Bridging the Computer Science K-12 Education Gap by Integrating Conventional Materials with an Immersive Virtual Environment

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Abstract

To address the national issue and urgent need for Computer Science Education in K-12 school systems, a new graduate certificate program is described. The graduate certificate in Computer Science Education at North Dakota State University is completely online and offered during the summer session in order to accommodate in-service teachers aiming to cross-train from other STEM teaching assignments into Computer Science. The second course in the required certificate sequence is described in detail. CS642: Problem Solving in Computer Science Education takes a novel approach to online course delivery. In addition to the traditional materials (textbook, slide-show style presentations, portfolios, online quizzes), the course is integrated with an Immersive Virtual Environment for Education named the MOO-based Education Platform (MEP). Details of this implementation are provided.

1. Introduction

According to the U.S. Bureau of Labor Statistics (USBLS), the computer and information technology field is expected to grow by 12 percent from 2018-2028 (CAITO 2020) — faster than the average growth rate of all occupations. 546,200 new jobs are projected to be added in the areas of cloud computing, the collection and storage of big data, predictive analysis with artificial intelligent, information security and similar jobs. However, computer science graduates are in low supply to fill the increasing demand of technical jobs (Outlook 2020). According to data compiled by code.org, the U.S. primary and secondary education systems are not upgraded to include technical skills needed to meet this demand (CSEW 2020). North Dakota currently has 575 open computing jobs (3.1 times the average demand rate in North Dakota), however, North Dakota had only 162 computer science graduates in 2017. Only 12 schools in ND (22% of ND schools with AP programs) offered an AP Computer Science course in 2017-2018 (13% offered AP CS A and 6% offered AP CSP), which is 2 more than the previous year. Universities in North Dakota did not graduate a single new teacher prepared to teach computer science in 2017 (SCSED 2020).

As computer science fuels technological innovation and drives career growth, waiting till college to learn the basic foundational principle could mean missed opportunities in a diverse array of careers within Computer Science. Support for K-12 academic and computer science teachers in designing interdisciplinary, project-based instruction and assignments that engage students in applying literacy, math and computational thinking skills to solve problems, hence, becomes critical to simulate interest and graduate students with the right skills.

The Department of Computer Science at North Dakota State University (NDSU) is developing a sequence of courses to be offered as part of a new Graduate Certificate in Computer Science Education (GCCSE). The certificate program is primarily aimed at in-service teachers hoping to be licensed to teach Computer Science in K-12 schools.

These teachers will implement their own courses, in compliance with the long awaited "State Standards" very recently published by the North Dakota Department of Public

Instruction. In support of this initiative, NDSU is positioning itself to serve as a statewide resource by creating the certificate program and developing this sequence of completely online summer school courses.

The GSCSE program at NDSU includes four "core" courses, plus another two courses chosen from a list of five electives. All courses are three credits. To achieve the certificate requires six courses, a total of 18 credits.

The key feature distinguishing the GSCSE program at NDSU from other online offerings is the decision to integrate conventional materials, either developed in house or provided by a textbook publisher, with an Immersive Virtual Environment (IVE) for Education.

2. Background

This project combines traditional online resources with an immersive virtual environment.

2.1 Online Courses

Today distance learning through online coursework has come a long way from its humble beginnings. It is estimated that one out of four college students today are enrolled in at least one online class. Since the mid 1990s we have seen a dramatic increase in available web content and online communication which has created an environment where most everything is now available online, including education. Where once it may have been important for students to physically attend a prestigious university, today there is more focus on the content that a student has learned than there is on the school they have attended. This is partially caused by the vast amount of available information and the need for students to learn new technology skills as the technology itself is quickly evolving. Where we once relied heavily on books that would stay in use for decades, the rate of software evolution now quickly renders books obsolete within a few short years after they are printed.

A solution to this problem comes as part of the changing technology itself. Where once everyone relied primarily on paperback books, we now have online documentation and specifications for virtually every field of study. Along with this new digital information comes the ability for schools to use these resources to constantly provide their students with the most current and up-to-date information possible. In the field of computer science outdated information can be quite useless due to the rate of change within our field. So, having current up-to-date information is quite crucial to students and instructors alike.

Today 93% of all brick and mortar universities in the US offer online classes and 83% of these schools say that they expect an increase in online enrollment (Online Schools 2020). The US government under President Barack Obama pledged over $500 million dollars to universities to help them expand their online course materials (Online Schools 2020). With more available online courses students who would otherwise not be able to

attend classes due to time constraints, and other restrictions now have access to the same high level of education as students physically attending classes. Universities benefit from online courses as well, because they can automate many portions of the classes with video lectures, and auto graded tests allowing the instructors more time to work on other class materials.

2.2 VCSU/MEP

The Valley City State University (VCSU) MOO Educational Platform (MEP) system (formerly known as the ProgrammingLand MOOseum of Computer Science) is a hypermedia textbook and a virtual museum with a web-based interface (Hill and Slator, 1998; Slator and Hill, 1999). The MEP MOOseum is divided into “wings” that are devoted to particular programming languages, each populated with an array of interactive objects and agents that facilitate an active learning experience.

The wings are divided into virtual lessons and exhibits which students browse through in a self-paced exploration. Lessons are interconnected clusters of related course content. Exhibits are interactive demonstrations of the course content, which the students are encouraged to manipulate as part of the learning process.

The MEP MOOseum is intended for use in distance learning and non-traditional classes. It is designed to both deliver content that would normally be obtained from a lecture or textbook, yet also have many of the attractive qualities of games and other learner centered activities.

The MEP MOOseum is hosted on a MOO ("MUD, Object-Oriented", where MUD stands for "Multi-User Domain" or, sometimes, "Dungeon"). MUDs are historically text-based electronic meeting places where players build societies and fantasy environments and interact with each other (Curtis 1998). The basic components are "rooms" with "exits", "containers" and "players". MOOs support the object management and inter-player messaging that is required for multi-player games, and at the same time provide a programming language for customization of the environment.

A lesson covers one distinct topic. It does not need to exhaust the topic but should be self-contained. Lessons are usually hierarchical, where a lesson may contain smaller lessons. A typical lesson has:

a) an introduction that explains the need for the topic,

b) the content material,

c) an exercise motivating the student to use the new knowledge, and

d) some type of assessment.

2.2.1 Goals and Assessment

As with more conventional course design, a course is a list of lessons and associated material. To complete lessons, students visit specific rooms and interact with specified

objects while there. When a student visits a room or interacts with an exhibit it is recorded.

Each student enrolled in a course is assigned a list of lessons, and a goalie agent to provide instruction and guidance on achieving course goals. A roving goalie is a software agent that gives assignments so that students will know what lessons they are expected to complete.

2.2.3 Quiz Rooms

There is a quiz room attached to each lesson and a quiz generator that looks at the player's history to determine if there are any required lesson rooms that were not visited. Five questions are gathered from these rooms. If the student answers incorrectly, the correct answer is given. If they answer four of the five correctly they get credit for the lesson.

2.2.4 Code Machines

A code machine, sometimes called a “codeapplet”, contains a piece of a program, which it will display, explain or trace what is happening at run time, including any variables changed. When a student completes either an explanation or trace of code in a machine, it is recorded, giving the student credit for using the machine.

3. Design Issues

Course construction is an exercise in design, and issues arise. Should social media be involved. If so, how? What are effective methods for employing presentation software? What is the role of portfolio construction? How are portfolios evaluated?

3.1 Social Media

It is a dispute that social media has the potential to attach formal and informal learning through participatory digital cultures. Social media includes social networking sites and microblogs where people can connect with one other. Scholars have expressed the potential of social media for integrating formal and informal learning, yet this work is commonly under-theorized. Social media has been mainly “the many relatively inexpensive and widely accessible electronic tools that facilitate anyone to publish and access information, collaborate on the common effort, or build a relationship” (Social media, 2020).

3.1.1 Advantages of Social Media on Education

There are several advantages of social media that are commonly cited.

- Social media helps the students to reach each other in terms of the classwork, discussion, projects, multiple assignments or for help on homework assignments (Revista Bem Legal, 2020).

- The students who are not regular and do not take an interest consistently in class might feel that they can express their thinking on social media.
- The instructor may post on social media about class activities, news, events, and homework assignments -- providing feedback from the instructor can be helpful to the whole class.
- A survey on social media in the European Union (Drahošová and Balco, 2017), noted 97.2 % of users exchange information and communication while 83.30% used social media for data sharing.
- Social networking sites focus primarily on constructing online communities with common interests or activities, and help students develop leadership, communication, planning and collaboration skills (LCIBS, 2019).

3.1.2 Disadvantages of Social Media on Education

- The prime disadvantage of social media is addiction. Constantly checking social media can negatively affect other valued activities like concentrating on studies, taking an active part in sports, real-life communication, and ignoring practical realities.
- One of the biggest breakdowns of social media in education is privacy issues like posting personal information on online sites, data security etc.
- In some of the cases, there was much inappropriate information posted, which may mislead the students.

In our GCCSE, our course will be available for currently enrolled participants only for a specified period. With time the community will grow, if anyone posts any problem or query, the current student, as well as an old student, can help with solutions or helpful resources because social media will keep all the old and new altogether.

Social media help us student to informal communication like discussing current work, idea sharing, and others. Have students follow the class's social media Page, and the instructor can use it to post class updates, share homework assignments, notice and encourage discussion. Also, instructors can stream live lectures. Also, students can connect with anyone at any point in time via instant messenger. As technology is emerging the social media has become the Inseparable for every person, peoples are seen addicted with these technologies every day.

3.2 Presentation Software:

Presentation software is a computer software package used to show information, normally in the form of a slide show. It mostly includes three major functions: an editor that allows text to be inserted and formatted, a method for inserting and manipulating graphic images and a slide-show system to display the content.

The most well-known presentation program is Microsoft PowerPoint, but there are alternatives such as OpenOffice.org Impress, Apple's Keynote and WPS Office.

Presentation software can be a great publishing tool. The ability to integrate words, visuals, and other interactive elements like hyperlinks and video are a few of the key attributes of a slide document. First, it's a practical alternative to traditional method of teaching, it's a tool you use every day and will work for most of your communication needs. It's a tool that has ability to visually guide and engage the reader.

Second, presentation software is pervasive. For example, PowerPoint® is installed on more than a billion computers worldwide. Many people use it to create concepts and strategies, and plenty of great ideas trickle out of these applications.

Lastly, some presentation tools allow you to pick up entire pages, rearrange them, easily merge them into existing documents, or save them into their own file. The ease with which you can accomplish these tasks with presentation software makes it the perfect platform for spreading information. Presentation software has a unique ability to facilitate and spread ideas.

3.2.1 Benefits of Presentation Software:

- **Visual:** Visualizing information helps your readers see what you're explaining.
- **Versatile:** It incorporates photos, illustrations, sketches, and even video if it's posted online.
- **Interactive:** You can embed links and jump around the document itself or out to the Internet.
- **Tablet-ready:** Its aspect ratio makes it easy to load onto devices.
- **Spreadable:** Its modular nature allows slides to be incorporated into other decks and spread it throughout the organization.
- **Shareable:** Platforms like SlideShare make it embeddable and shareable.

3.2.2 Importance in the Teaching/Learning Process:

1. Digital presentations are excellent medium for teaching activities, easy to create, use, copy, store and transport.
2. Presentation software used to enhance language learning. It encourages use of all four kind language skills: Reading, Writing, Speaking and Listening.
3. Presentation software makes the ability to communicate messages to a group of people much simpler than any other delivery methods.
4. Seeing the presentation while hearing about it helps both visual and audio learners absorb the information.
5. Presentation software is now used for a variety of tasks beyond simple presentations by teaching staff and students.

Presentation software extends a large amount of control over graphic parameters. This can be extremely important for professionals who work with special needs children and adults. A little well-placed know-how and creativity can turn presentation software into a surprisingly versatile tool. The result is an economical way for teachers to design the

unique materials they want for their students and clients, make lessons more accessible for individuals with low vision, and generate materials in a wide variety of formats.

3.3 Portfolios

Portfolios allow professionals to display their achievements and projects in a well-organized and easy to view structure. Many software developers and computer scientists use GitHub as a primary host site for their professional portfolios. Portfolios are important because they showcase important work as well as the owner's capabilities. Portfolios are easy to view by prospective companies and organizations and easy for the owner to update. It is crucial to maintain a clean well-organized portfolio that accurately reflects the owner's technical capabilities. Since the mid 1990s online portfolios have become quite common with several new varieties being developed.

A portfolio in academic settings is a collection of work that exhibits compilation of academic work, progress, achievements and skills. One essential element of portfolios is student reflection on their own learning and progression towards the mastery of the material documented in the portfolio. Portfolios are becoming increasingly popular in academia as well as in industry for learning, assessment, job search etc. The educational portfolio development process gives both the student and faculty an opportunity to reflect on student growth over time. Students can reflect on their academic journeys, achievements, skills in a centralized document. While teachers can use it to document the materials that collectively suggest the scope and quality of a professor's teaching performance. (Seldin, Miller, & Seldin, 2010, p. 4) In fact, most faculty spend a great deal of their time teaching; and portfolio is an effective way to reflect on and improve teaching process. Teaching portfolios usually include "artifacts of teaching" that demonstrate course design, course implementation, and student outcomes (Seldin, Miller, & Seldin, 2010, p. 4). Portfolios can be useful in the following cases: (1) Teacher/ Student evaluation (2) Dissemination of educational advancements, (3) Applications for grants, promotion, or awards, and (4) Job search.

Generally, contents of the portfolio include learning artifacts, course syllabus, reflection on course design and development, and student evaluations (Shah et al., 2019; Babin et al., 2002). Due to individual differences and variations in how faculty members teach, all portfolios are understandably unique. Teaching portfolios can be of two types: reflective and comprehensive portfolios (Driessen et al., 2019).

3.3.1 Reflective portfolios

Largely aim at the development of reflective skills. It requires student to write up a reflection on an aspect that is considered important to their learning or profession. It summarizes the insights and experiences a student has gained from the academic journey. It is used to assess the student's engagement with their fieldwork, and their ability to use theoretical knowledge and skills.

3.3.2 Comprehensive portfolios

Comprehensive portfolios are integrated into the curriculum i.e., they form part of an assessment program. They describe detailed abilities and skills of the students including the student academic journey, projects completed and research interests. It also focuses on the objectives of the courses taught and the methods used to accomplish these objectives, student outcomes, and lessons the instructor has learned. Comprehensive portfolios can contain reflections, but their content is much more diverse than that of reflective portfolios. The goal of comprehensive portfolios is to support the student's learning process and to assess the student's progress.

Portfolios serve to illustrate whether students or professionals have met the standards of their prospective fields (Portfolio 2016). They show an individual's professional progress and allow companies and organizations the ability to accurately understand that individual's capabilities. Review and assessment of a portfolio starts with analyzing the portfolio's organizational structure. A poorly organized portfolio is often an indication of a poorly organized individual.

3.3.3 Portfolio assessment

Serves to allow instructors to gauge where their students are in relation to where they should be at any given time in the learning environment. This supports the instructor's ability to see where students are struggling and where they are excelling thus allowing them to integrate assessment and instruction to promote classroom learning (Portfolio Assessment 2020). Portfolio assessment also allows students to evaluate and reflect on their own work and progress. This interaction with the learning process and subsequent self-review and reflection, leads to students better understanding any topics or fields where they need to improve, and allows them to focus on these critical areas as soon as possible.

4. Implementation

Following the design issues above, these steps were taken.

4.1 Integrating the IVE with Conventional Materials

The MEP IVE is vast and comprehensive (Hill 2008), with over 100 lessons (Hill 2006), and a well-documented system for using and maintaining the environment (Hill 2019). The total number of lesson rooms, exhibit rooms, quiz rooms, and other content exceeds 3000.

The course being developed is CSci 642: Problem Solving in Computer Science Education. CSci 642 is the second required course in the sequence leading to the GCCSE at NDSU. It is intended to be a completely online course, offered during the summer to accommodate in-service teachers. The textbook for the course is "Problem Solving and Programming Concepts" by Sprankle and Hubbard (2012). The course covers 12 chapters during the 12 weeks of NDSU Summer Session although, being completely online, it is

self-paced, with nothing to prevent a student from racing through the material in less time.

Despite it being online and self-paced, there is a “schedule” that describes what a student should accomplish each week in order to complete the course. Each week, the student is instructed to:

- Check for activity on the ND Computer Science Education Group Facebook page,
- Read one or two chapters in the textbook,
- Review one or two of the powerpoint summaries for the assigned chapters,
- Take the one or two 20-question online quizzes for the assigned chapters,
- Explore a “lesson” on the PLand/MEP IVE and take the associated online quiz.

4.1.1 Associating Weekly Activities with PLand/MEP Lessons

After a few introductory and background units, the PLand/MEP material closely aligns with textbook material. For example, Week 9 covers Chapter 11, "Linked Lists" and is associated with the PLand/MEP lesson and quiz: List Basics (#10568) and List Basics Quiz Room (#11437).

To complete the “List Basics” lesson on PLand/MEP the student must visit and absorb the material on the 15 connected exhibits: List Class Structure, A List Node Class, A List Class, More on traversing a list, A List Iterator Class, A sample iterator header, Introduction to Linked Lists, More on Linked Lists, List Types, Straight Linked Lists, Trailing Pointer Technique, Circular Linked Lists, An example needing a circular list, Singly Linked Lists, and Doubly Linked Lists.

Other examples include Chapter 7 of the textbook, "Problem Solving with Loops" associated with the PLand/MEP lesson and quiz: Loop Anatomy (#748) and the Loop Properties Quiz Room (#1283). The object numbers, #748 and #1283, uniquely identify specific locations in the IVE. Chapter 9 of the textbook "Sorting, Stacks, and Queues" is associated with the Sorting (#10787) lesson and the Sorting and Merging Quiz Room (#11538), the Stack (#2244) lesson and the Stack Quiz Room (#15884), as well as the Queue (#2243) lesson and the Queue Quiz Room (#15923). Chapter 13 of the textbook, "Database Management Systems" is associated with the Why is Database Important? (#17149) lesson and the Importance of database quiz room (#17226).

4.1.2 PLand/MEP $codeapplet Implementation

LambdaMoo is an object-oriented language/IDE that is programmed in an online collaborative environment. enCore is a distribution of LambdaMoo that provides web-ready object classes that, when extended, give LambdaMoo objects the capability to be rendered by a web browser.

The $codeapplet object extends both the $“enCore Web Object” and $code_machine objects. Its purpose is to render a $code_machine as Javascript so that a user may interact with a $code_machine in their web browser, if they do not wish to use the text interface implemented by $code_machine. In order to define a new $code_machine, three arrays of text must be defined: code_list, exp_list (“explain”), and tr_list (“trace”). code_list is merely the source code, each line of code is stored as a string in the array. exp_list is a one-to-one mapping of textual explanation for each line of source code. The final array, tr_list, uses a metalanguage to describe the flow of the program and the value of each variable as the program executes. Both exp_list and tr_list are accessed by the user in an interactive, one line at a time fashion. The metalanguage used to describe tr_list includes facilities to prompt the user "What is the number of the next line to be executed?" or "What is the new value of [variable-name]?” during an interactive trace.

Following are examples of $codeapplet objects with source code in BASIC, C++, and Java that have been created by faculty and students.

Syntax Lessons

Variable Declarations with Initializers: A code machine describing how to declare variables and initialize them in the declaration.

List Code Machine: Several list operations are explained in this code machine.

Form of the Select / Case Statement: A Select/Case code machine showing the multiple keywords and substantially different structure compared to other control-flow statements.

The Switch Case is Equivalent to an If: The equivalence between a Select/Case statement and an If statement is shown in this code machine.

For Example or Averaging Numbers: Part of a pair of code machines. This code machine uses a For statement to average a group of numbers.

While Example or Another averaging example: Part of a pair of code machines. This code machine uses a While statement to average a group of numbers.

Using a for loop to read a definite number of integers: A code machine that uses a count controlled For-loop.

C++ While Loops: Nested While statements are demonstrated in this code machine.

Operator Precedence Workroom: A code machine that shows the user the output of different combinations of arithmetic operators; demonstrates the operator precedence rules of C++.

Computing a Factorial: One of three code machines demonstrating a Factorial function. This code machine is written in BASIC and uses a For statement.

Two Factorials: Code machines two and three (out of three) demonstrating a Factorial function. Both are written in C++. One is a syntax translation of the BASIC For-loop, the other demonstrates a recursive function.

Algorithms

Exchange Code: A code machine demonstrating the Exchange Sort algorithm over a list of integers.

Selection Code: A code machine demonstrating the Selection Sort algorithm over a list of integers.

Insertion Code: A code machine demonstrating the Insertion Sort algorithm over a list of integers.

Binary Search code in Java: Given an array of Integers and an Integer to find, this code machine shows a Binary Search algorithm.

The RootApproximator Code Machine: A code machine that demonstrates Newton's Root Approximation algorithm.

Technical Lessons

Todd's Log Room: A code machine written by a student. Demonstrates the use of the mathematical Log function.

Tara's Room: A code machine written by a student. Demonstrates boolean operators and shows the output of various boolean statements.

Sam's Room on Tan Function: A code machine written by a student. Demonstrates the use of the mathematical Tan function and explains the expected input (radians) and possible outputs.

4.2 Implementing Projection Software

Choosing the right presentation software tool is essential to sustainably engage the digital learning professionals. Articulate Presenter is one of the many tools available in the market. It is an add on to powerpoint which makes online learning effective and versatile. It adds a variety of different useful features, including audio narration support, quiz integration, and interactive multimedia support. Inclusive learning environment is the commitment of the university, as such every presentation will embed accessibility features for visually impaired such as captions and compliance with a computer screen reader JAWS with text-to-speech output.

4.3 Implementing Portfolios with Blackboard

Choosing an appropriate portfolio for any given context is a crucial skill. Thus, students will create portfolios on the NDSU Blackboard and evaluate these portfolios. These exercises will give students experience both building portfolios, as well as evaluating portfolios. Blackboards portfolio tools will guide students through the setup of sections, artifacts, layout, and organization of their portfolios. After completion, students can download a copy of their portfolios for later use: such as showcasing their skills and accomplishments to future employers. Portfolios can also be implemented using NDSU Blackboard. Portfolio tools in Blackboard will help you in creating the portfolio where you can organize collection of artifacts such as achievement certificates, projects done previously etc. Further, portfolios can be further shared as evidence of your skills to the potential employers or for future reference. After you finish the course, you will not be able to access the Blackboard to edit or share your portfolios. To cater that, you can download your portfolio before completing your course.

5. Future Work

In the future we will try to set up a small study to evaluate our proposed methodology. We will be conducting qualitative and quantitative studies to determine effectiveness. We can evaluate the comprehensive portfolios. We also would like to investigate whether VSCU's MEP system causes a hindrance in the learning process of the teachers. The text-based nature of the interface might increase the cognitive load. We might try a Graphic User Interface (GUI) on top of the existing MEP system to reduce the cognitive load. We can also incorporate a portfolio evaluation at the end of our course for assessment.

6. References

CAITO (2020). Computer and Information Technology Occupations. Available at: https://www.bls.gov/ooh/computer-and-information-technology/home.htm [Accessed February 26, 2020]

CSSE (2020). Computer Science Education Week Resource Kit. https://csedweek.org/resource_kit/blurbs [Accessed March 4, 2020]

Curtis, Pavel (1998). Not just a game: How LambdaMOO came to exist and what it did to get back at me. In Haynes, Cynthia, and Jan Rune Holmevik, eds, High Wired: on the design, use and theory of educational MOOs. University of Michigan.

Drahošová, M., and Balco, P. (2017). The analysis of advantages and disadvantages of use of social media in European Union. Procedia Computer Science. Available at: https://www.sciencedirect.com/science/article/pii/S1877050917311286 [Accessed February 26, 2020].

Driessen, Erik (2017). Do portfolios have a future?. Advances in Health Sciences Education 22.1: 221-228.

Hill, Curt (2008). Using VCSU-MEP: An Introduction to the VCSU-MEP MOO Educational Platform. http://euler.vcsu.edu/MEP_intro.pdf. [Accessed 3/7/2020].

Hill, Curt (2006). All Lessons. http://euler.vcsu.edu/Lessons/Lesson_index.htm. Page created on 8/22/2006; [Accessed 3/7/2020].

Hill, Curt (2019). VCSU-MEP Objects. http://euler.vcsu.edu/Important_Objects.pdf. Updated August 19, 2019; [Accessed 3/7/2020].

Hill, Curt and Brian M. Slator (1998) "Virtual lecture, virtual laboratory, or virtual lesson," Proceedings of the Small College Computing Symposium (SCCS'98). Fargo-Moorhead, April. pp. 159-173.

Klenowski, Val, Sue Askew, and Eileen Carnell (2006). "Portfolios for learning, assessment and professional development in higher education." Assessment & Evaluation in Higher Education 31.3: 267-286.

LCIBS (2019). The Role of Social Media in Education. Available at: https://www.lcibs.co.uk/the-role-of-social-media-in-education/ [Accessed February 26, 2020].

Online Schools (2020). The History of Online Schooling. Onlineschools.org; https://www.onlineschools.org/visual-academy/the-history-of-online-schooling/; [Accessed 3/9/20].

Outlook (2020). What is the Employment Outlook for Computer Science Careers? [Available at: https://www.computersciencedegreehub.com/faq/what-is-the-employment-outlook-for-computer-science-careers/ [Accessed February 26, 2020]

Pegrum, Mark, and Grace Oakley (2017). The changing landscape of e-portfolios: Reflections on 5 years of implementing e-portfolios in pre-service teacher education. E-portfolios in higher education. Springer, Singapore. Pp. 21-34.

Portfolio (2016). Definition of Portfolio. Glossary Of Education Reform, The Great Schools Partnership. Last Updated: 02/18/16; https://www.edglossary.org/portfolio/. [Accessed 3/9/20].

Portfolio Assessment (2020). Assessment: Portfolio Assessment. Education Encyclopedia - StateUniversity.com. https://education.stateuniversity.com/pages/1769/Assessment-PORTFOLIO-ASSESSMENT.html. [Accessed 3/9/20].

Revista Bem Legal (2020). Should social media be used in classroom? A debatable question. Should social media be used in classroom? A debatable question - Revista Bem Legal. Available at: http://www.ufrgs.br/revistabemlegal/edicoes-anteriores/vol6n12016/should-social-media-be-used-in-classroom-a-debatable-question [Accessed February 26, 2020].

SCSED (2020). Support K-12 Computer Science Education in North Dakota https://code.org/advocacy/state-facts/ND.pdf [Accessed March 4, 2020]

Seldin, Peter, J. Elizabeth Miller, and Clement A. Seldin (2010). The teaching portfolio: A practical guide to improved performance and promotion/tenure decisions. John Wiley & Sons.

Shah, Purvi, Sreedhar Madhavaram, and Debra A. Laverie (2019). Developing and Demonstrating Effective Pedagogy in Marketing Education: Pedagogical Competence as an Organizing Framework for Teaching Portfolios. Marketing Education Review 29.4: 283-304.

Shaltry, Chris, et al. (2013) Situated learning with online portfolios, classroom websites and Facebook. TechTrends 57.3: 20-25.

Slator, Brian M. and Curt Hill (1999). "Mixing media for distance learning: using IVN And MOO in Comp372," World Conference on Educational Media, Hypermedia and Telecommunications (ED-MEDIA 99), June 19-24, Seattle, WA. pp. 881-886.

Social media (2020). Wikipedia. Available at: https://en.wikipedia.org/wiki/Social_media [Accessed February 26, 2020].

Sprankle, Maureen and Jim Hubbard (2012). Problem Solving and Programming Concepts, 9th Edition. Pearson. https://www.pearson.com/us/higher-education/program/Sprankle-Problem-Solving-and-Programming-Concepts-9th-Edition/PGM192419.html