NEW PROGRAM PROPOSAL

PRE-APPROVAL FORM

Complete and submit this template when seeking approval *in principle* to move forward with the development of a new programs including: new graduate degrees, diplomas (type 1, 2, or 3), collaborative specializations; new undergraduate degrees, majors, minors, areas of concentration, degree-credit certificates, degree-credit diplomas; major modifications to existing undergraduate programs.

In accordance with the University of Guelph's Institutional Quality Assurance Process (IQAP), all proposed new programs must receive a recommendation to move through the governance process from the Office of the Provost. Submit the completed Pre-Approval Form to either the Director, Academic Programs and Policy (undergraduate proposals) through the Office of Quality Assurance (crc@uoguelph.ca) or the Assistant Vice-President, Graduate Studies (AVPGS) through the Office of Graduate and Postdoctoral Studies (ogsadmin@uoguelph.ca) who, on behalf of the Provost, undertake initial review to ensure new programming is consistent with the strategic plans and directions for growth of the university. Academic units are encouraged to contact the Curriculum Manager in the Office of Quality Assurance or the Manager, Graduate Curriculum in the Office of Graduate and Postdoctoral Studies at the outset of proposal development.

Proposals which include new undergraduate co-op programs must also show evidence the market study is in progress with the Experiential Learning Hub.

Once the sponsoring department/school receives approval in principle, the completed full program proposal must be submitted to the Office of Quality Assurance (undergraduate) or Office of Graduate and Postdoctoral Studies (graduate) within 12 months or the approval will lapse and require resubmission.

Name of Proposed Program(s) and Degree Designation(s):	Master's in STEM education in the field of (Chemistry, Physics, Biology, Mathematics, Engineering, Computer Science, etc.) (Course-based)
Sponsoring Department(s)/School(s) and College(s):	CEPS CBS
Proposed Start Date:	Fall 2022
Proposal Lead(s):	Karen Gordon ADA, CEPS Brian Husband ADA, CBS

A. Executive Summary and Brief Program Description

Provide a brief program description and rationale (maximum 1 page) for developing this program. Identify its relationship to the plans of the Department/School and College, the University's Strategic Framework, the Strategic Mandate Agreement (SMA), and existing programs. Include expected program duration and structure, and highlight any potential distinctive curriculum aspects, program innovations, and/or creative components. If known, include proposed experiential learning activities and ways that issues of equity, diversity, inclusion, and accessibility may be addressed in the proposed program.

We propose a graduate degree program in STEM (Science, Technology, Engineering and Mathematics) education to address current challenges in Higher Education. These challenges include, but are not limited to, engaging a shifting student population, evolving job markets, ensuring workplace readiness of our graduates, creating innovative pedagogy, and renewing the connection between research and education.

Both the College of Engineering and Physical Sciences and the College of Biological Science have current strategic plans which speak to improving the quality of their undergraduate programs, producing graduates in high demand, driving innovation in undergraduate teaching, and increasing the impact and quality of their research. A graduate degree program in STEM pedagogical development will contribute both directly and indirectly to all of these objectives.

Pedagogical development involves investigation and implementation of innovative teaching techniques emerging from research, including those related to experiential learning, active learning, learning outcomes and competencies, and technology-enhanced teaching. A challenge in this work arises because STEM practitioners and Education specialists (who are predominantly social scientists) typically demonstrate different epistemologies; therefore, discipline-based education researchers must learn to bridge the gaps in terminology, knowledge base, and mindset between their technical disciplines and the teaching and learning research (NRC, 2012).

Bridging these fields will lead to an injection of different perspectives within STEM, promoting inclusive and diverse perspectives and approaches. In turn, this bridging will increase the pathways for students with more diverse backgrounds to choose both STEM and Education careers.

The proposed course-based Masters program in STEM Education would be a unique in Canada, multi-institutional partnership between the University of Guelph and Wilfrid Laurier University. Wilfrid Laurier has an established Faculty of Education, offering a selection of graduate level courses in education and faculty expertise. Students could enrol in the program from either university as their home institution and take courses from either campus. This innovative program would serve the dual purpose of providing a pathway for education professionals into STEM specializations, and for STEM experts into education. Students in the program would explore and develop specific skills related to evidence-based, discipline specific pedagogy; education research; and curriculum development.

The 16-month program would require completion of 4.0 academic credits selected by the student's advisory committee from a list of discipline specific offerings and education offerings, as well as 1.0 credits towards a Project (research) or practicum. Example courses from either institution are listed below, a minimum of 1.0 credits in STEM and 1.0 credits in Education courses would be required. The required project or practicum are experiential learning opportunities that may have the additional benefit of supporting the continual

improvement aspects of quality assurance programs, and advancing the strategic priorities of the home Institution.

Discipline based courses	Graduate Education Courses (Examples below)	1.0 Credits for STEM-ED Project/Practicum
Students would enroll in courses within the disciplines of Physics, Chemistry, Mathematics, Statistics, Engineering, Computer Science, Integrative Biology, Human Health, Nutrition, Microbiology Genetics etc. The selection of these courses (from an approved list) would be approved by the student's supervisor, and would result in graduate level expertise in a focused area within the student's discipline.	EU501 Investigating the Relationship between Theory and Practice (Laurier - Summer)	Students would enroll in the project course in the final 8 months of study. Projects would ideally be advised by one faculty member in a STEM based field, and one faculty member from the Faculty of Education
	EU 502: Interpreting Research in Education (Laurier - Summer)	
	EU 503: Learning Theories (Laurier - Summer)	
	EU 504/505: Quantitative or Qualitative Research Methods (Laurier - Fall)	
	UNIV*6800 University Teaching Theory and Practice (Guelph)	
	FRAN*6020 Qualitative Research Methods (Guelph)	
	SOC*6130 Quantitative Research Methods W [0.50] (Guelph)	

The degree program is envisioned to begin in the Spring/Summer semester and progress through four semesters, although alternate options may also be viable (see table below). An example of a practicum could be assisting in the delivery of a university course with a planned research component, or development of an aligned set of assessments within a curriculum to integrate a specific learning outcome. An example student sequence is given below:

Summer (Semester 1)	Fall (Semester 2)	Winter (Semester 3)	Summer (Semester 4)
1.5 credits (3 courses)	1.5 credits (3 courses)	0.5 credit (1 course)	0.5 credit (1 course)
Form advisory committee, discuss project/practicum ideas	Obtain REB approval if needed for project	0.5 credit Project/practicum Course	0.5 credit Project/practicum Course

Discipline based STEM education research in North America is a rapidly emerging field, and the demand for teaching professionals trained in both areas (STEM and education research) is growing. The proposed collaboration between the University of Guelph and Wilfrid Laurier would uniquely position this program, its students, and the associated faculty to become Canadian leaders in this space.

B. Need and Anticipated Demand

Outline why this program is needed (e.g. societal, industry need) and its anticipated demand by students.

Graduate programs in STEM education are beginning to emerge across Canada, with recently announced programs at the Universities of Calgary and British Columbia. In engineering alone, University of Calgary, University of Manitoba, and Queen's University are currently developing programs, in addition to the established program at the University of Toronto. Institutions in the United States are capitalizing on opportunities with robust graduate programs: Purdue and Virginia Tech have established Engineering Education programs with comprehensive suites of courses and research specializations, while the University of Texas at Austin also offers an established Master's Program in STEM Education. Recently, the American National Science Foundation (NSF) announced a $35 million funding opportunity in discipline based education research (DBER). The field of DBER is growing and increasingly recognized as foundational in continual improvement of higher education.

At the University of Guelph, many faculty in the College of Engineering and Physical Sciences (CEPS) and the College of Biological Science (CBS) have more than 40% allocation of effort in teaching and are actively engaged in pedagogical research (approximately 15 in CEPS, 8 in CBS). Unfortunately, recruiting graduate students for this work is difficult: currently, no degree programs provide an appropriate venue for conducting discipline-based pedagogical research. Some departments within the University of Guelph are currently permitting graduate students focused on discipline based education research to obtain graduate degrees within their disciplines, but typically these students have difficulty finding appropriate course work to complete and faculty mentors with expertise in education. For these faculty, a STEM education course based Master's program would be an ideal pathway, allowing them to educate and mentor aspiring STEM education professionals in a manner aligned with their research goals.

Every discipline has specific knowledge-base and methodologies that influence how students learn and how teachers teach, which are heavily influenced by the backgrounds of those teaching within the discipline. Education as a discipline is more closely related to the humanities and social sciences, and students in these non-STEM fields see the benefits in their learning. Indeed, non-STEM faculty use pedagogies that encourage higher-order, integrative, and reflective learning significantly more than STEM faculty counterparts, who also have lower expectations for these deep learning practices (Nelson Laird et al., 2008). There is also concern surrounding the extent, or lack thereof, to which STEM faculty incorporate evidence-based practices into their teaching, perhaps attributed to the lack of formal preparation for teaching during graduate experiences (Austin, 2011). Finally, the teaching innovations and education research that occurs in one STEM field is often not connected to similar contexts in a related STEM field (Borrego and Henderson, 2014), emphasizing the need for more generalizable skills in STEM Education work.

Typically, discipline-specific pedagogical research associated with STEM is either done by individuals with PhDs in their STEM field who have branched into education/pedagogy/Scholarship of Teaching and Learning (SoTL) later in their careers, or by education specialists who later transitioned into STEM fields. This situation leads to an interesting dynamic of individuals with very different epistemologies, often resulting in a lack of shared understandings. It can be challenging for established experts in academia to shift their ways of thinking and theoretical framings of research (especially when grounded in STEM, with mostly implicit framing). Individuals with foundational understanding in both STEM *and* Education from the outset of their careers would span the dual approaches and play an important role in contributing to transdisciplinary STEM Education fields as scholarly pursuits.

Beyond higher education, there is significant demand for STEM specialists in K-12 education, which will lead to better prepared students and recruitment of more diverse student populations. Further, the challenges facing society are increasing in complexity, requiring more interdisciplinary approaches. STEM fields in general would

benefit from an injection of educational principles to better support interfacing beyond each profession (i.e., promote STEM 'literacy'). Furthermore, there are a number of industry roles that require discipline-based expertise AND an ability to understand and apply teaching/cognitive science tools to their work.

Graduates of this program could be employed in the following fields:

- Higher Education (lecturer, teaching track faculty, education research)
- K-12 Education
- Student Life programs
- Scientific Writing
- Education training, teaching support, experiential learning experts, online education, etc.
- Quality assurance; curriculum management
- Learning technology (e.g., D2L, Axonify)

Graduates of this degree program will deepen discipline based knowledge and skills to the equivalent level of expertise as a Master's student. Students will be able to integrate discipline specific evidence-based practices in three major areas: advancing their teaching practice, conducting discipline specific research in education, and understanding the foundations of curricular development within their discipline. More specifically, graduates of this degree program would be uniquely qualified with the following skills:

- Ability to conduct discipline-specific pedagogical research
- Ability to develop STEM-related course material using evidence-based education research
- Deliver STEM content using advanced/effective teaching methods
- Knowledge of curriculum development as applied to their discipline
- Design and develop higher-ed products for STEM Education
- Integrate education-based principles for interfacing beyond STEM fields

C. Anticipated Enrolment

Identify anticipated enrolment in the program initially and at steady-state, and specify a timeline for achieving steady-state.

With approximately 20-25 faculty at the University of Guelph in STEM fields currently engaged in pedagogical research, we anticipate approximately 10-15 students the program in its first year, with growth to 20-25 students in 5 years. Demand for the program is growing with STEM education research being undertaken in fourth year projects, through existing, discipline-specific course-based Master's programs, and with a planned undergraduate course in CBS (3rd year offering called "Implementation Science" on Science Education).

We anticipate that there will also be both immediate and long term demand from the Faculties of Education and Science at Wilfrid Laurier, these enrolment numbers are yet to be determined in talks with the Administration at Laurier.

In the current environment, funding in STEM education research is difficult to obtain: NSERC is not funding pedagogical research programs, and SSHRC funding is typically granted to faculty in the social sciences instead of STEM disciplines. Therefore, the collaborations brokered in our proposed course-based program would foster future interdisciplinary teams that would have greater success at obtaining external funding. Moreover, the course-based Masters program would alleviate the advisor's need to fund the student, and allow an appropriate venue for students to conduct smaller research projects in the area, building expertise and relationships that will grow into future external funding success in an area of research currently untapped at the University of Guelph.

D. Resources

Briefly describe any anticipated resource needs (human, physical, financial, or otherwise) that will be required to launch and/or sustain the program long-term.

To launch the program, very few additional resources are required. We propose one new course bridging specific concepts in STEM higher education pedagogy, including application of teaching and learning theory to specific discipline based content. This course would be a foundational course, taken in the student's first semester, to introduce the student to the program. Assessments within the course would include the student participating in ethics training and preparing a Research Ethics Board application for their project or practicum. Delivery of this course would require one additional teaching effort each year (proposed summer offering). A thorough review of graduate course offerings at both Institutions is needed, in addition to development of learning outcomes for the program and curriculum mapping, in order to determine if any additional resources/course offerings would be required.

In addition to the proposed new course offering, administrative support for graduate student enrollment and financial organization and budgeting will be required.

References

Austin, A.E., 2011. Promoting Evidence-Based Change in Undergraduate Science Education.

Borrego, M., Henderson, C., 2014. Increasing the use of evidence-based teaching in STEM higher education: A comparison of eight change strategies. J. Eng. Educ. 103, 220–252. https://doi.org/10.1002/jee.20040

Nelson Laird, T.F., Shoup, R., Kuh, G.D., Schwarz, M.J., 2008. The Effects of Discipline on Deep Approaches to Student Learning and College Outcomes. Res. High. Educ. 49, 469–494. https://doi.org/10.1007/s11162-008-9088-5

National Research Council, 2012 (edited by Singer, S., Nielsen, N.R., and Schweingruber H.A.). Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering, Published by the National Academy of Sciences, Washington DC, USA.

SIGNATURES

Signatures confirm receipt, review, and approval *in principle* of the proposed new program.

For expediency, it is recommended that Proposal Leads secure the signatures of the Department Chair/Director and College Associate Dean prior to submission to the Office of Quality Assurance or Office of Graduate and Postdoctoral Studies.

Department Chair(s)/Director(s)	*Date*

Karen Jacobs, ADA, CEPS

Associate Dean Acad, CBS

Nov 5, 2019

College Associate Dean Research and Graduate Studies or Associate Dean, Academic — *Date*

Executive Director, Budget and Financial Planning — *Date*

Assistant Vice-President, Institutional Analysis and Research — *Date*

Assistant Vice-President, Graduate Studies or Associate Vice-President (Academic) — *Date*