TO: Randy Smith, Vice Provost for Academic Programs
Eric Bielefeld, Chair, Council on Academic Affairs
FROM: Shari Speer, Associate Dean for Academic Affairs, Graduate School
DATE: 4-8-20
RE: Certificate, College of Arts and Sciences

The College of Arts and Sciences is proposing a new certificate in Advanced Chemistry Knowledge for Educators.

The proposal was received by the Graduate School on February 11th, 2020. It was reviewed by GS/CAA on February 13th, 2020. No revisions were requested, and the proposal was recommended for approval by the Graduate Council. The proposal was approved by the Graduate Council on March 13th, 2020.

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Offices of the Associate
and Assistant Deans

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October 10, 2019

I am pleased to offer the College of Arts and Sciences' support for the proposed stand-alone graduate certificate in "Advanced Chemistry Knowledge for Educators." This proposed certificate will become part of a larger ASC initiative (supported by OAA) to provide College Credit Plus authorization programs in several fields for qualified high school teachers.

We are particularly pleased that CBC has developed this as an online program, which will undoubtedly enhance its reach and sustainability. We hope the other existing CC+ teacher programs (in English, Math, and Physics) will follow this example and develop online versions of their programs as well. In addition to CBC's efforts, ASC is working with ESCCO (Educational Service Center of Central Ohio) and Columbus State Community College to facilitate teacher access to our programs.

Sincerely,

Steve Fink

Associate Executive Dean

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Department of Chemistry and Biochemistry

Christine M. Thomas
Fox Professor of Chemistry
Vice Chair of Graduate Studies
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October 8, 2019

Dear ASC Curriculum Committee,

The Department of Chemistry and Biochemistry Graduate Studies Committee supports the proposed graduate academic certificate program and the four associated course proposals. This program will provide a valuable opportunity for high school chemistry teachers who want to further their chemistry education so that they can become accredited to teach College Credit Plus chemistry courses.

Sincerely,

Christine M. Thomas
Vice Chair of Graduate Studies
Department of Chemistry and Biochemistry

Department of Molecular Genetics

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January 16, 2020

Alison Crocetta
Chair, ASCC

Dear Alison,

The NMS Panel of the ASCC reviewed and discussed the Advanced Chemistry Knowledge for Educators Certificate at the regular NMS panel meeting on December 2, 2019.

The proposed Advanced Chemistry Knowledge for Educators Certificate is a Type 3A Stand Alone Certificate that will be delivered through a combination of synchronous and asynchronous online courses. The certificate will strengthen and enhance the skills of high school teachers or individuals interested in becoming high school teachers. It will further provide accreditation to teach College Credit Plus chemistry courses. The proposed certificate requires 18 credit hours that are distributed over four online courses and will provide evidence that a teacher possesses the minimum academic qualifications to teach CCP courses.

The certificate is well designed and comes with compelling justification. The NMS panel unanimously approved the proposed certificate with two contingencies that have been satisfied in the resubmission.

The NMS Panel forwards the certificate to ASCC with a motion to approve.

Sincerely,

Dr. Harald Vaessin
Chair, NMS Panel of ASCC
Professor and Chair, Molecular Genetics

ASC Proposal Guidelines

1. Required Information

Name: Advanced Chemistry Knowledge for Educators. Type 3A (Stand-Alone) and 3B (Embedded) Certificate.

Delivery: Combination of synchronous and asynchronous online courses.

Proposed implementation: Initial cohort begins summer 2020.

Academic units responsible for certificate administration: Department of Chemistry and Biochemistry, College of Arts and Sciences.

Description: The type 3A (Stand-Alone) and 3B (Embedded) certificate "Advanced Chemistry Knowledge for Educators" consists of a total of 18 credit hours distributed across four online courses. The certificate is designed to enhance the skills of high teachers, or those interested in becoming high school teachers, and provide accreditation to teach College Credit Plus chemistry courses. The proposed curriculum will begin in summer 2020. We anticipate an initial cohort of 8-10 students during the first year. Our goal is to award 30 certificates in the first three years of the program.

2. Rationale

Under the 2014 state law known as the "College Credit Plus Program," minimum credentials have been established for instruction in College Credit Plus (CCP) courses. High school teachers who wish to be the instructors of record for survey-level college courses need one of the following: a Master's degree in the content area, or a Master's degree in a different area plus 18 graduate credits in the content area. The Department of Chemistry and Biochemistry has developed an 18-credit certificate to meet the needs of high school teachers who already possess a Master's degree and who seek to be credentialed to teach College Credit Plus courses in Chemistry. This certificate provides evidence that a teacher possesses the minimum academic qualifications to teach CCP courses.

In the state of Ohio, total College Credit Plus enrollment was nearly 70,000 students in the 2016-2107 academic school year. The most common delivery method for these courses is by a credentialed high school instructor. Science is a subject taken by a significant number of students, trailing only English and Social Sciences. However, many high school science teachers lack the appropriate credentials to teach CCP Chemistry courses, and there are limited opportunities to earn these credentials in Ohio. This certificate program will address this need.

Student demand for the proposed certificate include 1) experienced teachers in Ohio currently teaching high school Chemistry course but are not eligible to teach CCP courses, 2) individuals completing a Masters of Education (MEd) program and who plan to teach CCP courses, 3)

educators outside of Ohio seeking graduate credits in Chemistry in order to teach CCP-equivalent courses in their own states.

Upon completion of the academic certificate in the Advanced Chemistry Knowledge for Educators program, learners will be better prepared to 1) design a General Chemistry CCP course comparable to undergraduate courses in the Ohio, 2) deliver the course with an understanding of advanced, foundational content knowledge, 3) evaluate student achievement in the course.

3. Relationship to Other Programs

This certificate does not overlap with other programs or departments within the university.

This certificate has not been previously submitted for approval.

The University of Toledo currently offers an online program leading to the credentialing of CCP teachers in Chemistry as part of its Masters of Science and Education program.

4. Student Enrollment

We anticipate an initial cohort of 8-10 students during the first year. Our goal is to award 30 certificates in the first three years of the program. Efforts will be made to recruit teachers, both in Ohio and nationwide, using networks such as the American Modeling Teachers Association and regional National Science Teachers Association (NSTA) conferences. These efforts will include seeking to enroll underrepresented participants in STEM. STEM students who have completed the OSU Masters of Education program will also be targeted.

5. Curricular Requirements

A minimum of 18 credits is required for completion of the certificate. The curriculum is a four-course sequence. Courses are intended to be taken in order, although this is not a requirement.

- Summer: Online course (5 credit)
- Fall: Online course (4 credit)
- Spring: Online course (4 credit)
- Summer: Online course (5 credit)

The time to completion is a maximum of four years. The recommended curriculum is four semesters (summer, autumn, spring, summer).

Certificate Completion Sheet

Department of Chemistry and Biochemistry, The Ohio State University

Advanced Chemistry Knowledge for Educators, Type 3A (Stand-Alone) and 3B (Embedded) Certificate

Student Name:

Student OSU Email:

Certificate Advisor Name:

Coursework

Course (hours)	Course Grade	Term Completed
Chemistry 6086, Advanced Chemistry Knowledge for Educators: Atomic Structure and Quantum Mechanics (5 credits).		
Chemistry 6087, Advanced Chemistry Knowledge for Educators: Bonding Models and States of Matter (4 credits).		
Chemistry 6088, Advanced Chemistry Knowledge for Educators: Kinetics, Thermodynamics, and Equilibrium (4 credits)		
Chemistry 6089, Advanced Chemistry Knowledge for Educators: Modern Applications and Instrumental Analysis (5 credits)		

Substitutions Approved:

Certificate Advisor Signature:

Date:

Program Goals:

Upon completion of the program students will be able to:

(Goal 1) Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.

(Goal 2) Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.

(Goal 3) Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.

(Goal 4) Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.

(Goal 5) Collaborate on teacher inquiry projects based on topics of their choosing.

Assessment Plan
Goal 1 will be assessed by applying rubrics for lesson plans that integrate, and describe the use of, delivery of content, homework, practice exams, and other class resources

Goal 2 will be assessed by using exams.

Goal 3 will be assessed by using rubrics.

Goal 4 will be assessed by evaluating student writing of literature reviews.

Goal 5 will be assessed through the use of student writing assignments, including ones that include quantitative and qualitative data analysis.

The Ohio State University
Arts and Sciences

Graduate Academic Certificate Advanced Chemistry Knowledge for Educators

Ted Clark, Associated Associate Professor

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Overview

Graduate Academic Certificate Program: Post-Bachelor Degree Stand-Alone Certificate Advanced Chemistry Knowledge for Educators consists of a total of 18 credit hours distributed across four online courses. The certificate is designed to enhance the skills of high teachers, or those interested in becoming high school teachers, and provide accreditation to teach College Credit Plus chemistry courses.

Certificate Requirements

Four required courses (18 credits).

Chemistry 6086 – Atomic Structures and Quantum Mechanics (5 credits)

Chemistry 6087 – Bonding Models and States of Matter (4 credits)

Chemistry 6088 – Kinetics, Thermodynamics, and Equilibrium (4 credits)

Chemistry 6089 – Modern Applications and Instrumental Analysis (5 credits)

Advanced Chemistry Knowledge for Educators program guidelines

Credit hours required
A minimum of 18 hrs. Credits must be at the 6000 level.

Overlap with courses in degree
Max 50% overlap with degree program.

Grades required
- Minimum C- for a course to be counted on the certificate.
- Minimum 3.00 cumulative point-hour ratio required for the certificate.
- Course work graded Pas/Non-Pass cannot be applied toward the certificate.

X193 credits
Not permitted.

Approval required
The certificate must be approved by the academic unit.

Assessment Plan

Direct measures will be used to assess the proposed graduate certificate. Direct measures will include analysis of data directed tied to program learning outcomes.

Data Collection
Learning outcomes and Assignments

- Outcome: Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Assignment: Student-generated **lesson plans** based on learning objectives that guide the integration, and use of, lessons, activities, homework, practice exams, and other class resources. A given lesson plan corresponds to a typical chapter of content in an undergraduate General Chemistry course. Lessons plans are usually 1-3 pages in length.

Lesson Plan Assignments

Chem 6086	Chem 6087	Chem 6088	Chem 6089
Measurement. Discovery of Atomic Structure. Energy, the First Law of Thermodynamics. Electronic Structure of Atoms. Quantum Mechanics.	Periodic Properties and Ionic Bonding. Lewis Structures and VSEPR. Valence Bond Theory and Molecular Orbital Theory. Gases, Liquids, Intermolecular Forces. Solids and Materials.	Properties of Solutions. Chemical kinetics and Equilibrium. Acid-Base Equilibria. Solubility and Complex Ion Equilibria. Entropy and Free Energy.	Electrochemistry Nuclear Chemistry Atomic Spectroscopy Molecular Spectroscopy Separation Methods

- Outcome: Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Assignment: **Exams** are intended to assess competency and communicate the format of typical tests, and the range and depth of topics found in undergraduate General Chemistry courses. Exams are 20-30 multiple choice questions and are completed in a single 75-minute period. Each course will include two exams.

- Outcome: Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Assignment: **Design instructional activities**. Activities may take many different, such as worksheets, computer simulations (like PhET) that are instructor or student-led, demonstrations, chapter reading guides, and laboratory experiments. They should be included in the corresponding lesson plan and have a supporting rationale. The scope of the activity is open-ended, e.g. it may be a week-long experiment or a targeted worksheet.

- Outcome: Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Assignment: A **literature review** that must include at least 5 primary research article references, with at least 2 primary references being found by the student. Each article is to be reviewed in one or two paragraphs, and the entire review must have a cohesive framework including an introduction and a conclusion.

- Outcome: Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing.
- Assignment: The **teacher inquiry project** is a collaboration between student(s) and the instructor. The overarching research question is "How does a deeper understanding of 'topic x' inform your own instructional practices, and how can it inform the practices of others?' Students have an opportunity to select both their own topic, and the format of the final product, e.g. it may be a paper, research poster, or narrated slide presentation. The topic will be selected by the student in the first one-third of the course. The first draft will be due at approximately two-thirds of the way through the course. Based on student interest, a broader dissemination of findings may be possible outside of the course setting, including at regional science education conferences. This assignment is graded in two stages. It is likely that significant changes and improvements will be made following feedback on the first draft.

Data analysis

Qualitative data, such as lesson plans and the literature review, will be coded using a phenomenographic methodology. In this approach, the coding will be used to investigate the different ways teachers experience their learning of content knowledge fundamental to General Chemistry at a graduate-level vis-à-vis their classrooms, students, and pedagogical content knowledge. This information will be paired with other descriptors, such as years in the profession and teaching philosophy, to consider whether a deeper content understanding influences teacher pedagogical content knowledge and leads to specific changes in their practices. Results from the teacher inquiry project and the design of instructional activities are additional data sources to be used to investigate the manner in which teachers do, or do not, plan to modify their practices. Quantitative data from exams will be used gauge basic teacher content knowledge, which will then be considered as part of a larger description of their self-

efficacy as teachers. Attention will be directed to investigate whether teacher's perceptions of their own self-efficacy are improved or diminished, by taking these courses, both at the topic level and for the courses as a whole.