING MATHEMATICS AND SCIENCE IN AUSTRALIAN TEACHER EDUCATION:  
MAKING CONNECTIONS ACROSS DISCIPLINARY CONTEXTS**MERRILYN GOOS  
University of Queensland

KIM BESWICK

TRICIA FORRESTER

In this workshop participants will interpret the preliminary outcomes of an Australian project that is developing new interdisciplinary approaches to mathematics and science pre-service teacher education. They will also provide feedback on the transferability of the project's intended outcomes to international contexts. The aim of the project is to foster enduring collaborations between university-based education, mathematics, and science academics in order to prepare teachers who have a contemporary and dynamic view of

the STEM disciplines. To this end, the project seeks to institutionalize new ways of integrating the content and pedagogical expertise of STEM academics and mathematics and science educators to enrich three key stages in the preparation of teachers: Recruitment into teaching careers, participation in the pre-service program, and continuing professional learning following graduation. The six participating universities are collaborating to develop, test, and evaluate the following approaches: (a) recruitment

and retention strategies that promote teaching careers to undergraduate mathematics and science students; (b) innovative curriculum arrangements that combine authentic content and progressive pedagogy to construct powerful professional knowledge for teaching; (c) approaches by which universities can build long term relationships with teacher education graduates, enabling them to continually renew their professional and pedagogical knowledge of mathematics and science.

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T PAPER

### 8.8.2 DOES USABILITY ENGINEERING MATTERS FOR STEM EDUCATION?

TONY SAHAMA  
Queensland University of  
Technology

ANDRE KUSHNIRUK

ELIZABETH BORYCKI

Technological maturity and the exponential growth of digital applications are contributing to lifestyle changes worldwide. Consequently, learning and teaching is demanding more effective sociotechnical interactions involving emerging technologies, as opposed to traditional, conventional face-to-face learning and teaching approaches. In this context, usability engineering is making significant contributions for improving computer and distance-based learning, both for learners and instructors, which have often been ignored when designing online learning and teaching

applications. Usability testing is a central part of the human centered learning approach for developing sustainable STEM education from the socio-technological perspective. Our experiences with usability engineering and the impact of teaching low-cost rapid usability testing methods on knowledge translation from undergraduate to graduate courses to real-world practice (i.e. getting the methods out there in real use) are diverse and multi-modal. Our sample space has been hundreds of trained students who have learned how to do effective usability engineering in real-world

situations at higher levels of realism (i.e. fidelity) and at a much lower cost than using traditional fixed usability labs. Furthermore, this low-cost rapid approach to usability engineering has been adopted by many of our graduates who are now managers, CIOs etc and who are using the methods routinely in their organizations in real world applications and scenarios. This knowledge has been used to improve design and implementation of a wide range of applications, including applications designed for teaching and learning.



## S PAPER

**8.8.3 DIALOGICAL PRACTICES IN STEM CLASSES: THE CASE OF A BEGINNING TEACHER**

JAMES WATTERS  
Queensland University of  
Technology

CARMEL DIEZMANN

Beginning teachers tend to adopt styles of teaching that they themselves experienced. For career change teachers who left their own classrooms many years ago, their memories of teaching practices may often be at odds with contemporary approaches. In this study, we followed a beginning teacher who had changed from an information technology career to teach middle school. His subject

matter knowledge was strong and hence his focus was on implementing effective pedagogical practices. We followed his evolving teaching expertise over three years focusing on his communicative practices informed by socio-cultural theory. His practices exemplified a non-interactive dialogical communicative approach where ideas were readily discussed but were concentrated

on the class acquiring acceptable scientific understandings. His focus on the language of science was a significant aspect of his study and one that emerged from his professional background. The study affirms the theoretical frameworks proposed by Mortimer and Scott (2003) highlighting how dialogue contributed to heightened student interest in STEM.

## M PAPER

**8.9.1 MATHEMATICS WORKSHEETS: THE LANGUAGE OF THE TEXT**

OZLEM DENIZ  
University of British Columbia

Worksheets are dominant elements of mathematics education with profound effects on pedagogy (Mousley, 2003). While worksheets play a vital role as teaching and learning tools, there have been very few systematic attempts to investigate this generic form of schooling (i.e. Gerofsky, 2012). As part of the broader research project, this paper explores author's own creation of worksheets through an action research/self-study where demonstrating a reflective practice

is critical in her teacher-researcher role (Whitehead & McNiff, 2006). By the aid of linguistic approach (Morgan, 1996), she revisits her teaching philosophy (values) and her practice around worksheets; and attempts to understand the possible contradiction between two (Argyris et al., 1985). In this paper, self-study not only has the capacity to improve personal practice but also to contribute to the efforts to better understand the place of worksheets in mathematics education. In return, the inquiry

of mathematics worksheets has been a way to understand a self-study through a language analysis of a curriculum text material. The findings of this study may shed light into our understanding of the textual and contextual features of worksheets. This may, consecutively, raise awareness among educators to revise their practices of creating and using worksheets, and ultimately, improve mathematics education.



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M PAPER

### **8.9.2 A MODEL FOR AN OPEN-ENDED TASK-BASED APPROACH IN GRADE 11 MATHEMATICS CLASSES**

RADLEY K MAHLOBO  
Vaal University of Technology

In the experimental school, where the author intervened by introducing an open-ended approach to teaching mathematics (by means of giving the learners an open-ended approach compliant worksheet to work on throughout the intervention period), the performance of the learners in the post-test was better than that of the learners from the control

school. Both schools were of similar performance in the pre-test. The two schools wrote the same pre-test and same post-test. Both schools were following common work schedule. Within the experimental school, post-test performance of the learners in the monitored experimental class (where the intervention was monitored throughout the

intervention period, thus ensuring compliance of the teacher to the open-ended approach) out-performed those in which monitoring was less frequent (unmonitored experimental group). There was no significant difference in performance between learners from the unmonitored experimental class and those from the control class.

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M PAPER

### **8.9.3 "ARE THERE ANY WINNERS IN HIGH STAKES TESTING IN MATHEMATICS?"- AN INVESTIGATION INTO THE IMPACT OF HIGH STAKES TESTING ON THE TEACHING AND LEARNING OF MATHEMATICS IN AUSTRALIAN PRIMARY SCHOOLS**

LINDA CRANLEY  
University of Notre Dame

In 2008, the National Assessment Program - Literacy and Numeracy (NAPLAN) commenced in Australian schools. Every year, all students in years 3, 5, 7 and 9 are assessed on the same days using national tests in numeracy. The results are reported nationally through summary and national reports. An individual report is provided to parents and caregivers for each student. The results show student's achievements against a national average and school scores are posted on My School

Website. The aim of the testing is to compare results of each cohort, over a two year period. The testing of mathematical standards across the nation, through the annual implementation of NAPLAN, invokes many questions about the potential that high stakes testing has for academic reform. The role of the teacher is instrumental in the results children achieve through high-stake testing. This presentation will report on whether instructional pedagogy has been affected by the implementation

of high stakes testing and the publication of results. The purpose of the investigation is to seek perspectives of NAPLAN on key stakeholders. These stakeholders have been identified as parents, teachers and children. This investigation will summarise the impact that this mandatory implementation of national testing in all Australian primary schools has had on the attitudes and pedagogies of the teach.



## WORKSHOP

### 9.1 AN AUSTRALIAN SOLUTION TO STEM EDUCATION USING LEGO EDUCATION RESOURCES

MARK LOCKETT  
Southport School

Robotics is a great way to get students excited about science, technology, engineering, and math (STEM) topics. Studies show that it is highly effective in developing sequential and logical thinking, team-work and self-confidence. Robotics is all about the future. We live in a complex world of big problems which need courageous, talented young people to help tackle them. The activities outlined in the presentation will highlight the open ended nature of LEGO

Technology courses. These Courses place the students in the position of solution-seekers. This active engagement takes its starting point from questions asked by the students themselves, thereby, building on their own initiative and interests. When students construct prototypes and models in the real world, they construct knowledge in their minds. This new knowledge allows students to build more sophisticated designs which yield yet more

knowledge, in a self-reinforcing cycle. Robotics is highly effective in developing students' team-work and self-confidence. Constructing collaboratively extends student learning. Solutions that we create together are generally better than those we create as individuals. In addition, the presentation will outline how the courses combine Art Costa's "Habits of Mind" to enhance students' communication, team work and social justice.

## WORKSHOP

### 9.2 THE REFRAMING MATHEMATICAL FUTURES RESEARCH PROJECT- ADDRESSING THE EIGHT-YEAR GAP IN MATHEMATICS LEARNING IN JUNIOR SECONDARY SCHOOLS

DIANNE SIEMON  
RMIT University Australia

The Reframing Mathematical Futures project is a priority project funded by the Australian Government under the auspices of the Australian Mathematics and Science Partnerships Program (AMSPP). The project is aimed at improving student outcomes in relation to multiplicative thinking and proportional reasoning in Years 7 to 9 so necessary for future success in school mathematics and subsequent STEM career opportunities. It is particularly

targeting those students whose future would otherwise be constrained by lack of access to these critical aspects of school mathematics. Existing research-based materials developed by the presenter are being used to deepen teacher knowledge in this domain and improve responsiveness to student learning needs. These include validated assessment tasks and a research-based learning and assessment hierarchy for multiplicative thinking

that includes advice for teaching. The workshop will explore the tools and approaches being used in 28 junior secondary schools in Australia at the current time and report on the results of the targeted teaching approach to improving student mathematics outcomes and attitudes at this critical level of schooling.



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WORKSHOP

### 9.3 LIFE-CYCLE ANALYSIS OF A PRODUCT IN TEACHING SCIENCE – STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

MARIANNE JUNTUNEN  
University of Helsinki

The huge sustainability challenges of the Earth and the recent studies address the need for improved sustainability education within chemistry. The 21st century citizens need versatile and complex capabilities in their daily life e.g. system thinking skills. This workshop illustrates a teaching concept, which is collaboratively designed by chemistry teachers: an interdisciplinary, inquiry-based life-cycle thinking project. It is suitable at all school levels. The

findings imply that the teaching concept creates opportunities to reach several modern goals in chemistry education. The goals are related to students' sustainability competencies, socio-scientific reasoning skills, active citizenship, peer collaboration and environmental literacy. Furthermore, the life-cycle analysis in teaching is an effective approach to more motivating and sustainable chemistry education. The participants of this workshop

get a change to understand the strengths, weaknesses, opportunities and threats of teaching the life-cycle analysis in science education.

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WORKSHOP

### 9.4 THINKING SCIENCE AUSTRALIA - COGNITIVE ACCELERATION THROUGH SCIENCE EDUCATION (CASE). IMPROVING TEACHER PEDAGOGY AND STUDENT THINKING

SONIA HUEPPAUFF  
University of Western Australia

The teaching of 'thinking' is explicitly stated in the Australian national curriculum as a cross curricula general capability without any clear guidance of how to teach critical and creative thinking in students. Thinking Science Australia, an evidence-based intervention program, is carried out in 30 science lessons over a two-year period (ideally in Grades 7 and 8). The goal of Thinking Science through its rich pedagogy is to develop formal operational thinking in all students

regardless of their maturation or schooling. The program is designed to accelerate students' level of thinking so they are better able to cope with the demands of the curriculum and runs parallel to, but does not replace, other science lessons which give curriculum coverage. It is structured in such a way that the lessons spiral through increasing levels of complexity of reasoning patterns. The program currently involves more than 30 schools across

Australia. Data show that students make considerable cognitive gains, and teachers change their pedagogy, by allowing students to think and solve problems. In this workshop, participants will gain an understanding of what Thinking Science is all about, explore how to improve their students' thinking and take part in a Thinking Science lesson.



## WORKSHOP

**9.5 KID'S S.T.E.M. CONVENTION: INSPIRATION, INVESTIGATION, CELEBRATION**

 DAVID COLIN WILLIS  
 Queensland

The Kids' S.T.E.M. Convention, three times a State Finalist in Education Queensland's Showcase Awards for Excellence in Education (<http://education.qld.gov.au/community/events/showcase/2012/index.html>) and 2013 State winner of the Peter Doherty Science Education Partnership and Community Science Awards (<http://education.qld.gov.au/curriculum/area/science/all-stars.html>), is moving into its eighth consecutive year of operation. Highly regarded by Education Queensland, the S.T.E.M. Kids' Convention provides Middle Years students with authentic inquiry based learning experiences.

The Kids' S.T.E.M. Convention is a successful partnership project between Metropolitan Schools, the University of Queensland, industries (eg. Dell Computer, Toyota Australia, BP, Santos Energy) and local community. Students experience an exciting opportunity to extend and broaden their knowledge in Science, Technology, Engineering and Mathematics through participation in an innovative three-phase learning experience.

The objective of this workshop is to present the progressive development, refinement, processes, management and

outcomes which have enabled this unique annual learning innovation to inspire over 2,300 students since our inaugural event in 2007. Documented longitudinal tracking of participating students has proven the project's effectiveness in influencing students in the making of academic choices across the S.T.E.M. fields, thus creating future S.T.E.M. career pathways.

This workshop will practically outline how the creation of sustainable partnerships and the provision of ongoing sequentially stepped professional development for educators functions to tap student aptitudes and attitudes in S.T.E.M. education

## WORKSHOP

**9.6 AUTOMATA IN THE PRIMARY CLASSROOM- A PRACTICAL DEVELOPMENTAL APPROACH**

 ALWYN POWELL  
 STAQ Australia

This hands-on workshop provides participants with practical suggestions for introducing STEM to children in a cost effective and enjoyable manner. Discussion of the meaning of Technology syllabi in the primary school in relation to materials, tools and techniques is supported by practical

suggestions. All the resources and tools required are available locally at minimal cost and allow for maximum participation and ideation by participants.

Participants will construct their own working model in stages that explores differing concepts

of Science and Technology. Each participant will be able to use their knowledge and skills immediately to engage students in modelling and ideation.



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G PAPER

### 10.1.1 STEM AND SCIENCE FICTION COURSES

CHANGYI FU

Nanjing University of Technology

RONG ZHOU

The integration of science, technology, engineering and mathematics (STEM) in STEM education has become a mainstream topic nowadays. Science fiction has the characteristics of simulating practice and mixing together multi-disciplinary knowledge. So it is good to use science fiction courses to integrate science, technology,

engineering and mathematics, and let students understand the importance of science, technology, engineering and mathematics, and let them further learn to integrate these four things together in daily school life. Like STEM education, science fiction courses can also develop students' exploring abilities and critical thinking, let them understand the spirit

of science and technology and engineering ethics. In this case study, we use questionnaires to compare the changes in exploring ability, critical thinking as well as the understanding of scientific ethos, ethics in technology and engineering between the students having science fiction courses and those who do not.

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S PAPER

### 10.1.2 CREATING CONTEXTS FOR GENERATING PRODUCTIVE KNOWLEDGE THROUGH COLLABORATIVE ACTION RESEARCH: CASE STUDIES IN CONSTRUCTIONIST STEM EDUCATION

KAREN GOODNOUGH

Memorial University of  
Newfoundland

KEITH POWER

This study examined how K-6 teachers engaged in constructing classroom experiences for their students in STEM disciplines, as well how they constructed their own learning through collaborative action research. Teachers participated in a professional development project, Teachers in Action, focused on enhancing the science, technology, engineering, and mathematics (STEM) pedagogical

content knowledge of K-6 teachers in Newfoundland and Labrador (NL) and supporting teachers in fostering active, inquiry-based student approaches to teaching and learning in STEM subject areas. Constructionist learning theory (Harel & Papert, 1991) was adopted as a lens to understand how the teacher inquiry group constructed their professional development experiences and the

nature of the learning that resulted through this shared construction. Through qualitative case study methodology, outcomes focus on the nature of the artifacts, processes, and praxis resulting from teacher engagement in classroom inquiry and how these constructions impact their professional learning in STEM.



## S PAPER

**10.1.3 THE IMPACT OF WHOLE-SCHOOL INQUIRY-BASED TEACHER PROFESSIONAL DEVELOPMENT ON STEM ACHIEVEMENT: A CASE STUDY**MICHAEL TUTWILER  
Harvard University

Situated learning theories (Lave & Wenger, 1988) predict that students who work collaboratively in environments that are similar to the real world should experience deeper learning. To that end, the Connecticut Science Center has partnered with a local school over the course of the last four years

to provide teacher professional development designed to support an inquiry-based learning approach. This study aims to measure the impact of this teacher professional development on student achievement. Observational longitudinal analysis of Connecticut Mastery Test science

scores over a six year period (two before and four after the PD partnership started) indicates a strong positive relationship. If accepted for the conference, a regression discontinuity analysis will be conducted to quantify this impact.

## WORKSHOP

**10.2 PATHWAYS TO IMPROVING MATHEMATICS AND SCIENCE LITERACY: STEM COMMUNITY ENGAGEMENT**JO-ANNE NASLUND  
University of British ColumbiaSHAR LEVINE  
LESLIE JOHNSTONE

MARINA MILNER-BOLOTIN

The success of developed countries depends on a scientifically literate population. Despite worldwide recognition of Canada's contributions to science, technology, engineering and mathematics, a large segment of the population remains ill-informed and disengaged in these disciplines. Recent results of the 2013 OECD survey of adult skills as well as OECD PISA have shown inadequate science and mathematics performance by Canadian students and adults. To help address this problem

Canadian families and educators need to foster excellence in STEM education. Our response at the UBC Faculty of Education has been to offer two annual community events: Celebrate Science and Family Mathematics and Science Fair. Such STEM outreach activities have involved partnerships between the University of British Columbia Library, Children's Writers and Illustrators of British Columbia Society, Faculties of Education, Science, Land and Food Systems, and Beaty Biodiversity Museum. UBC scientists together

with science writers for children speak about their research, books and passions. Participants leave inspired with increased awareness of the importance of science and mathematics. At the Family Mathematics and Science Fair, prospective teachers and teacher-educators, engage families in hands-on mathematics and science activities. The presenters will offer descriptions of these programs, resource lists and insights on some of the benefits and challenges encountered.





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WORKSHOP

**10.3 CONFLICTS IN CHEMISTRY: THE CASE OF PLASTICS**

GIGI NAGLAK  
Chemical Heritage Foundation

STEPHANIE CORRIGAN

Conflicts in Chemistry: The Case of Plastics is a role-playing game developed by the Chemical Heritage Foundation (CHF) to help students understand the relevance of science in their lives. Students adopt the roles of characters representing disparate positions on plastics,

from activists to manufacturers, and engage in a debate about the positives, negatives, and conflicting perspectives on plastics. In this workshop, participants will experience The Case of Plastics for themselves. The workshop will introduce participants to the project, the results of its pilot

program, and ways they can use the program in their classrooms or in other educational environments. Participants will then be invited to play a modified version of the game. Players will adopt characters from the game and work in small groups and then discuss the experience with all participants.

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WORKSHOP

**10.4 CREATING A MAKERSPACE: USING LITTLEBITS TECHNOLOGY TO ENHANCE A LANGUAGE ARTS UNIT**

DERECK DIROM  
School District 34 Abbotsford,  
GearBots Educational Resources

In this workshop, participants will have a hands-on opportunity to integrate STEM and enhance a language arts unit using littleBits technology. Participants will learn about how the Maker Movement with a STEM focus can be an effective way to foster inquiry and the 4C's in our classrooms at all

levels. While working in engineering teams, participants will use littleBits and art supplies to animate their creations in a technological version of reader's theatre. In addition, during the workshop, participants will learn how this resource is an effective way to make explicit career literacy connections for

their student on potential post secondary pathways and career options. Web Based

Resources:  
<http://littlebits.cc/steam-resources>  
<http://www.makered.org/resources/>



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WORKSHOP

**10.5 DEVELOPING 21ST-CENTURY MINDS WITH VERNIER  
PROBEWARE**

VERNIER INTERNATIONAL INC

Developing 21st-Century Minds with Vernier Probeware: Are you preparing future science teachers for the expectations of the 21st-Century science classroom? Explore state-of-the-art probeware solutions that help teach core science topics in physics, chemistry, biology, Earth science and environmental science. Educators receive hands-on training with Vernier's new LabQuest2, LoggerPro software and the Connected Science System, and a suite of commonly used probes and sensors.

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Pre-registration is required to attend this workshop, limited to 32 participants per workshop.

The registration sheet is at the registration/information desk in ESB Lobby.

**CONFERENCE  
COMMITTEE**

CHAIR

SAMSON NASHON

FACULTY

ANN ANDERSON

DAVID ANDERSON

MARK EDWARDS

MARINA MILNER-  
BOLOTIN

SAMSON NASHON

STEPHEN PETRINA

GRADUATE  
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FU GUOPENG

WINSTON MASSAM

LATIKA RAISINGHANI

ASHLEY WELSH

CONFERENCE  
ADMINISTRATION

FIONA CZESCHEL

HEATHER MCGREGOR

PROGRAM DESIGN

JENNY VAN ENCKEVORT





## On-Campus Dining at the University of British Columbia

### Student Union Building (1)

#### Pacific Spirit Place Cafeteria M-F 7:30am-2pm

The cafeteria includes a Bake Shop, Pasta Bar, Pho Soup Bar, and Salad Bar, as well as fast food outlets A&W, Koya Japan, Manchu Wok, and Subway.

#### Blue Chip Cookies

Assorted cookies, pastries, and coffee

#### The Delly

Sandwiches, soups, curries, assorted hot and cold savory pastries, and baked goods

#### Pie R Squared

Pizza by the slice

#### The Pit Burger Bar

Variety of burgers and fries, daily burger specials

#### The Pit Pub

No. 1 bar on campus, student-friendly pricing

#### Bernoulli's Bagels

Montreal-style bagels, sandwiches

#### The Gallery

Variety of take-out or dine-in options including pasta, quesadillas, and salads

#### The Moon

Noodle and wonton soups, stir fries, and rice bowls

#### The Honour Roll

Freshly made sushi and assorted Japanese dishes

### University Village (2)

University Village has many take out and dine in options; diner-style breakfasts, coffee shops, pizza by the slice, bubble tea, a full-service sushi restaurant, a small grocer selling fresh produce and assorted goods, as well as an international food court

Blenz	Booster Juice	Mio Japan	Granville Island Produce
McDonalds	Pearl Fever Tea House	FreshSlice Pizza	One More Sushi
Only U Café	Starbucks	Pita Pit	Vera's Burger Shack
Subway	Red Burrito	Well Tea	5 Tastes Chinese Bistro

#### International Food Court

A-1 Vietnamese Food	Curry Point	Donair Town	Leona Mediterranean
Malasian Cuisine	Osaka Sushi	Timpo Mongolian BBQ	Yi Kou Xiang

### Wesbrook Village (3)

Wesbrook Village, located on south campus, offers shops, services and homes within a quaint, pedestrian-friendly setting, with access to Pacific Spirit Park and all the amenities of the UBC campus.

#### Save-On-Foods

Large grocery store with a deli and small café

#### Chef Hung Taiwanese Beef Noodle

Noodles, soups, rice dishes, and sides

#### Jugo Juice

Fresh fruit smoothies

#### Menchie's Frozen Yogurt

Frozen yogurt and sorbet bar

#### Togo Sushi

Fresh sushi made to order

#### Blenz

Coffee shop

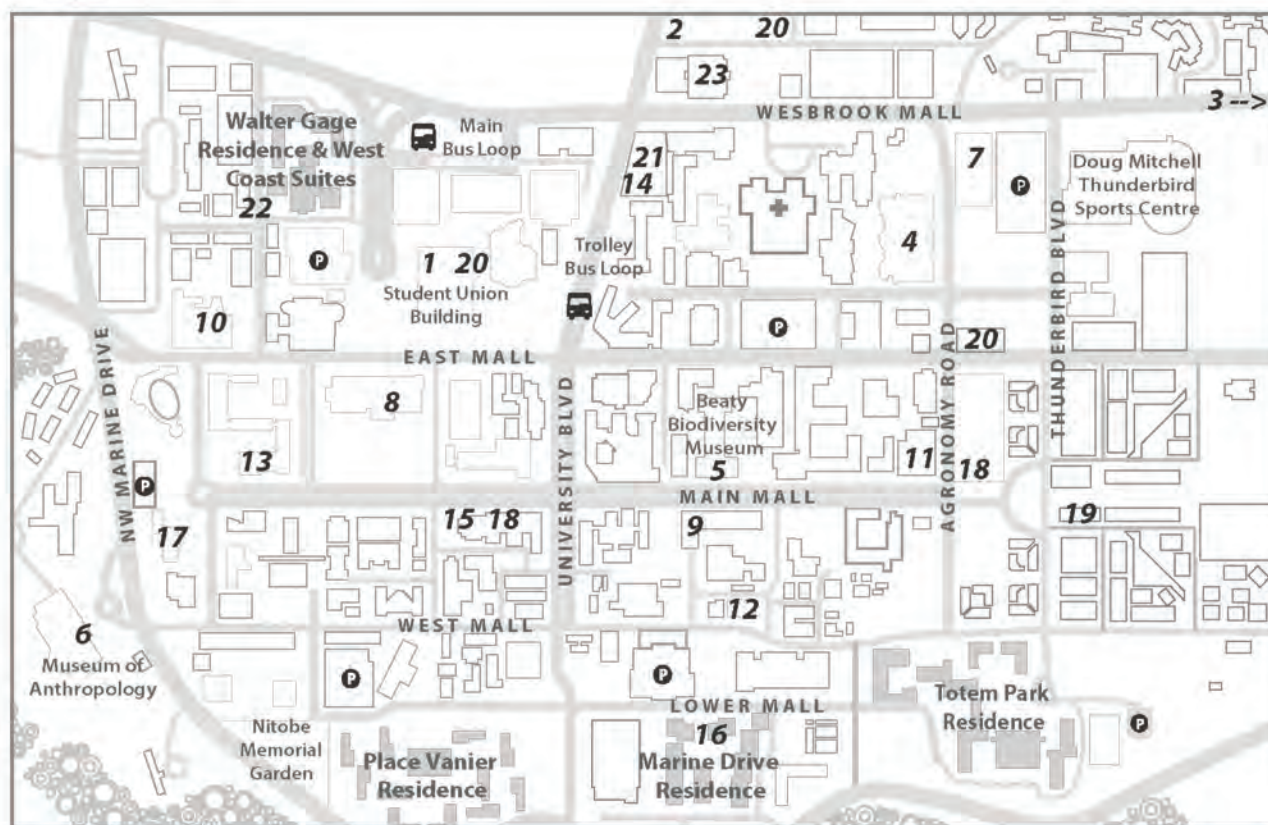


UBC Mobile App





## On-Campus Dining at the University of British Columbia



### Full-Service Restaurants

#### Mahoney & Sons Public House (14)

Irish-style pub serving salads, appetizers, pizzas, and a sampling of classic pub fare

#### Triple O's (15)

Dine in or take out - breakfast sandwiches, beef, chicken, and veggie burgers, and milkshakes

#### The Point Grill (16)

Burgers and sandwiches, salads, local seafood, and an outdoor patio to enjoy the sun

#### Sage (17)

Healthy, modern West Coast cuisine paired with breathtaking views.

### Coffee Shops

Tim Hortons (18)

Bean Around the World (19)

Starbucks (20)

The Boulevard Coffee Roasting Co (21)

Great Dane Coffee (22)

The Well Café (23)

### Quick-Service Cafés

These cafés, located in convenient spots across campus, offer a range of snacks and lunch items, including soups, sandwiches, salads, and a variety of hot dishes.

Caffe Perugia (4)

Niche Café (5)

Café MOA (6)

Pharmacy Café (7)

Ike's Café (8)

Magma Café (9)

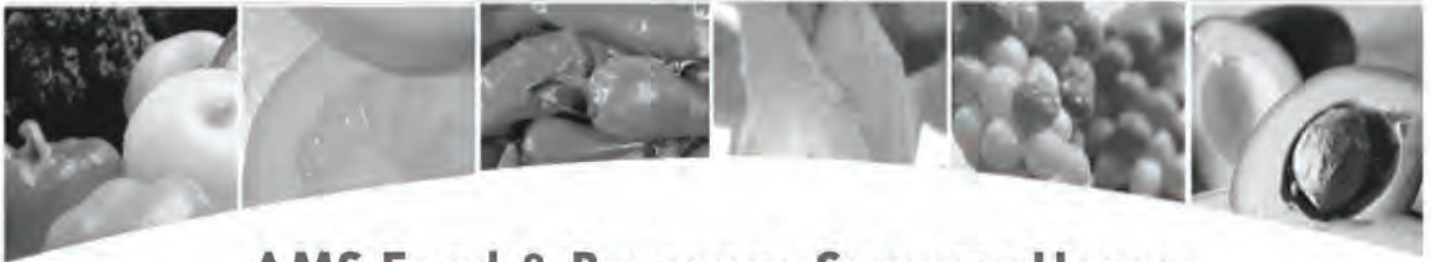
Law Café (10)

Reboot Café (11)

The Loop Café (12)

Stir It Up Café (13)





## AMS Food & Beverage Summer Hours

at the Student Union Building, UBC, Vancouver (May 1- Aug 31)

The AMS features a variety of food outlets all under one roof and conveniently located at the heart of campus. Almost everything is made from scratch right on the premises. Our coffee is organic fair trade, our eggs are from a cage free facility and much of our produce is sourced locally. For full menus, check out our website [www.ams.ubc.ca](http://www.ams.ubc.ca) under businesses. Purchase meal tickets for your group to use at any of the eight AMS Food outlets (and the Patio BBQ operating Monday to Friday, weather permitting!). You can set the maximum value of the meal tickets and we will reimburse you for any unredeemed tickets that you return.



### BLUE CHIP COOKIES

Proudly serving organic, Fair Trade coffees, cappuccinos & lattes since 2003. All our cookies & fabulous baked goods are made in-house and baked fresh every day.

Mon - Fri 7am - 7pm  
Sat/Sun 9am - 3pm  
604.822.6999

### THE HONOUR ROLL

Maki rolls, nigiri, sushi, Donburi rice bowls, bento boxes are made fresh throughout the day. Ask about our party platters and catering.

Mon - Fri 10am - 5pm  
Sat 10am - 3pm  
Sun CLOSED  
604.827.5589



### BERNOULLI'S BAGELS

Montreal style bagels made fresh daily on the premises. Great sandwiches, Calzones, Pizza Pretzel and more.

Mon - Fri 7am - 2pm  
Sat 10am - 3pm  
Sun CLOSED  
604.822.8806

### THE Gallery Restaraunt & Lounge MUST BE 19+

Excellent breakfast, salads, pasta, quesadilas and delicious desserts. Lots of vegetarian and vegan dishes. Unbeatable drink prices, fast service and an unbeatable atmosphere. Eat in or take out.

Mon-Fri 9am - 3pm  
OPEN FOR BRUNCH Sat 10am - 4pm  
Sun CLOSED  
604.822.4508



### THE MOON NOODLE HOUSE

Great wonton, daily specials, fresh steamed veggies, combos, hot and sour soup

Mon - Fri 11am - 5pm  
Sat/Sun CLOSED  
604.822.3164



### THE PIT PUB

Satellite big screen sports, 6 high definition TVs, Unbeatable drink prices and a great atmosphere!

Tues - Fri 3pm-10pm  
Sat 4pm-11pm  
Sun/Mon CLOSED  
604.822.6511

### THE PIT PUB BURGER BAR

Charbroiled hamburger specials, veggie burgers, hot wings, beer battered fish & chips and more  
\*no trans fats used in our frying!

Mon - Sat 11am - 9pm  
Sun CLOSED  
604.822.6511



### OutPost/Canada Post Outlet

Mon - Fri 9am - 5:30pm  
Sat 11am-4pm  
Sun CLOSED  
604.822.6272 (Outpost)  
604.822.8196 (Post Outlet)

### PIE R SQUARED

Great pizza slices, great prices, cold drinks

Mon/Sun 11am - 9pm  
604.822.4396



**Need Catering?** For catered events or meals on the go, AMS Catering offers a multitude of menu ideas to meet every occasion, and a range of dietary needs. We pride ourselves on our knowledgeable and friendly staff, professional service and quality ingredients.

For more information on meal tickets or catering, please visit [www.ams catering.com](http://www.ams catering.com) or contact us at:

Phone: 604-822-4617 [catering@ams.ubc.ca](mailto:catering@ams.ubc.ca)

The Student Union Building (SUB) is located at 6138 Student Union Boulevard  
at the University of British Columbia, Vancouver





# Summer 2014 HOURS

[www.food.ubc.ca](http://www.food.ubc.ca)

**Welcome!** UBC Food Services provides a wide range of sustainable, affordable and nutritious food options to our community. We are known for our excellent service, skillful food preparation and our environmental commitment.

Locations listed below are open between May 5 to September 1. Hours subject to change, visit [food.ubc.ca](http://food.ubc.ca) or [m.ubc.ca](http://m.ubc.ca) for current information, full listings and descriptions.

## Restaurants

The Point Grill at Marine Drive, Building #4	11:00am – 10:00pm	Daily	Brunch: 11:00am – 3:00pm Wkn
Sage at the University Centre	11:30am – 2:00pm	M-F	
Triple-O's at David Lam Research Centre	11:00am – 7:00pm	Daily	

## Eateries

Pacific Spirit Place at Student Union Building			
Bakeshop	7:30am – 2:00pm		M-F
Pasta Bar	10:00am – 2:00pm		M-F
Salad and Soup Bar	11:00am – 2:00pm		M-F
Subway	8:30am – 7:00pm	M-Th	6:00pm F
A & W	7:30am – 3:00pm		M-F
Breakfast Buffet	6:45am – 9:00am	Daily	May 11 to August 26
Caffè Perugia at Life Sciences Centre	7:30am – 4:30pm	M-Th	4:00pm F
Ike's Café at Irving K. Barber Learning Centre	9:00am – 5:00pm		M, Th, F
	9:00am – 7:00pm		T, W
Hungry Nomad	11:00am – 2:00pm		M-F
Mercante	8:00am – 5:00pm		M-F
The Loop Café at CIRS	9:00am – 2:00pm		M-F
Tim Hortons at Forest Sciences Centre	7:00am – 6:00pm		M-F

## Cafes

Café MOA	10:00am – 4:00pm	Daily	2:00pm M 8:00pm T
	10:00am – 4:00pm	Daily	8:00pm T (starting May 20)
Neville's at Scarfe	7:45am – 2:45pm		M-F (June 23 to August 8 only)
Niche Café at Beaty Biodiversity	11:00am – 3:00pm		M-F
	12:00pm – 4:00pm		Weekends & Holidays
Stir It Up at the Buchanan	7:30am – 2:30pm		M-F (June 16 to August 8 only)
Sauder Exchange Café at Henry Angus	8:00am – 3:00pm		M-F
Tim Hortons at David Lam Research Centre	7:30am – 4:00pm		M-F
Starbucks Coffee at SUB	7:00am – 7:00pm	M-Th 6pm F	8:30am – 3:00pm Sat
Starbucks Coffee at Fred Kaiser	7:00am – 3:30pm		M-F
Starbucks Coffee at UBC Bookstore	Opening soon!		

Summer conference catering by Wescadia: for information please contact 604-822-2018 or visit [catering.ubc.ca](http://catering.ubc.ca)



FAIRTRADE  
CANADA

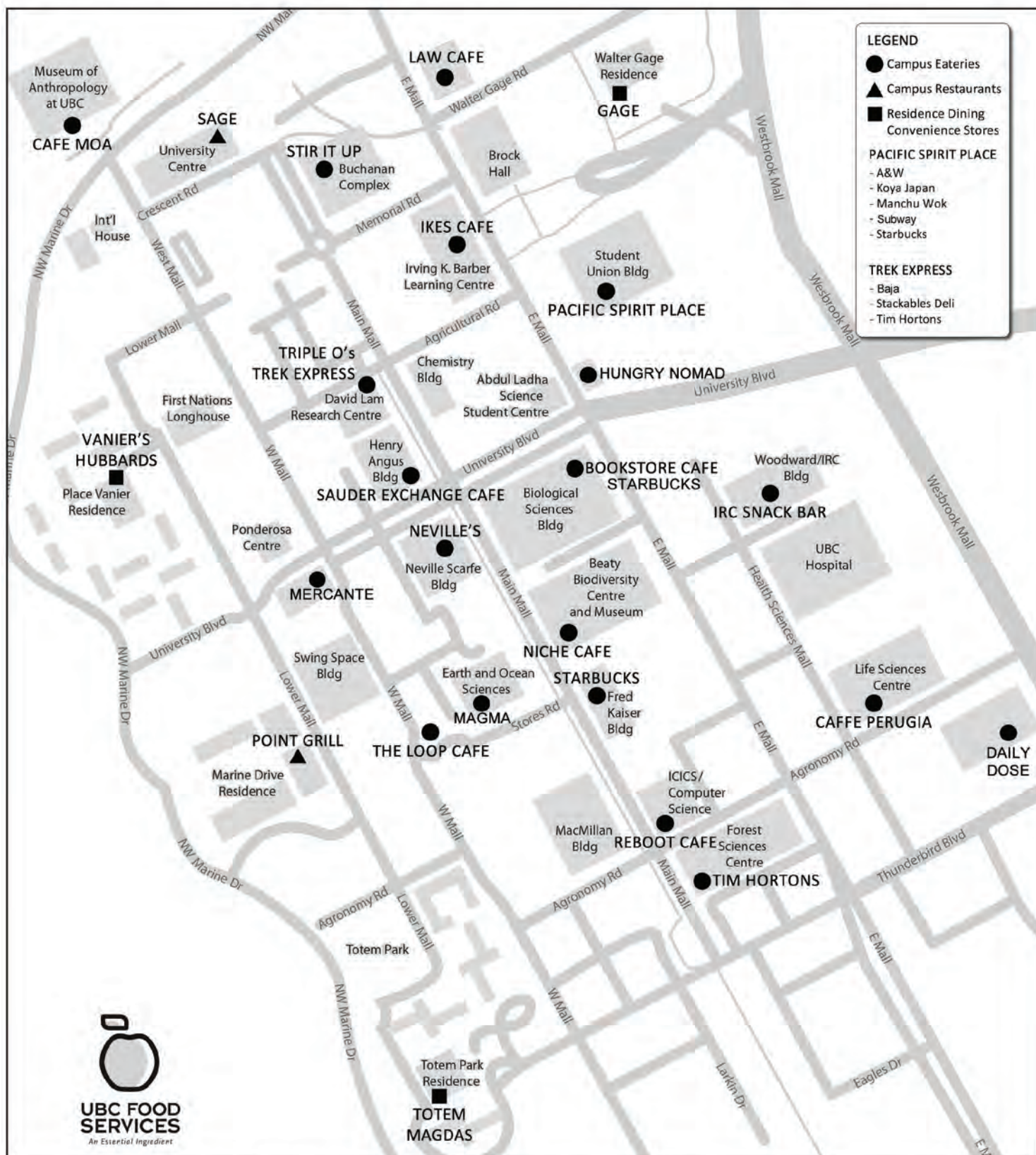


UBC Food Services—Committed to a Sustainable Campus. We are Canada's first Fair Trade campus, our seafood is Ocean Wise™ certified, and we feature fresh produce from our very own UBC Farm. Find out more @ [www.fairtrade.ca](http://www.fairtrade.ca) | [www.sustain.ubc.ca](http://www.sustain.ubc.ca)



# FIND A RESTAURANT NEAR YOU

## UBC Food Services Campus Dining Locations



Hours subject to change, please visit [food.ubc.ca](http://food.ubc.ca) or [m.ubc.ca](http://m.ubc.ca) for current hours of operation

# NOTES

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