Curricular Affairs Committee of the Faculty Senate

MEMO

To: Faculty Senate
From: Stephen Everse, Co-Chair of the Curricular Affairs Committee of the Faculty Senate
Date: April 9, 2024
Re: **Approval of a proposal for a new Certificate of Graduate Study in Computer Science Education** submitted by the Department of Education in the College of Education and Social Services, the Department of Computer Science in the College of Engineering and Mathematical Sciences, and the Graduate College

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At the April 4, 2023 meeting of the CAC we unanimously approved (19-0-0) a proposal for a new Certificate of Graduate Study in Computer Science in Education (CGS-CSE) submitted by the Department of Education in the College of Education and Social Services, the Department of Computer Science in the College of Engineering and Mathematical Science, and the Graduate College. No comments were received during the 15-day comment period. If approved by the Faculty Senate and Board of Trustees, this certificate will be implemented starting with the FY 24-25 catalog.

Over the last year this group has worked on the creation of the CGS-CSE):

- Robert Erickson (CS)
- Jackie Horton (CS)
- Lisa Dion (CS)
- Regina Toolin (CESS)

Program Description and Rationale

A creative collaboration between faculty in CEMS and CESS has generated a proposal for an 18 credit Certificate of Graduate Study in Computer Science in Education (CGS-CSE) which, upon its completion, currently licensed grade 7 – 12 educators in Vermont will be eligible for a teaching endorsement in Computer Science Education (supporting letter provided by the VT Agency of Education). The program's courses will be offered in an online format, expanding the certificate's geographic reach.

Computing represents two-thirds of projected new STEM jobs in the US, but less than 3% of college students earn a Computer Science (CS) degree and only 8% of STEM graduates major in Computer Science. (https://csedweek.org/resource_kit/blurbs). Computing and information technologies have driven many aspects of Vermont's economic growth, as evidenced by the presence of Dealer.Com, NRG Systems, Competitive Computing, the Vermont Technology Alliance, and over 200 other related companies statewide. Vermont's IT future is bright and job growth is projected to remain strong over the next decade; however, there is a disparity between CS employment opportunities and the CS learning opportunities available for K-12 students in the state.

Justification and Evidence for Demand

Currently Vermont's minimal adoption of computer science education standards places it in the bottom tier in the US (with 9 other states). A joint study by the Association for Computing Machinery (ACM) and the Computer Science Teachers Association (CSTA) notes that these nine states give no attention to Level II or

Level III standards at the secondary level and have adopted less than 10% of CS concepts overall (Wilson et al., 2010). Further, only 15 schools in VT (22% of VT schools with AP programs) offered an AP CS course in 2019-2020, which is 3 more than the previous year and only 27 teachers (or less than 1%) are licensed to teach CS.

A statewide survey conducted by Vermont Agency of Education (VT AOE) revealed that over 600 teachers in Vermont were interested in furthering their knowledge of computer science via professional learning and coursework (VT AOE, 2018). Teacher preparation programs in Vermont did not graduate a single new teacher prepared to teach CS in 2018. Sixty-two percent of Vermont principals think CS is just as or more important than required core classes and state that one of the biggest barriers to offering CS is the lack of funds for hiring and training teachers. (Code.org, https://code.org/promote/vt)

There has been a growing push in recent years to offer more computer science education in the K-12 space. For example, Amazon Future Engineer kicked off their Teacher Ambassador Program this past summer to identify the current state of CS education in different regions and look for ways to improve it. The Vermont ambassador for this program, Ollie Brown, teaches computer science courses in grades 7 and 8 in Rutland, VT; although he is not yet endorsed by the VT AOE to teach computer science. Mr. Brown surveyed the teachers at Rutland High School who teach computer science and found that they have Education Tech endorsements, but not Computer Science endorsements. This is one small example of a growing trend in our state: middle and high school teachers currently teach computer science classes in the state even without endorsements to teach in that field. This naturally leads to inconsistent and potentially insufficient knowledge of the subject area and understanding of best teaching practices of content and pedagogy in the computer science field.

NSF EPSCoR SOCKS Project (see: https://www.uvm.edu/socks/) includes full tuition support for 20 teachers (2 cohorts of 10 teachers) and stipends for computers and classroom supplies for each teacher. Only those teachers enrolled in the GCCSE will be eligible for tuition support through the EPSCoR grant.

Relationship to Existing Programs

The CGS-CSE is similar in content to the undergraduate minor and major concentration in Computer Science Education that was approved by the Faculty Senate in 2019 in that the certificate and minor/major concentration are aligned to the Agency of Education (AOE) Computer Science Endorsement Standards with the primary goal of earning licensure to teach CS in grades 7-12. This graduate certificate is different from the undergraduate minor and major concentration in that CS content and pedagogy are integrated throughout 5 required courses (18 credits) with corresponding readings, assignments and projects that are representative of graduate study.

Curriculum

This 18-credit hour certificate must be completed in order as the courses build upon each other.

	Required Core Coursework (18 credits)		
Course Number*	**Title**	**Semester**	**Credits**
EDCI 5001	Python Programming for Educators	Fall	4
EDCI 5002	Java Programming for Educators	Spring	4
EDCI 5003	Interactive Web Design for Educators	Summer	4
EDCI 5004	Computer Organization for Educators	Fall	3
EDCI 5005	Data Science for Educators	Spring	3

*All courses are approved and in CourseLeaf.

The proposers chose to offer one course at a time to support the target audience of in-service teachers, knowing that they are occupied with full-time teaching jobs through ten months of the year. They will also offer all courses in remote hybrid format (asynchronous and synchronous) because they want to reach in-service teachers across the state of Vermont. We specifically designed the courses, sequence, and modality to be the most equitable solution for any middle/high school teacher in Vermont to add computer science as an endorsement area to their teaching license.

Admission Requirements and Process

To enroll in the CGS-CSE, candidates will be required to hold a teaching license in middle or secondary education in any approved subject area endorsed by the VT Agency of Education (or other state agencies of education). A minimum 2.75 overall and content GPA will be required for admission to the CGS-CSE. In addition, candidates will need to provide 3 letters of recommendation, an application essay/statement of purpose, UG and/or graduate transcripts, and stated commitment to teaching CS to adolescents.

Regina Toolin (CESS) and Lisa Dion (CS) will collaborate with Gillian Homsted, CESS Director of Graduate and Non-Degree Enrollment Management, in the recruitment of potential candidates and evaluation of applications to the CGS-CSE. Candidates' applications will be initially screened by Gillian Homsted, and then reviewed by Regina Toolin and Lisa Dion. A four-point rubric that evaluates candidate's qualifications including 3 letters of recommendation, application essay/statement of purpose, UG and/or graduate transcripts and commitment to teaching CS to adolescents will be utilized in the screening and evaluation process for candidate selection. Candidates will need a minimum of 17/21 points on the selection process rubric in order to be considered for acceptance into the GCCSE.

To be in good standing in the program, candidates will need to maintain a minimum 3.0 GPA in coursework with a grade of B or better in all courses. Since these candidates will already hold a teaching license, they are not required to complete a practicum or student teaching experience. In addition, candidates will not be required to complete the Vermont Licensure Portfolio.

Anticipated Enrollment and Impact on Current Programs

The CGS-CSE will not compete with any other programs at UVM for student enrollment. Initially, they anticipate that the first cohort of 10 teachers will enroll in the program beginning in Fall 2024. Teachers will enroll in the online GCCSE program on a part-time basis taking 1 course each semester over a 2-year period including one summer session course offering. It is anticipated that the second cohort (n=10) will enroll in the program beginning Fall 2026. Additionally, enrollment will be open to other teachers or individuals who might be interested in applying to the program or taking specific courses as needed.

Advising

Regina Toolin will serve as program coordinator and primary advisor for the students enrolled in the CGS-CSE program. Advisement will include a CGS-CSE orientation program at the onset of the program and continue with required advising meetings on a semester basis and as needed for those students who request additional advising and mentorship.

Assessment Plan

The long-term goal of the CGS-CSE is to educate the next generation of computer science teachers (grades 7-12) in Vermont and across New England that will encourage and support diverse groups of students as they become computer science literate and consider computer science careers. More specifically, the program level learning goals are directly aligned to the VT Agency of Education (5440-14) Computer Science Educator

Endorsement Standards (https://education.vermont.gov/sites/aoe/files/documents/Rules%20Governing%20the%20Licensing%20of%20Edu cators%20.pdf - See p. 86.):

Goal 1. Teachers will demonstrates knowledge of essential computer science concepts, skills and history including:

1.2.1. &1.2.2. Important contributions of individuals or groups, particularly those made by underrepresented populations', to the development of computer technology and generational milestones in the historical development of computer technology

1.3.1. Basic steps in algorithmic problem-solving to design solutions (e.g., problem statement and exploration, examination of sample instances, design, implementing a solution, testing, evaluation, revising).

1.4.1. The function, application, capabilities and limitations of computers, their operating systems, software applications, and networking components

1.4.2. Appropriate use of hardware components (e.g. input, processing, output, primary / secondary storage devices) with respect to functionality, cost, size, speed, accessibility, and aesthetics

1.4.3. Role of compilers and interpreters in translating programming languages into machine instructions 1.5.1. Various types of networks and their performance characteristics, models for defining network standards and protocols, and network topology

1.5.2. Cybersecurity including identifying features and functions of security tools (e.g., firewalls, antivirus programs, filtering software, and encryption).

1.5.3. The relationship between clients and servers on a network (e.g., cloud storage, web browsers, email)

1.6.1. & 1.6.2. Collecting, aggregating, cleaning, and modeling data. Using simulations, visualizations, and statistical models to perform exploratory data analysis

1.7.1. Fluency in at least one high-level language used in current pedagogy including variables, data types, creating and using methods, passing data between methods, control structures, and data structures

1.7.2. Programming languages, including the definition and structure of languages and comparison of existing high-level languages, particularly including object-oriented program design

1.7.3. The specification, design, implementation, testing, modification, and debugging of software

1.7.4. Apply problem-solving strategies such as design specification, top-down design, step-wise refinement, object-oriented design

1.7.5. Algorithm analysis using big-O notation to evaluate best-, average-, and worst-case space and time techniques

1.7.6. Important programming concepts such as modularity, abstraction, recursion, libraries and Application Programming Interfaces (APIs)

1.8.1. Ethical acquisition (e.g., citing sources using established methods) and acceptable versus unacceptable use of information (e.g., privacy, hacking, piracy, vandalism, viruses, current laws and regulations).

1.8.2. Intellectual property rights and related issues (e.g., copyright laws, fair use, patents, trademarks) when using, manipulation, and editing electronic data.

1.8.3. Issues related to the equitable use of technology (e.g. gender, ethnicity, language, disabilities, access to technology)

1.8.4. Digital citizenship, digital footprints, and other ways technology is shaping culture and social interactions

1.8.5. Identifying and avoiding online threats including phishing schemes, sextortion, and identity theft among others.

1.9. The concepts, vocabulary, and issues found in two or more of the sub-disciplines of computer science (including but not limited to: abstract data types, advanced computer science algorithms, computer architecture, networks and data communications, physical computing, digital forensics, machine learning)

Goal 2. Teachers will implement an inquiry-based computer science curriculum that integrates conceptual understanding and skill development including:

2.1. Plans and implements instruction that allows students to use computer science in problem-solving and decision-making situations

2.2. Keeps current with the use of technology in education and issues related to legal and ethical use of technology resources

2.3. Designs and implements activities which reinforce verbal and written technical communication skills central to computer science

2.4. Uses basic steps in algorithmic problem-solving to design solutions (e.g., problem statement and exploration, examination of sample instances, design, implementing a solution, testing, evaluation)

2.5. Uses effective management strategies for teaching computer science (e.g. laboratory work, cooperative learning, electronic communication)

2.6. Uses appropriate instructional strategies for teaching computer science (e.g., case studies, role-playing, manipulatives, visualizations, simulations, modeling)

The program will undergo APR evaluation along with the Department of Education.

Staffing Plan, Resource Requirements, and Budget

Regina Toolin currently serves as Program Coordinator for the Undergraduate minor and major concentration in Computer Science Education. She will continue to serve in this role for the CGS-CSE.

As this is an entirely online CGS, no physical space is necessary. The library has been consulted and current holdings are adequate to support this certificate.

As mentioned previously, the NSF EPSCoR SOCKS Project full tuition support for 20 teachers (2 cohorts of 10 teachers) and stipends for computers and classroom supplies for each teacher enhances the program's attractiveness and financial sustainability!

Evidence of Support

Dean of Graduate College Holger Hoock provided a strong letter of support as did Dean of the College of Education and Social Sciences Katharine Shepherd and Dean of the College of Engineering and Mathematical Sciences Linda Schadler. Endorsements were also provided by Department of Education Chair Kimberly Vannest, Department of Computer Science Chair Christian Skalka, and the CESS Curriculum Committee.

Summary

The proposal clearly articulated a need for Vermont K – 12 students to have a strong computer science education and a desire by both Vermont educators and administrators to be able to provide this. This 18-credit graduate certificate in Computer Science Education for currently licensed grade 7 – 12 educators in Vermont will immediately enhance the quality of CS education in our middle and high schools because those completing it will be eligible for a teaching endorsement in Computer Science Education.