SIMON FRASER UNIVERSITY
SUMMER INTERSESSION 2009

EDUC 454-4
MEASUREMENT AND EVALUATION IN ENVIRONMENTAL EDUCATION
(E100)

David Zandvliet
604-802-0036
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Lower Mainland (F/Sa/Su, May 8/9/10; 15/16/17; Jun 12/13/14)
Harbour Centre Room 1505
Friday - 4:30-8:20 pm
Saturday - 8:30-4:20
Sunday - 8:30-4:20

PREREQUISITE
EDUC 401/402 (or permission from the instructor)

COURSE DESCRIPTION
The focus will be on integrating mathematical, scientific and socio-cultural methods and processes of learning across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply approaches to environmental education that are situated in the practices of environmental scientists and social scientists through modelling, simulation and evaluation.

COURSE OBJECTIVES
In this course students will :
- Explore the ways mathematical thinking impacts environmental curriculum and instruction;
- Participate in a stewardship training workshop / authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine different approaches to environmental education research;
- Design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.

REQUIREMENTS
Students will complete the following course assignments and will be graded on a Pass/Fail basis:
- Attend an information session prior to the course start date (to be scheduled April 21, 2009)
- Develop lesson plans for the educational use of EE resources (mathematical reasoning focus)
- Develop a strategy for Environmental Education at the classroom, school or district level
- Prepare a portfolio of their own design that may include aspects of all of the above plus demonstrates a mastery of concepts and experiences component to the course

COURSE READINGS

Readings will be provided from a variety government, on-line sources and current education journals. There will be no textbook, however there is an *activity fee of $200 dollars* to cover Fieldtrip and retreat expenses. Students should also budget a small amount for copying.

NOTE

A mandatory information session is scheduled for Tuesday April 21st (time and location TBA)

Simon Fraser University
Faculty of Education
Special Topics Proposal Form

1. Course Number: ______ST 3xx_________ Credit Hours_______4______
Vector: ________SEM___________
Semester to be offered:
____________________________Summer 2009______________________
Title of Course : Measurement & Evaluation in Environmental Education

NOTE: Maximum length of course title is 34 characters due to scheduling restrictions.

Measurement and Evaluation

Description of Course:

The focus will be on integrating mathematical, scientific and socio-cultural methods and processes of learning across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply approaches to environmental education that are situated in the practices of environmental scientists and social scientists through modelling, simulation and evaluation.

Prerequisite(s) (or special instructions):
60 credit hours, including 6 credits in Education (Students may not receive credit for both 3xx and 452).

2. Objectives (including a statement of how the course is embedded in a theoretical/cognitive/interpretive intellectual framework):

Objectives

Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.

- Identify and explore the ways mathematical thinking impacts environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;

- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.
-

3. Rationale for course offering (reason why course is needed):

This course is drawn from ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

4. Faculty who were consulted/involved in the development of the proposal:
David Zandvliet

5. Budgetary and Space Requirements (for information only)
What additional resources will be required in the following areas:
Faculty: Sessional instructors (no additional expense as will be fulfilling demand / load for Q requirement)
Staff: no additional staff required
Library: no additional resources expected
Audio Visual: none required
Space: no additional space required
Equipment: no additional space required
Funds: any additional field expenses to be reimbursed by students

6. Bibliography: See attached.
If you require more space, please attach additional page(s).

7. List of student assignments to be completed and any other expectations of students:
See attached course outline.

8. Description of student assessment and grading procedure:
Grading: Pass/Fail

9. Please attach a course outline (expecting the course to pass):
Attached.

10. Please send the instructor's curriculum vitae (if other than tenure track faculty)

11. Signatures of Approval
Proposed By: ______________________________

Supportive Faculty Member:

____

Date: ______________________________________

UPC, Chairperson: ______________________________________

Synopsis of Plan for Environmental Ed Course with Q designation
Course: *Environmental Education: Cross-Curricular by Nature*
Under development - By J. M Young

Rationale
The rationale for the course is drawn from ecoolgical and systems thinking critiques of the compartmentalisation of knowledge into separate subject areas. Thinkers which inform this thinking include David Bohm, Fritjof Capra, William Doll and David Orr. The course is intended to allow students to explore and practice the integration of subject matter through the context of environmental education.

Content
The focus will be on integrating curriculum, thus it will be inclusive of mathematical, scientific and socio-cultural methods of learning about our world. In keeping with these epistemic roots, students will experience and apply approaches to environmental education which are situated in the practices of environmental science.

First, students will participate in the first four modules of the Streamkeepers Training Program, which provides stream assessment and monitoring training. From this, students will develop activities and unit plans that can be used with K-12 students. They will then develop activities and unit plans based on different environmental science practices which they will identify and research.

Complementing this focus on the practice of environmental science and teaching, students will critically analyse environmental education research with a focus on the tools used to conduct that research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / unused in environmental education research. Students will be expected to develop their own mini-action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach the can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Q Course Requirements
The course will qualify as a Q course by including quantitative (numerical, geometric) reasoning. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential." This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education

Examples of Q components of course activities:

The Streamkeepers Training Program includes the following mathematical applications:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);

- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 (m/sec x m^2 x 0.8);
- reading charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of numbers of insects and taxa in samples.

Other environmental education activities will include mathematical applications such as:
- Calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and calculating the length of time till the landfill is full with increases in recycling and composting;
- Calculating the environmental costs of driving to school versus taking transit or walking;
- Given the amount of garbage created by a restaurant over 4 days, identifying the pattern, determining the algebraic equation associated with it and use it to figure out the garbage creation in one year.

The analysis and creation of research tools and methodologies will require:
- Interpreting empirical / statistical information;
- Evaluating the use of particular quantitative methodologies in environmental education research;
- Creating tools for the collection of empirical data and planning methods for analysis

(Some) Objectives
Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.
- Introduce students to the epistemological roots of ecological thinking;
- Identify and explore the ways ecological thinking impacts curriculum and instruction;
- Participate in the Pacific Streamkeeper's Training Program so as to experience an authentic environmental assessment which includes science, mathematics and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical research project that explores an environmental education practice.

Possible Assignments
Group cross-curricular unit plan development
Cross-curricular unit plan development
Mini-action research proposal
Paper: critique of environmental education research
Paper: rationale for cross-curricular environmental education

Educ~~4XX~~3XX: Measurement and Evaluation in Environmental Education

Rationale

Cross-Curricular

The overall rationale for the course is drawn ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

Focus on Mathematics

The more specific focus on the mathematical dimensions of environmental education grows from studies which have described the positive results achieved in programs that integrated mathematics with other subject areas. Findings have shown small but positive achievement increases in both mathematics and science for students participating in programs which integrate these two subject areas (Hurley, 2001). There is also evidence to suggest that students demonstrate greater enthusiasm, engagement and enjoyment in classrooms where mathematics and science have been integrated (Austin, Hirstein & Walen, 1997 as cited in Hurley, 2001; O'Neal, 1995 as cited in Hurley, 2001; Reeder & Moseley, 2006). Similarly, studies have shown that students' engagement in the study of mathematics was increased by integrating it with other subject areas such as dance (Werner, 2001).

Although there is plenty of evidence to suggest that the integration of mathematics with other subject areas can have a positive impact on student engagement and achievement across subject boundaries, teachers may not be trying to integrate subject content in their classrooms. One reason may be that teachers feel they have inadequate content knowledge to integrate curricula (Lehman, 1994, as cited in Basista & Mathews, 2002). Another possibility, specific to the case of mathematics, is that their ideas about teaching and learning mathematics may be "deeply rooted" and "largely shaped by their own experience in mathematics classes that offered traditional instruction": that is, separate from other subject areas, teacher centred, decontextualised, and without argument or ambiguity (Schram & Rosaen, 1996, p.26). As Basista and Mathews (2002) contend

> *If teachers have not experienced this integration of science and mathematics, they are unlikely to teach integrated curricula in their classrooms* (p.359).

This course offers pre- and in-service teachers the opportunity to (re)discover their knowledge of mathematics and practice ways that it can be integrated into their teaching through the context of environmental education. It is an opportunity to encourage and prepare new and practicing teachers to make mathematics an integral language in the discourse of environmental education.

Community Partnerships: Situating Learning in Place

Woodhouse and Knapp (2000) describe place-based education as having the following characteristics:

- It emerges from the particular attributes of a place
- It is inherently multidisciplinary
- It is inherently experiential
- It is reflective of an educational philosophy that is broader than "learn to earn"
- It connects place with self and community

In keeping with these principles of place-based education, this course will include a partnership with a local community environmental NGO (non-governmental organisation) through which students will engage in the practice of environmental stewardship situated in their local community. Many environmental NGO's offer workshops in environmental science in order to train volunteers to act as stewards in their local natural communities. Such workshops will allow student teachers to learn the skills and practices of environmental science and to apply them in data collection, monitoring and evaluation. This kind of experiential learning gives students a deeper understanding of the principles and practices of environmental science which will inform their teaching practice.

As well as modelling the kind of community partnership possibilities that they may want to develop in their teaching practice, working with local environmental NGO's in the course will give pre- and in-service teachers the opportunity to develop relationships with local groups who are working in the field of environmental stewardship.

3XX

Educ~~4XX~~: Measurement and Evaluation in Environmental Education

Course Outline

Content

The focus will be on integrating mathematical, scientific and socio-cultural methods and processes of learning across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply approaches to environmental education which are situated in the practices of environmental scientists and social scientists through modelling, simulation and evaluation.

First, students will participate in a community based environmental stewardship training program.

British Columbia environmental organisations which offer either professional development for teachers or stewardship training, and who could act as community partners, include:

- Pacific Streamkeepers Federation: Streamkeepers Training Program, stream assessment and monitoring
- British Columbia Wildlife Federation: wetland stewardship workshop, which includes mapping, conducting plant and bird inventories, and sampling soils
- Georgia Straight Alliance: "Straitkeepers" training, learning to use the Intertidal Quadrat Studies tool
- Hecate Strait Streamkeepers Society: creek restoration and monitoring
- WILD BC: A variety of workshops for K-12 educators

Following their participation in environmental stewardship training, students will develop activities and unit plans that can be used with K-12 students. They will then develop activities and unit plans based on different environmental science practices which they will identify and research.

Complementing this focus on the practice of environmental science and teaching, students will critically analyse two areas of environmental education which are key to their own practice: environmental education programs and resources and environmental education research. In keeping with the focus on mathematics as enhancing and enriching the study of the environment, students will examine programs and research in order to identify and evaluate their use of quantitative tools and mathematical reasoning.

Students will identify and analyse environmental education programs and resources. Specifically, students will evaluate the extent and quality of mathematical language and reasoning within the resources. Individually and together, students will determine ways to modify or add to the resources as necessary, with particular attention paid to appropriate mathematics curricula (IRPs).

They will also focus on the tools used to conduct environmental research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / unused in environmental education research. Students will be expected to develop their own mini-action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach they can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Q Course Requirements

The course will qualify as a Q course by focusing on quantitative (numerical, geometric) reasoning within environmental science and education. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential" (SFU, 2008). This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education including the use of scientific and mathematical inquiry as a pedagogical model.

Examples of Q components of course activities:

In class and stewardship training activities will include mathematical applications such as:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);
- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 (m/sec x m^2 x 0.8);
- reading gauges and charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of numbers of insects and taxa in samples (measures of biodiversity).
- calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and calculating the length of time till the landfill is full with increases in recycling and composting;
- calculating the environmental costs of driving to school versus taking transit or walking;
- given the amount of garbage created by a restaurant over a number of days, identifying the pattern, determining the algebraic equation associated with it and using it to figure out the garbage creation in one year.

- calculating individual, family and school eco-footprints. Comparing calculating tools eg. MEC, Earthday.org, Redefining Progress, etc.

The analysis and evaluation of environmental education programs and resources will require:
- identifying mathematical concepts and structures in environmental science and environmental education;
- evaluating the quality of curricular connections within inter-disciplinary environmental education programs and resources
- modifying or adding mathematical analysis and/or reasoning to existing programs or resources

The analysis and creation of research tools and methodologies will require:
- interpreting empirical / statistical information;
- evaluating the use of particular quantitative methodologies in environmental education research;
- creating tools for the collection of empirical data and planning methods for analysis

Objectives

Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.
- Identify and explore the ways mathematical thinking impacts environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.

Suggested Course Readings and Resources

British Columbia K-12 Integrated Resource Packages (IRPs). http://www.bced.gov.bc.ca/irp/irp.htm

British Columbia Wildlife Federation. http://www.bcwf.bc.ca/

Caduto, M.J. & Bruchac, J. (1989). *Keepers of the earth: Native stories and environmental activities for children.* Saskatoon: Fifth House Publishers.

Correlation between global average temperature and number of pirates. http://www.venganza.org/

Canadian Journal of Environmental Education

Environmental Learning And Experience: An interdisciplinary guide for teachers. (2007). British Columbia Ministry of Education. Available at: *http://www.bced.gov.bc.ca/environment_ed/*

Environmental Education Research, Volume 12 Issue 3 & 4. Researching education and environment: retrospect and prospect.

ESLEI (Environmental Science Learning Environment Inventory). In Henderson, D.G., Fisher, D.L. & Fraser, B.J. (1998). Learning Environment, Student Attitudes and Effects of Students' Sex and Other Science Study in Environmental Science Classes. Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).

Freedman, B. (2007). *Environmental science: A Canadian perspective.* Toronto: Pearson Education Canada.

Georgia Strait Alliance. http://www.georgiastrait.org/

Green Teacher: Education for Planet Earth. Magazine for K-12 Educators

Mason, Adrienne. (1991). *The green classroom.* Markham, Ontario: Pembroke Publishers.

Marcinkowski, T.C. (2004). Monograph 1 - Using a Logic Model to Review and Analyze an Environmental Education Program. NAAEE (North American Association For Environmental Education) Publications.

Pacific Streamkeepers Federation. http://www.pskf.ca/

Ravindranath, S. & Premnath, S. (Eds.). (1997). *Biomass studies: Field methods for monitoring biomass.* New Delhi: Oxford & IBH.

Sierra Club, British Columbia. http://www.sierraclub.bc.ca/

SOLEI (Science Outdoor Learning Environment Inventory). In Orion, N., Hofstein, A., Tamir, P. & Giddings, G.J. (1998). The development and validation of an instrument for assessing the learning environment of outdoor science activities. *Science Education, 81*(2), pp. 161 - 171

Stocker, D. (2006). *Math that matters.* CCPA Education Project.

References

Basista, B. & Mathews, S. (2002). Integrated science and mathematics professional development programs. *School Science and Mathematics 102*(7), pp.359-370.

Capra, F. (1982). *The turning point: Science society, and the rising culture*. New York: Simon and Schuster.

Hurley, M.M. (2001). Reviewing integrated science and mathematics: The search for evidence and definitions from new perspectives. School Science and Mathematics 101(5) p. 259-668.

Orr, D. W. (1994). *Earth in mind: On education, environment, and the human prospect.* Washington, DC: Island Press.

Reeder, S. & Moseley, C. (2006). Oh deer! Predator and prey relationships: Students make natural connections through the integration of mathematics and science. *Science Activities 43*(3), p. 9-14.

Schram, P.W.& Rosaen, C.L. (1996). Integrating the language arts and mathematics in teacher education. *Action in Teacher Education 18,* p. 23-38.

SFU (Simon Fraser University). (2008). What is a Quantitative/Analytical course? Retrieved 30 April, 2008 from http://www.sfu.ca/ugcr/For_Students/WQB_Requirements/Quantitative/

Werner, L. (2001). Arts for academic achievement. Changing student attitudes toward math: using dance to teach math. Teacher Guide prepared for The Minneapolis Public Schools. Full Text available from ERIC online at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1b/92/85.pdf

Woodhouse, J.L. & Knapp, C.E. (2000). Place-based curriculum and instruction: Outdoor and environmental education approaches. ERIC Digest. Full Text available on-line from ERIC at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/b4/43.pdf

WILD BC. http://www.hctf.ca/wild.htm

Zandvliet, D.B. (2007). Learning environments that support environmental learning. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, Louisiana, 2007.

Suggested Assignments

- In class quantitative assignments and exercises (see examples above)
- Cross-curricular unit plan development with significant mathematics component
- Project: Critical examination of environmental education program or resource with focus on extent and quality of mathematical component. Suggested additions or modifications.
- Mini action-research proposal: evaluating environmental education practice

Sent to Susan Rhodes Sept 11/08 posted

Q-COURSE CERTIFICATION REQUEST

Thank you for your interest in planning and offering a Quantitative/Analytic (Q) course. Quantitative/Analytic courses will help meet Simon Fraser University's commitment to the education of undergraduate students as defined by the new curriculum. This form is intended to:

- determine whether proposed or existing courses meet the Q criteria;
- estimate the number of Q seats available to students;
- assist faculty to think through the elements of a Q course

This form is divided into TWO sections:

Section I requests instructor, program and course information;
Section II requests detailed course content information.

Please contact Susan Rhodes at slrhodes@sfu.ca or Local 3312 if you have any questions about completing this form. Completed forms can be sent either electronically to the email address above or through campus mail to Susan Rhodes, Curriculum Office, VP Academic.

Course Title: Measurement and Evaluation in Environmental Education

Course # (if known): Education 454

Is the course (double-click the applicable box, select "checked" from the Default Value and click "OK"):

- ☒ a new course?
- ☐ a modification of an existing course that has not been taught as a Q course?
- ☐ a course that has previously been piloted as a Q course?
- ☐ an existing course that fulfills the Q criteria for certification?

To be considered, this form must be approved by the Chair/Director of your program and by the Associate Dean of your Faculty. Please have them sign off as noted below, or send an email confirmation to slrhodes@sfu.ca

Chair/Director: Paterson Date approved:

Associate Dean: Date approved: Sept 11/08

Section I

INSTRUCTOR/PROGRAM INFORMATION

Name of Instructor(s): David B. Zandvliet (core faculty)

Department: Education

E-mail: dbz@sfu.ca Telephone: 5680

If not the instructor named above, who will develop or revise the course? ______

If the course has multiple instructors, how will the department ensure that the varying course content will routinely meet the Q criteria?

Designated sessionals will work under the guidance of the faculty member above --

Has the instructor(s) previously taught a Quantitative course? (Please specify)

No

COURSE INFORMATION

If this is a new course:

- when will it first be offered? Summer 2009
- how often will it be offered? As a component of summer institute in Environmental Education
- what is the expected enrolment per offering? 30

If this is an existing course:

- how often is it offered? ______
- what is the current average enrolment per offering? ______
- what is the expected enrolment increase, if relevant, with Q designation? ______

Section II

THE Q CRITERIA

Definition:

To qualify as Quantitative/Analytic (or 'Q' for short), a course must have either quantitative (numerical, geometric) or formal (deductive, probabilistic) reasoning as part of its primary subject matter, or make substantial use of such reasoning in practical problem solving, critical evaluation, or analysis.

Interpreting the Definition:

Mathematics courses already required in Math, the Sciences, Engineering, Business Administration and Economics, and statistics courses required in Social Science programs clearly qualify as Q courses, as do the symbolic logic courses offered in Philosophy.

Courses currently offered in programs such as Engineering Science, Physics, Chemistry, Biology, Business, Economics and other Social Science programs that contain a significant math or stats component also would be eligible for Q designation.

A third type of course eligible for Q designation will be designed especially for students in the Humanities and Fine Arts. The goal of such courses will not be simply to nurture traditional math skills. Such courses will aspire to the greater challenge of deepening the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential. We view such courses as focusing on the relation between (a) concepts and structures communicated through numbers and other systems of abstract representation (such as formal languages, programming languages, geometries, graphs) and (b) fostering students' ability to engage more effectively with the subject matter of their respective programs and practical everyday situations. Such courses need not focus primarily on quantitative or formal reasoning methods, but should give significant exercise to such techniques through model building and problem solving, both in class and in course assignments.

Please give a one-paragraph description of the content of the course, listing any prerequisites, and provide a syllabus (if available).

See attached.

Identify explicitly the Quantitative components of the course.

See attached.

Description of Quantitative assignments: Please write a one-paragraph description of each Q assignment or the types of Q assignments your course will require. We are interested in the Q content of the assignments, and particularly in how you will facilitate the learning of Q concepts by students without Quantitative/Analytic backgrounds.

See attached.

Educ4XX: Measurement and Evaluation in Environmental Education

Rationale

Cross-Curricular

The intent of this course is to drawn on ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas and to extend this framework to include mathematical or quantitative reasoning. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

Focus on Quantitative Reasoning

The more specific focus on the mathematical dimensions of environmental education grow from research that have described many positive results achieved in programs that integrated mathematics with other subject areas. Findings have shown positive achievement increases in both mathematics and science for students participating in programs which integrate these two subject areas (Hurley, 2001). There is also evidence to suggest that students demonstrate greater enthusiasm, engagement and enjoyment in classrooms where mathematics and science have been integrated (Austin, Hirstein & Walen, 1997; Reeder & Moseley, 2006). Similarly, studies have shown that students' engagement in the study of mathematics increases when it is integrating with other subject areas (Werner, 2001).

Although there is evidence to suggest that the integration of quantitative methods into other subject areas can have a positive impact on student engagement and achievement across subject boundaries, teachers may not be trying to integrate subject content in their classrooms. One reason may be that teachers feel they have inadequate content knowledge to integrate curricula (Lehman, 1994, 2002). Another possibility, specific to the case of mathematics, is that their ideas about teaching and learning mathematics may be "deeply rooted" and "largely shaped by their own experience in mathematics classes that offered traditional instruction": that is, separate from other subject areas, teacher centred, decontextualised, and without argument or ambiguity (Schram & Rosaen, 1996, p.26). As Basista and Mathews (2002) contend

> *If teachers have not experienced this integration of science and mathematics, they are unlikely to teach integrated curricula in their classrooms* (p.359).

This course offers pre- and in-service teachers the opportunity to (re)discover their knowledge of mathematics and practice ways that it can be integrated into their teaching through the context of environmental education. It is an opportunity to encourage and prepare new and practicing teachers to make quantitative reasoning an integral language in the discourse of environmental education.

Community Partnerships: Situating Learning in Place

Woodhouse and Knapp (2000) describe place-based education as having the following characteristics:

- It emerges from the particular attributes of a place
- It is inherently multidisciplinary
- It is inherently experiential
- It is reflective of an educational philosophy that is broader than "learn to earn"
- It connects place with self and community

In keeping with these principles of place-based education, this course will include a partnership with a local community environmental NGO (non-governmental organisation) through which students will engage in the practice of environmental stewardship situated in their local community. Many environmental NGO's offer workshops in environmental science in order to train volunteers to act as stewards in their local natural communities. Such workshops will allow student teachers to learn the skills and practices of environmental science and to apply them in data collection, monitoring and evaluation. This kind of experiential learning gives students a deeper understanding of the principles and practices of environmental science which will inform their teaching practice.

As well as modelling the kind of community partnership possibilities that they may want to develop in their teaching practice, working with local environmental NGO's in the course will give pre- and in-service teachers the opportunity to develop relationships with local groups who are working in the field of environmental stewardship.

Educ4XX: Measurement and Evaluation in Environmental Education

Course Outline

Objectives

- Identify and explore the ways quantitative reasoning is a component part of environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.

The focus for this course will be to integrate quantitative reasoning, scientific and socio-cultural methods and processes across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply authentic approaches to environmental education which are situated in the practices of scientists and social scientists through monitoring, modelling, simulation and evaluation. This will also include participation in a community based environmental stewardship training program. Examples of potential community partners include:

- Pacific Streamkeepers Federation: Streamkeepers Training Program, stream assessment and monitoring
- British Columbia Wildlife Federation: wetland stewardship workshop, which includes mapping, conducting plant and bird inventories, and sampling soils
- Georgia Straight Alliance: "Straitkeepers" training, learning to use the Intertidal Quadrat Studies tool
- Hecate Strait Streamkeepers Society: creek restoration and monitoring
- WILD BC: A variety of workshops for K-12 educators

In addition, students will develop activities and unit plans based on different environmental science practices and inquiry methods which they will identify and research. Complementing this focus, students will critically analyse two areas of environmental education which are key to their own practice: environmental education programs and resources and environmental education research. In keeping with the focus on mathematics as enhancing and enriching the study of the environment, students will examine programs and research in order to identify and evaluate their use of quantitative tools and mathematical reasoning.

Students will also focus on the quantitative tools used to conduct environmental research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / in environmental education research. Students will be expected to develop their own action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach they can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Content

Topic 1: Environmental education. Conceptual Frameworks (BC, Canada UN)
Topic 2: Measurement and Mapping in the Environment
Topic 3:. Biodiversity and Reasoning with Environmental Measures
Topic 4: Climate change (Estimates and Models)
Topic 5: Quantitative Reasoning in the Curriculum (IRP inquiry)
Topic 6: Analysis and adaptation of EE resources
Topic 7: Quantitative Evaluation methods in Environmental Education Research

Q Course Requirements

The course is designed to meet the Q requirements as it focuses on quantitative (numerical, geometric) reasoning within environmental science and education. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential" (SFU, 2008). This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education including the use of scientific and mathematical inquiry as a pedagogical model.

Examples of Q components of course activities:

In class and stewardship activities will include mathematical applications such as:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);
- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 (m/sec x m^2 x 0.8);
- reading gauges and charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of insects and taxa in samples (measures of biodiversity).

- calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and forecasting the time till the landfill is full with increases in recycling and composting;
- calculating environmental costs of driving to school versus taking transit or walking;
- given the amount of garbage created by a restaurant over a number of days, identifying the pattern, determining the algebraic equation associated with it and using it to figure out the garbage creation in one year.
- calculating individual, family and school eco-footprints. Comparing calculating tools eg. MEC, Earthday.org, Redefining Progress, etc.

The analysis and evaluation of environmental education programs / resources requires:
- identifying mathematical concepts and structures in environmental science and environmental education;
- evaluating the quality of curricular connections within inter-disciplinary environmental education programs and resources
- modifying or adding mathematical analysis and/or reasoning to existing programs or resources

The analysis and creation of research tools and methodologies will require:
- interpreting empirical / statistical information;
- evaluating the use of particular quantitative methodologies in environmental education research;
- creating tools for the collection of empirical data and planning methods for analysis

Suggested Course Readings and Resources

British Columbia K-12 Integrated Resource Packages (IRPs). http://www.bced.gov.bc.ca/irp/irp.htm

British Columbia Wildlife Federation. http://www.bcwf.bc.ca/

Caduto, M.J. & Bruchac, J. (1989). *Keepers of the earth: Native stories and environmental activities for children.* Saskatoon: Fifth House Publishers.

Correlation between global average temperature and number of pirates. http://www.venganza.org/

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Pacific Streamkeepers Federation. http://www.pskf.ca/

Ravindranath, S. & Premnath, S. (Eds.). (1997). *Biomass studies: Field methods for monitoring biomass*. New Delhi: Oxford & IBH.

Sierra Club, British Columbia. http://www.sierraclub.bc.ca/

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Stocker, D. (2006). *Math that matters*. CCPA Education Project.

WILD BC. http://www.hctf.ca/wild.htm

Zandvliet, D.B. (2007). Learning environments that support environmental learning. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, Louisiana, 2007.

References

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Hurley, M.M. (2001). Reviewing integrated science and mathematics: The search for evidence and definitions from new perspectives. School Science and Mathematics 101(5) p. 259-668.

Orr, D. W. (1994). *Earth in mind: On education, environment, and the human prospect.* Washington, DC: Island Press.

Reeder, S. & Moseley, C. (2006). Oh deer! Predator and prey relationships: Students make natural connections through the integration of mathematics and science. *Science Activities 43*(3), p. 9-14.

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SFU (Simon Fraser University). (2008). What is a Quantitative/Analytical course? Retrieved 30 April, 2008 from http://www.sfu.ca/ugcr/For_Students/WQB_Requirements/Quantitative/

Werner, L. (2001). Arts for academic achievement. Changing student attitudes toward math: using dance to teach math. Teacher Guide prepared for The Minneapolis Public Schools. Full Text available from ERIC online at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1b/92/85.pdf

Woodhouse, J.L. & Knapp, C.E. (2000). Place-based curriculum and instruction: Outdoor and environmental education approaches. ERIC Digest. Full Text available on-line from ERIC at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/b4/43.pdf

Simon Fraser University
Faculty of Education
Special Topics Proposal Form

1. Course Number: ______ST 3xx________ Credit Hours_______4______
Vector: ________SEM__________
Semester to be offered:
____________________________Summer 2009_____________________
Title of Course : Measurement & Evaluation in Environmental Education

NOTE: Maximum length of course title is 34 characters due to scheduling restrictions.

Measurement and Evaluation

Description of Course:

The focus will be on integrating mathematical, scientific and socio-cultural methods and processes of learning across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply approaches to environmental education that are situated in the practices of environmental scientists and social scientists through modelling, simulation and evaluation.

Prerequisite(s) (or special instructions):
60 credit hours, including 6 credits in Education (Students may not receive credit for both 3xx and 452).

2. Objectives (including a statement of how the course is embedded in a theoretical/cognitive/interpretive intellectual framework):

Objectives

Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.

- Identify and explore the ways mathematical thinking impacts environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;

- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.
-

3. Rationale for course offering (reason why course is needed):

This course is drawn from ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

4. Faculty who were consulted/involved in the development of the proposal:
David Zandvliet

5. Budgetary and Space Requirements (for information only)
What additional resources will be required in the following areas:
Faculty: Sessional instructors (no additional expense as will be fulfilling demand / load for Q requirement)
Staff: no additional staff required
Library: no additional resources expected
Audio Visual: none required
Space: no additional space required
Equipment: no additional space required
Funds: any additional field expenses to be reimbursed by students

6. Bibliography: See attached.
If you require more space, please attach additional page(s).

7. List of student assignments to be completed and any other expectations of students:
See attached course outline.

8. Description of student assessment and grading procedure:
Grading: Pass/Fail

9. Please attach a course outline (expecting the course to pass):
Attached.

10. Please send the instructor's curriculum vitae (if other than tenure track faculty)

11. Signatures of Approval
Proposed By: ____________________

Supportive Faculty Member:
____

Date: ______________________________

UPC, Chairperson: ______________________________

Synopsis of Plan for Environmental Ed Course with Q designation
Course: *Environmental Education: Cross-Curricular by Nature*
Under development - By J. M Young

Rationale

The rationale for the course is drawn from ecoolgical and systems thinking critiques of the compartmentalisation of knowledge into separate subject areas. Thinkers which inform this thinking include David Bohm, Fritjof Capra, William Doll and David Orr. The course is intended to allow students to explore and practice the integration of subject matter through the context of environmental education.

Content

The focus will be on integrating curriculum, thus it will be inclusive of mathematical, scientific and socio-cultural methods of learning about our world. In keeping with these epistemic roots, students will experience and apply approaches to environmental education which are situated in the practices of environmental science.

First, students will participate in the first four modules of the Streamkeepers Training Program, which provides stream assessment and monitoring training. From this, students will develop activities and unit plans that can be used with K-12 students. They will then develop activities and unit plans based on different environmental science practices which they will identify and research.

Complementing this focus on the practice of environmental science and teaching, students will critically analyse environmental education research with a focus on the tools used to conduct that research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / unused in environmental education research. Students will be expected to develop their own mini-action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach the can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Q Course Requirements

The course will qualify as a Q course by including quantitative (numerical, geometric) reasoning. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential." This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education

Examples of Q components of course activities:

The Streamkeepers Training Program includes the following mathematical applications:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);

- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 ($m/sec \times m^2 \times 0.8$);
- reading charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of numbers of insects and taxa in samples.

Other environmental education activities will include mathematical applications such as:

- Calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and calculating the length of time till the landfill is full with increases in recycling and composting;
- Calculating the environmental costs of driving to school versus taking transit or walking;
- Given the amount of garbage created by a restaurant over 4 days, identifying the pattern, determining the algebraic equation associated with it and use it to figure out the garbage creation in one year.

The analysis and creation of research tools and methodologies will require:

- Interpreting empirical / statistical information;
- Evaluating the use of particular quantitative methodologies in environmental education research;
- Creating tools for the collection of empirical data and planning methods for analysis

(Some) Objectives

Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.

- Introduce students to the epistemological roots of ecological thinking;
- Identify and explore the ways ecological thinking impacts curriculum and instruction;
- Participate in the Pacific Streamkeeper's Training Program so as to experience an authentic environmental assessment which includes science, mathematics and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical research project that explores an environmental education practice.

Possible Assignments

Group cross-curricular unit plan development
Cross-curricular unit plan development
Mini-action research proposal
Paper: critique of environmental education research
Paper: rationale for cross-curricular environmental education

Educ~~4XX~~ 3XX: Measurement and Evaluation in Environmental Education

Rationale

Cross-Curricular

The overall rationale for the course is drawn ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

Focus on Mathematics

The more specific focus on the mathematical dimensions of environmental education grows from studies which have described the positive results achieved in programs that integrated mathematics with other subject areas. Findings have shown small but positive achievement increases in both mathematics and science for students participating in programs which integrate these two subject areas (Hurley, 2001). There is also evidence to suggest that students demonstrate greater enthusiasm, engagement and enjoyment in classrooms where mathematics and science have been integrated (Austin, Hirstein & Walen, 1997 as cited in Hurley, 2001; O'Neal, 1995 as cited in Hurley, 2001; Reeder & Moseley, 2006). Similarly, studies have shown that students' engagement in the study of mathematics was increased by integrating it with other subject areas such as dance (Werner, 2001).

Although there is plenty of evidence to suggest that the integration of mathematics with other subject areas can have a positive impact on student engagement and achievement across subject boundaries, teachers may not be trying to integrate subject content in their classrooms. One reason may be that teachers feel they have inadequate content knowledge to integrate curricula (Lehman, 1994, as cited in Basista & Mathews, 2002). Another possibility, specific to the case of mathematics, is that their ideas about teaching and learning mathematics may be "deeply rooted" and "largely shaped by their own experience in mathematics classes that offered traditional instruction": that is, separate from other subject areas, teacher centred, decontextualised, and without argument or ambiguity (Schram & Rosaen, 1996, p.26). As Basista and Mathews (2002) contend

> *If teachers have not experienced this integration of science and mathematics, they are unlikely to teach integrated curricula in their classrooms* (p.359).

This course offers pre- and in-service teachers the opportunity to (re)discover their knowledge of mathematics and practice ways that it can be integrated into their teaching through the context of environmental education. It is an opportunity

Educ~~4XX~~ 3XX: Measurement and Evaluation in Environmental Education

Course Outline

Content

The focus will be on integrating mathematical, scientific and socio-cultural methods and processes of learning across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply approaches to environmental education which are situated in the practices of environmental scientists and social scientists through modelling, simulation and evaluation.

First, students will participate in a community based environmental stewardship training program.

British Columbia environmental organisations which offer either professional development for teachers or stewardship training, and who could act as community partners, include:

- Pacific Streamkeepers Federation: Streamkeepers Training Program, stream assessment and monitoring
- British Columbia Wildlife Federation: wetland stewardship workshop, which includes mapping, conducting plant and bird inventories, and sampling soils
- Georgia Straight Alliance: "Straitkeepers" training, learning to use the Intertidal Quadrat Studies tool
- Hecate Strait Streamkeepers Society: creek restoration and monitoring
- WILD BC: A variety of workshops for K-12 educators

Following their participation in environmental stewardship training, students will develop activities and unit plans that can be used with K-12 students. They will then develop activities and unit plans based on different environmental science practices which they will identify and research.

Complementing this focus on the practice of environmental science and teaching, students will critically analyse two areas of environmental education which are key to their own practice: environmental education programs and resources and environmental education research. In keeping with the focus on mathematics as enhancing and enriching the study of the environment, students will examine programs and research in order to identify and evaluate their use of quantitative tools and mathematical reasoning.

Students will identify and analyse environmental education programs and resources. Specifically, students will evaluate the extent and quality of mathematical language and reasoning within the resources. Individually and together, students will determine ways to modify or add to the resources as necessary, with particular attention paid to appropriate mathematics curricula (IRPs).

to encourage and prepare new and practicing teachers to make mathematics an integral language in the discourse of environmental education.

Community Partnerships: Situating Learning in Place

Woodhouse and Knapp (2000) describe place-based education as having the following characteristics:

- It emerges from the particular attributes of a place
- It is inherently multidisciplinary
- It is inherently experiential
- It is reflective of an educational philosophy that is broader than "learn to earn"
- It connects place with self and community

In keeping with these principles of place-based education, this course will include a partnership with a local community environmental NGO (non-governmental organisation) through which students will engage in the practice of environmental stewardship situated in their local community. Many environmental NGO's offer workshops in environmental science in order to train volunteers to act as stewards in their local natural communities. Such workshops will allow student teachers to learn the skills and practices of environmental science and to apply them in data collection, monitoring and evaluation. This kind of experiential learning gives students a deeper understanding of the principles and practices of environmental science which will inform their teaching practice.

As well as modelling the kind of community partnership possibilities that they may want to develop in their teaching practice, working with local environmental NGO's in the course will give pre- and in-service teachers the opportunity to develop relationships with local groups who are working in the field of environmental stewardship.

They will also focus on the tools used to conduct environmental research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / unused in environmental education research. Students will be expected to develop their own mini-action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach they can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Q Course Requirements
The course will qualify as a Q course by focusing on quantitative (numerical, geometric) reasoning within environmental science and education. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential" (SFU, 2008). This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education including the use of scientific and mathematical inquiry as a pedagogical model.

Examples of Q components of course activities:

In class and stewardship training activities will include mathematical applications such as:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);
- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 (m/sec x m^2 x 0.8);
- reading gauges and charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of numbers of insects and taxa in samples (measures of biodiversity).
- calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and calculating the length of time till the landfill is full with increases in recycling and composting;
- calculating the environmental costs of driving to school versus taking transit or walking;
- given the amount of garbage created by a restaurant over a number of days, identifying the pattern, determining the algebraic equation associated with it and using it to figure out the garbage creation in one year.

- calculating individual, family and school eco-footprints. Comparing calculating tools eg. MEC, Earthday.org, Redefining Progress, etc.

The analysis and evaluation of environmental education programs and resources will require:

- identifying mathematical concepts and structures in environmental science and environmental education;
- evaluating the quality of curricular connections within inter-disciplinary environmental education programs and resources
- modifying or adding mathematical analysis and/or reasoning to existing programs or resources

The analysis and creation of research tools and methodologies will require:

- interpreting empirical / statistical information;
- evaluating the use of particular quantitative methodologies in environmental education research;
- creating tools for the collection of empirical data and planning methods for analysis

Objectives

Any examination of ecological phenomena or issues are necessarily inclusive of scientific, mathematical and socio-cultural dimensions – to separate them reduces them and denies the meaning and functions which are found in their relationality.

- Identify and explore the ways mathematical thinking impacts environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.

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Schram, P.W.& Rosaen, C.L. (1996). Integrating the language arts and mathematics in teacher education. *Action in Teacher Education 18,* p. 23-38.

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Woodhouse, J.L. & Knapp, C.E. (2000). Place-based curriculum and instruction: Outdoor and environmental education approaches. ERIC Digest. Full Text available online from ERIC at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/b4/43.pdf

WILD BC. http://www.hctf.ca/wild.htm

Zandvliet, D.B. (2007). Learning environments that support environmental learning. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, Louisiana, 2007.

Suggested Assignments

- In class quantitative assignments and exercises (see examples above)
- Cross-curricular unit plan development with significant mathematics component
- Project: Critical examination of environmental education program or resource with focus on extent and quality of mathematical component. Suggested additions or modifications.
- Mini action-research proposal: evaluating environmental education practice

454 09[illegible]2 Q

Sent to Susan Rhodes Sept 11/08 passed

Q-COURSE CERTIFICATION REQUEST

Thank you for your interest in planning and offering a Quantitative/Analytic (Q) course. Quantitative/Analytic courses will help meet Simon Fraser University's commitment to the education of undergraduate students as defined by the new curriculum. This form is intended to:

- determine whether proposed or existing courses meet the Q criteria;
- estimate the number of Q seats available to students;
- assist faculty to think through the elements of a Q course

This form is divided into TWO sections:

Section I requests instructor, program and course information;
Section II requests detailed course content information.

Please contact Susan Rhodes at slrhodes@sfu.ca or Local 3312 if you have any questions about completing this form. Completed forms can be sent either electronically to the email address above or through campus mail to Susan Rhodes, Curriculum Office, VP Academic.

Course Title: Measurement and Evaluation in Environmental Education

Course # (if known): Education 454

Is the course (double-click the applicable box, select "checked" from the Default Value and click "OK"):

- [x] a new course?
- [ ] a modification of an existing course that has not been taught as a Q course?
- [ ] a course that has previously been piloted as a Q course?
- [ ] an existing course that fulfills the Q criteria for certification?

To be considered, this form must be approved by the Chair/Director of your program and by the Associate Dean of your Faculty. Please have them sign off as noted below, or send an email confirmation to slrhodes@sfu.ca

Chair/Director: ______________ Date approved: ______________

Associate Dean: Paterson Date approved: Sept 11/08

Section I

INSTRUCTOR/PROGRAM INFORMATION

Name of Instructor(s): David B. Zandvliet (core faculty)

Department: Education

E-mail: dbz@sfu.ca Telephone: 5680

If not the instructor named above, who will develop or revise the course? ____________

If the course has multiple instructors, how will the department ensure that the varying course content will routinely meet the Q criteria?

Designated sessionals will work under the guidance of the faculty member above --

Has the instructor(s) previously taught a Quantitative course? (Please specify)

No

COURSE INFORMATION

If this is a new course:

- when will it first be offered? Summer 2009
- how often will it be offered? As a component of summer institute in Environmental Education
- what is the expected enrolment per offering? 30

If this is an existing course:

- how often is it offered? ____________
- what is the current average enrolment per offering? ____________
- what is the expected enrolment increase, if relevant, with Q designation? ____________

Section II

THE Q CRITERIA
Definition:
To qualify as Quantitative/Analytic (or 'Q' for short), a course must have either quantitative (numerical, geometric) or formal (deductive, probabilistic) reasoning as part of its primary subject matter, or make substantial use of such reasoning in practical problem solving, critical evaluation, or analysis.

Interpreting the Definition:
Mathematics courses already required in Math, the Sciences, Engineering, Business Administration and Economics, and statistics courses required in Social Science programs clearly qualify as Q courses, as do the symbolic logic courses offered in Philosophy.

Courses currently offered in programs such as Engineering Science, Physics, Chemistry, Biology, Business, Economics and other Social Science programs that contain a significant math or stats component also would be eligible for Q designation.

A third type of course eligible for Q designation will be designed especially for students in the Humanities and Fine Arts. The goal of such courses will not be simply to nurture traditional math skills. Such courses will aspire to the greater challenge of deepening the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential. We view such courses as focusing on the relation between (a) concepts and structures communicated through numbers and other systems of abstract representation (such as formal languages, programming languages, geometries, graphs) and (b) fostering students' ability to engage more effectively with the subject matter of their respective programs and practical everyday situations. Such courses need not focus primarily on quantitative or formal reasoning methods, but should give significant exercise to such techniques through model building and problem solving, both in class and in course assignments.

Please give a one-paragraph description of the content of the course, listing any prerequisites, and provide a syllabus (if available).

See attached.

Identify explicitly the Quantitative components of the course.

See attached.

Description of Quantitative assignments: Please write a one-paragraph description of each Q assignment or the types of Q assignments your course will require. We are interested in the Q content of the assignments, and particularly in how you will facilitate the learning of Q concepts by students without Quantitative/Analytic backgrounds.

See attached.

Educ4XX: Measurement and Evaluation in Environmental Education

Rationale

Cross-Curricular

The intent of this course is to drawn on ecological and systems thinking literature which critique the compartmentalisation of knowledge into separate subject areas and to extend this framework to include mathematical or quantitative reasoning. Environmental education informed by a systems thinking epistemology is a cross-curricular endeavour, as is the practice of environmental science and environmental activism (Capra, 1982; Orr, 1994). The study of the environment and our relationship with/in environments will always include scientific, mathematical and socio-cultural perspectives.

Focus on Quantitative Reasoning

The more specific focus on the mathematical dimensions of environmental education grow from research that have described many positive results achieved in programs that integrated mathematics with other subject areas. Findings have shown positive achievement increases in both mathematics and science for students participating in programs which integrate these two subject areas (Hurley, 2001). There is also evidence to suggest that students demonstrate greater enthusiasm, engagement and enjoyment in classrooms where mathematics and science have been integrated (Austin, Hirstein & Walen, 1997; Reeder & Moseley, 2006). Similarly, studies have shown that students' engagement in the study of mathematics increases when it is integrating with other subject areas (Werner, 2001).

Although there is evidence to suggest that the integration of quantitative methods into other subject areas can have a positive impact on student engagement and achievement across subject boundaries, teachers may not be trying to integrate subject content in their classrooms. One reason may be that teachers feel they have inadequate content knowledge to integrate curricula (Lehman, 1994, 2002). Another possibility, specific to the case of mathematics, is that their ideas about teaching and learning mathematics may be "deeply rooted" and "largely shaped by their own experience in mathematics classes that offered traditional instruction": that is, separate from other subject areas, teacher centred, decontextualised, and without argument or ambiguity (Schram & Rosaen, 1996, p.26). As Basista and Mathews (2002) contend

> *If teachers have not experienced this integration of science and mathematics, they are unlikely to teach integrated curricula in their classrooms* (p.359).

This course offers pre- and in-service teachers the opportunity to (re)discover their knowledge of mathematics and practice ways that it can be integrated into their teaching through the context of environmental education. It is an opportunity to encourage and prepare new and practicing teachers to make quantitative reasoning an integral language in the discourse of environmental education.

Community Partnerships: Situating Learning in Place

Woodhouse and Knapp (2000) describe place-based education as having the following characteristics:

- It emerges from the particular attributes of a place
- It is inherently multidisciplinary
- It is inherently experiential
- It is reflective of an educational philosophy that is broader than "learn to earn"
- It connects place with self and community

In keeping with these principles of place-based education, this course will include a partnership with a local community environmental NGO (non-governmental organisation) through which students will engage in the practice of environmental stewardship situated in their local community. Many environmental NGO's offer workshops in environmental science in order to train volunteers to act as stewards in their local natural communities. Such workshops will allow student teachers to learn the skills and practices of environmental science and to apply them in data collection, monitoring and evaluation. This kind of experiential learning gives students a deeper understanding of the principles and practices of environmental science which will inform their teaching practice.

As well as modelling the kind of community partnership possibilities that they may want to develop in their teaching practice, working with local environmental NGO's in the course will give pre- and in-service teachers the opportunity to develop relationships with local groups who are working in the field of environmental stewardship.

Educ4XX: Measurement and Evaluation in Environmental Education

Course Outline

Objectives

- Identify and explore the ways quantitative reasoning is a component part of environmental curriculum and instruction;
- Participate in an environmental stewardship training workshop so as to experience an authentic environmental assessment which includes scientific, mathematical and socio-cultural perspectives;
- Develop a variety of cross-curricular environmental education lessons and activities which include mathematical practice and thinking;
- Identify and critically examine a variety of environmental education programs and resources, specifically for the extent and quality of their mathematical perspective;
- Critically examine the value of quantitative and qualitative approaches to environmental education research;
- Enable students to design and develop a quantitative/empirical evaluation project that explores an environmental education practice in context.

The focus for this course will be to integrate quantitative reasoning, scientific and socio-cultural methods and processes across the curriculum and in teaching practice. In keeping with these epistemic roots, students will experience and apply authentic approaches to environmental education which are situated in the practices of scientists and social scientists through monitoring, modelling, simulation and evaluation. This will also include participation in a community based environmental stewardship training program. Examples of potential community partners include:

- Pacific Streamkeepers Federation: Streamkeepers Training Program, stream assessment and monitoring
- British Columbia Wildlife Federation: wetland stewardship workshop, which includes mapping, conducting plant and bird inventories, and sampling soils
- Georgia Straight Alliance: "Straitkeepers" training, learning to use the Intertidal Quadrat Studies tool
- Hecate Strait Streamkeepers Society: creek restoration and monitoring
- WILD BC: A variety of workshops for K-12 educators

In addition, students will develop activities and unit plans based on different environmental science practices and inquiry methods which they will identify and research. Complementing this focus, students will critically analyse two areas of environmental education which are key to their own practice: environmental education programs and resources and environmental education research. In keeping with the focus on mathematics as enhancing and enriching the study of the environment, students will examine programs and research in order to identify and evaluate their use of quantitative tools and mathematical reasoning.

Students will also focus on the quantitative tools used to conduct environmental research and their effectiveness in informing curriculum development and teaching practice. They will examine particularly how qualitative and quantitative methods are used / misused / in environmental education research. Students will be expected to develop their own action research project to examine the environmental science activity/unit plan which they are developing (see above). The intention is that when they have the opportunity to teach they can use the plan they have developed and concurrently critically reflect on their own practice and/or the impact on students.

Content

Topic 1: Environmental education. Conceptual Frameworks (BC, Canada UN)
Topic 2: Measurement and Mapping in the Environment
Topic 3: Biodiversity and Reasoning with Environmental Measures
Topic 4: Climate change (Estimates and Models)
Topic 5: Quantitative Reasoning in the Curriculum (IRP inquiry)
Topic 6: Analysis and adaptation of EE resources
Topic 7: Quantitative Evaluation methods in Environmental Education Research

Q Course Requirements

The course is designed to meet the Q requirements as it focuses on quantitative (numerical, geometric) reasoning within environmental science and education. The course will also meet the standards of the third type of Q course which is "designed especially for students in the Humanities and Fine Arts: to deepen the understanding and appreciation of quantitative and formal reasoning, their ubiquitous utility, and their creative potential" (SFU, 2008). This course will focus on the relation between:

- concepts and structures communicated through numbers and other systems of abstract representation (such as geometries, graphs); and
- fostering students' ability to engage more effectively with pedagogical practices and environmental science and education including the use of scientific and mathematical inquiry as a pedagogical model.

Examples of Q components of course activities:

In class and stewardship activities will include mathematical applications such as:

- estimating the sizes of fish barriers and calculating the fish' ability to jump (the height of the jump should be less than 1.25 times the depth of the plunge pool);
- calculating stream discharge by measuring rate of water flow at surface (average of 5 trials) and multiplying by the area of the wetted cross section and a correction factor of 0.8 (m/sec x m^2 x 0.8);
- reading gauges and charts to determine Q values of dissolved oxygen, pH turbidity and temperature when assessing water quality;
- calculating ratios of insects and taxa in samples (measures of biodiversity).

- calculating percentages of types of waste produced by a given community in a period of time, determining how much landfill waste can be recycled or composted, and forecasting the time till the landfill is full with increases in recycling and composting;
- calculating environmental costs of driving to school versus taking transit or walking;
- given the amount of garbage created by a restaurant over a number of days, identifying the pattern, determining the algebraic equation associated with it and using it to figure out the garbage creation in one year.
- calculating individual, family and school eco-footprints. Comparing calculating tools eg. MEC, Earthday.org, Redefining Progress, etc.

The analysis and evaluation of environmental education programs / resources requires:
- identifying mathematical concepts and structures in environmental science and environmental education;
- evaluating the quality of curricular connections within inter-disciplinary environmental education programs and resources
- modifying or adding mathematical analysis and/or reasoning to existing programs or resources

The analysis and creation of research tools and methodologies will require:
- interpreting empirical / statistical information;
- evaluating the use of particular quantitative methodologies in environmental education research;
- creating tools for the collection of empirical data and planning methods for analysis

Suggested Course Readings and Resources

British Columbia K-12 Integrated Resource Packages (IRPs). http://www.bced.gov.bc.ca/irp/irp.htm

British Columbia Wildlife Federation. http://www.bcwf.bc.ca/

Caduto, M.J. & Bruchac, J. (1989). *Keepers of the earth: Native stories and environmental activities for children*. Saskatoon: Fifth House Publishers.

Correlation between global average temperature and number of pirates. http://www.venganza.org/

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Environmental Learning And Experience: An interdisciplinary guide for teachers. (2007). British Columbia Ministry of Education. Available at: *http://www.bced.gov.bc.ca/environment_ed/*

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ESLEI (Environmental Science Learning Environment Inventory). In Henderson, D.G., Fisher, D.L. & Fraser, B.J. (1998). Learning Environment, Student Attitudes and Effects of Students' Sex and Other Science Study in Environmental Science Classes. Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).

Freedman, B. (2007). *Environmental science: A Canadian perspective*. Toronto: Pearson Education Canada.

Georgia Strait Alliance. http://www.georgiastrait.org/

Green Teacher: Education for Planet Earth. Magazine for K-12 Educators

Mason, Adrienne. (1991). *The green classroom*. Markham, Ontario: Pembroke Publishers.

Marcinkowski, T.C. (2004). Monograph 1 - Using a Logic Model to Review and Analyze an Environmental Education Program. NAAEE (North American Association For Environmental Education) Publications.

Pacific Streamkeepers Federation. http://www.pskf.ca/

Ravindranath, S. & Premnath, S. (Eds.). (1997). *Biomass studies: Field methods for monitoring biomass.* New Delhi: Oxford & IBH.

Sierra Club, British Columbia. http://www.sierraclub.bc.ca/

SOLEI (Science Outdoor Learning Environment Inventory). In Orion, N., Hofstein, A., Tamir, P. & Giddings, G.J. (1998). The development and validation of an instrument for assessing the learning environment of outdoor science activities. *Science Education, 81*(2), pp. 161 - 171

Stocker, D. (2006). *Math that matters*. CCPA Education Project.

WILD BC. http://www.hctf.ca/wild.htm

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Capra, F. (1982). *The turning point: Science society, and the rising culture*. New York: Simon and Schuster.

Hurley, M.M. (2001). Reviewing integrated science and mathematics: The search for evidence and definitions from new perspectives. School Science and Mathematics 101(5) p. 259-668.

Orr, D. W. (1994). *Earth in mind: On education, environment, and the human prospect.* Washington, DC: Island Press.

Reeder, S. & Moseley, C. (2006). Oh deer! Predator and prey relationships: Students make natural connections through the integration of mathematics and science. *Science Activities 43*(3), p. 9-14.

Schram, P.W.& Rosaen, C.L. (1996). Integrating the language arts and mathematics in teacher education. *Action in Teacher Education 18,* p. 23-38.

SFU (Simon Fraser University). (2008). What is a Quantitative/Analytical course? Retrieved 30 April, 2008 from http://www.sfu.ca/ugcr/For_Students/WQB_Requirements/Quantitative/

Werner, L. (2001). Arts for academic achievement. Changing student attitudes toward math: using dance to teach math. Teacher Guide prepared for The Minneapolis Public Schools. Full Text available from ERIC online at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1b/92/85.pdf

Woodhouse, J.L. & Knapp, C.E. (2000). Place-based curriculum and instruction: Outdoor and environmental education approaches. ERIC Digest. Full Text available on-line from ERIC at http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/b4/43.pdf