ECP

Excellence in Computer Programming

A New Direction for a Coding Workforce

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I. OVERVIEW

Excellence in Computer Programming provides opportunities to experience the value of computer coding to enhance the sharing of knowledge.

We live in a world of rapidly changing ability to interact through vast capabilities of computers. We have incredible opportunities to share what is in our mind through smart phones, messaging, and a wide range of online services. We are challenged to redefine our lifetime of experiences to adapt to the impact of computers on the freedoms and security that had been our way of life.

The rapid evolution of computers in solving problems has led to the increasing awareness of the value of the knowledge and experience gained through directing computers to solve problems, a process called coding. There is need to continue the growth of the capabilities of excellence in coding. While in America coding has largely been the focus of specialized computer education, other countries have recognized the value of coding in the development of the critical thinking experiences to prepare leaders in the computer and associated industries. Increasingly, coding has become recognized as vital for success in our rapid changing world.

An evaluation of the coding resources available to support the development of a South Dakota workforce prepared with the knowledge and experience to be global leaders in the computing industries identified the extensive capabilities that are shared in the following pages of this report. As a result of this evaluation the nonprofit corporation, Excellence in Computer Programming, has been formed to assist with the implementation of a potentially unique environment that will bring recognition of South Dakota as a leader in the development of coding.

II. Organization

The Excellence in Computing Programming, Inc. (ECP) is dedicated to preparing opportunities to develop the knowledge and experiences to enable the use coding to improve the life of all peoples. The evolution of coding has revolutionized the role of computing in the global economy. There is an increasing emphasis on the value of coding in innovating solutions to the challenging problems of today's world. The preparation of people to use computers is expanding from the specialize discipline of computer science to the broad application coding as preparation for success in life.

In the summer of 2015, funding from the Governors Workforce Initiative and Black Hills Vision enabled the implementation of the Excellence in Computer Programming team of experienced K-12 educators: Kimberly Darata, Douglas School District; Trent Moehlman, Rapid City School District; Terry Lundeen, Rapid City Schools/St. Thomas More. The ECP team identified extensive resources available through the Internet and other information sources for use by students, teachers, and parents for the preparation of excellence in computer coding.

These identified resources will assist educators and other members of the community to increase the commitment of individuals to excellence in computer coding. The nonprofit Excellence in Computer Programming, Inc. is preparing programs to encourage broad participation developing the knowledge and experiences for excellence to become the South Dakota coding workforce. There is need to expand the development of coding through curriculum provided both in classrooms and through activities accessible beyond the traditional school environment. There is need to make available resources for both students and adults to develop the knowledge and experiences essential for the growth of excellence in the many aspects of computer coding.

The ECP will foster the development of coding processes to mitigate the challenges of cyber security through the formation of teams experiencing global competition. The development of the ECP workforce will adapt the processes of preparation, mentoring, and coaching that successfully support excellence in sports, music, writing, and the arts.

The resources identified by the ECP C team of educators are grouped in topic areas to facilitate teachers, parents and students to become engaged in the process of coding while developing other communicating skills. The coding resources provide access to a wide range of experiences from to coding to storytelling to the preparation of curriculum.

III. Internet Coding Resources

This selection of resources available through the Internet illustrates the how easy it is to become engaged in developing excellence in computer programming through the process called coding.

1. Code.org - Code.org is the comprehensive site to provide information about coding and introduces coding through the Hour of Code with coding for beginners. The site includes materials for teachers providing support for coding and includes successive courses for students ranging from beginning block coding through applications of Java script. Provides links to other coding languages and applications of coding including mathematics, science, and robotics. The site is primarily oriented to support in-school learning with teachers, but the information can easily be adapted for after school and extracurricular coding learning. Provides demographic information on the need for coding qualified workforce, the development of support groups, and extensive links to a wide range of partner cording sites.

2. Scratch.mit.edu - Scratch drag and drop coding program is designed for ages 8-16. Content can be created using the features available within the program. This site has explicit instructions for students to use to create content with drag-and-drop instructions. Enables students to advance to the ability to create their own content and share their projects.

3. Blockly-games.appspot.com - Blockly is a series of games that teach programming, beginning with the novice level and becoming increasingly challenging as the player progresses. Players can advance to the next game even if they have not mastered the one they are currently working through. Recommended links are provided for those who master the games and want further instruction and practice. Ages 10+.

4. Code Monster - Code Monster is a program that teaches Java with a very simplistic presentation. Fifty-nine lessons are offered with directions that allow for discovery on the part of the user and immediately visible results to code. The program saves the user's place when the user accesses the site from the same browser and the same machine. Crunchzilla identifies Code Monster as a first step in learning to program, and not a complete teaching of computer science and programming. Ages 10+.

5. Alice - Alice is a software program to teach basic object-oriented coding to prepare JavaScript graphics for 3D programming environment to create animations for telling stories, creating interactive games, and for preparing videos. Previous experience in object-oriented coding is required. The site has instructions and tutorials to enable students with experience in programming to create programs. The site includes resources for teachers to learn how to use the program before teaching it to students.

6. MIT App Inventor 2 - MIT App Inventor is a block-based programming tool that allows everyone, even novices, to start programming and build fully functional apps for Android devices. Newcomers to App Inventor can have their first app up and running in an hour or less, and can pro-

gram more complex apps in significantly less time than with more traditional, text-based languages. Requires a Google account.

7. Teaching Kids Programming- Teaching Kids Programming is a non-profit organization of volunteer programmers and school teachers who have developed a framework designed specifically for teaching basic programming to children aged 10 and up, providing middle school teachers the tools to build the next generation of creators using TKPJava courseware.

8. Teaching Kids to Code- Articles are provided in the areas of getting started, opportunities and resources, stories from coding classrooms, personal reflections, and a comparison of 50+ coding tools.

9. Processing - Processing is a programming language, development environment, and online community that promotes software literacy within the visual arts and visual literacy within technology. This language allows users to create multimedia artworks with their programming skills.

IV. iPad App Coding Resources

This selection of resources use iPads to provide an introduction to the basic concepts of coding.

1. Bee Bots - Bee Bots is a beginning level app that requires minimal reading and is easy to pick up the procedures. Players choose directional arrows to guide the bee to the flower in the yard. A record of commands is not provided, so memory or pen & paper must be utilized.

2. Cato's Hike - In this App, players must lead Cato to pick up certain treasures to proceed in the app. A tutorial is provided. Reading is required. Ages 8 and up.

3. Daisy The Dinosaur - In this App, players learn to drag and drop code to get Daisy to do what they want. Challenge mode provides a direction for players to follow. Free play mode allows players to create their own actions. While this App appeals to a younger audience, some reading is necessary. Ages 5 and up.

4. The Foos - In this App, players choose directions to drag and drop code so the character collects jewels and other items. No reading is necessary, as all directions are given as illustrations. Ages 5 and up.

5. Hopscotch - Hopscotch is an iPad app that allows users to make games, animations, stories, and other interactive programs by dragging and dropping colorful blocks of code. Use shaking, tilting, or even shouting at the iPad to control characters on screen. In app purchases available and a fully unlocked version is available for $10. Ages 9-11.

6. Light-Bot - Light Bot is an App that allows users to learn programming skills with picture commands. The intended audience is ages 9-11, however the reviews indicate that teachers of students as

young as K & 1st grade are using it in the classroom. The process is easily learned. Younger students will need the directions explained at first, as they require reading. The cost is $5.00. The Hour of Code version of the app is free. Ages 5 and up.

7. Run Marco - In this App, players learn code by using blocks to guide Marco to the treasures he needs to advance to the next race. Minimal reading is required. Ages 8 and up.

8. Scratch Jr. – Inspired by the popular Scratch language, Scratch Jr. is an App for iPad and Android Tablets that allows very young children to program stories and games, while engaging in problem solving, project design, and creative expression through the use of the tablet. No reading is required. Ages 5 and up.

V. Develop Coding Experience

This selection of resources provides opportunities to develop excellence in coding through competitive experiences

1. ACM-ICPC - The International Collegiate Programming Competition is revered as the oldest, largest, and most prestigious programming contest in the world. Open to university level students in teams of three to an Olympic style elimination process through regional contests. Each fall begins with teams from over 2000 universities and the world finals held in the spring bring the top 130 university teams to compete to determine the best of the best in the world.

2. Bebras Computing Challenges – Introduces computational thinking to students ages 10-18 through the completion of 15 multiple-choice questions that focused on computational and logical thinking. Questions are answered in a period of 45 minutes.

3. CodeChef - India's top competition site with a mission to have a team from India win the ACM-ICPC World Finals when held in India in 2019. An extensive site with ongoing contests, well-developed problems, detailed profiles of each contestant, including a record of all problems solved. An excellent site to establish a record of coding**.**

4. Codeforces - Top Russian coder teams compete to be the first to solve challenging problems. Open for international contestants.

5. First - Leading robotics competition that includes programs in the *FIRST*® LEGO® League, *FIRST*® Tech Challenge and *FIRST*® Robotics Competition. Annual 10-person robotics competition. Grades 7-12.

6. Google Code-In - Google open-source competition for students ages 13-17. This competition is held annually and is open to pre-university students internationally.

7. Technology Student Association - One of the longest running STEM competitions for middle and high school students. The site includes several middle and high school competitions that are held each year at the TSA National Conference.

8. TopCoder - Top coders compete to solve challenges in graphics design, software development, and data science. The first to finish a challenge with an acceptable solution is eligible for a cash prize. A description of each challenge and a completion deadline to encourage the submission of innovative solutions to each challenge.

9. USA Computing Olympiad - Considered the top high school computing contest in the nation. The winners represent team USA at the International Olympiad in Informatics, which is the most prestigious high school level competition in the world.

10. w3schools - W3Schools is a web developer site, with tutorials and references on web development languages such as HTML, CSS, JavaScript, PHP, SQL, and JQuery, covering most aspects of web programming. Courses are free. Certification certificates are available for a fee.

VI. Develop Computer Science Curriculum

There is increasing interest in developing school curricular for teaching computer programming through coding. The following sites offer lesson plans and materials for coding courses. Access the computer science curriculum for middle school at - https://docs.google.com/spreadsheets/d/1-lbIKCkcVWWTFhcmpZkw8AcGv0iPj-hEqvO0Eu0N1hU/pubhtml?gid=1162176811&single=true

VII. Articles Available From Libraries

These resources are available free through the services of libraries

1. “Coding: A Pathway To 21st-Century Skills.” Schombs, Jamie-Lee. *Independent School* 74.4 (2015): 9. The article focuses on the annual Hour of Code event by the Code.org held in the U.S. from December 8-14, 2014.
2. “Coding For Middle Schoolers.” Pierce, Margo. *THE Journal* 40.5 (2013): 20-23. Discusses developments related to teaching middle school students computer programming in the U.S. as of May 2013. Topics discussed include how the development of the Logo programming language made it easier for children to learn computer programming,
3. “Computer Programming Goes Back To School.” Kafai, Yasmin B., and Quinn Burke. *Phi Delta Kappan* 95.1 (2013): 61-65. Explores the re-emergence of programming in K-12 schools.
4. “How Programming Fits With Technology Education Curriculum.” Wright, Geoffrey A., Peter Rich, and Keith R. Leatham. *Technology & Engineering Teacher* 71.7 (2012): 3-9. Discusses the need to support programming literacy in schools in the U.S. and how it fits the framework of the International Technology and Engineering Educators Association (ITEEA)'s Standards for Technological Literacy (STL).

5. “Introduce Programming In A Fun, Creative Way.” Flanagan, Sandra. *Tech Directions* 74.6 (2015): 18-20. Discusses computer programming language Scratch.
6. “The Kindergarten Coders” by Michael Reilly. *New Scientist* 219.2927 (2013): 21. Discusses computer programming by children using graphics-based coding language, including a pilot study at Tufts University in Medford, Massachusetts investigating young children's response to Scratch Jr. and a block-based language called Blockly.
7. “Library Programming With LEGO MINDSTORMS, Scratch, And Picocricket: Analysis Of Best Practices For Public Libraries.” Romero, Juan Suarez. *Computers In Libraries* 30.1 (2010): 16-19.
8. “The Maker Movement Connects To The Classroom.” Thompson, Greg. *Education Digest* 80.3 (2014): 34-37. Discusses how to integrate Science, Technology, Engineering and Math (STEM) education with the maker movement. Topics addressed include the connections between project-based learning and standardized testing, trends in the embracing of maker spaces in higher education, and examples of maker clubs at the secondary level.
9. “The Not-So-Secret Code.” Fredrick, Kathy. *School Library Monthly* 31.6 (2015): 23-24. The article reviews several free websites for coding in school.
10. “Ode To Code” by Chad Sandsing. *School Library Journal*, 61.5 (2015): 42-47. Explains what coding is, why we should be teaching it, and how it will benefit learners.
11. “Ready To Learn?” Staff. *School Library Journal* 61.5 (2015): 43. Discusses coding in computer programming. It notes that coding could give all children the chance to understand and interact with technologies, including the social ones, in their lives. Cites several sites that offer free, online, self-paced lessons that can help in learning text-based codes, including Codeacademy, Treehouse and Khan Academy.
12. “Teaching With Scratch.” Staff. *School Library Journal* 61.5 (2015): 47. Discusses how a teacher can teach coding to students using the platform Scratch.
13. “We Can Code” by Ki Mae Heussner. *Scholastic Parent & Child* 22.7 (2015): 22-26. Discusses the importance of coding and offers some ideas for using coding with kids.

VIII. **Books on Coding**

These resources are available for purchase to bookstores or online services.

1. 3D Game Programming For Kids: Create Interactive Worlds With JavaScript by Chris Strom. 2013. Pragamatic Bookshelf. Using interactive examples, this title teaches the reader how to make online games. Grades middle school and up. $36.00
2. Code Power: A Teen Programmer’s Guide. Rosen Publishing. 2015. This series of books discusses the most important programming languages and introduces easy to use hardware for kids to learn computer programming. Titles include: Getting To Know Alice by Nagle, Jeanne; Getting To Know Arduino by Niver, Heather Moore; Getting To Know Hackety Hack by Rauf, Don; Getting To Know Lego Mindstorms by Shea, Therese; Getting To Know Python by Payment, Simone; Getting To Know The Raspberry Pi by Petrikowski, Nicki Peter; Getting To Know Ruby by Niver, Heather Moore; Getting To Know Scratch by Nagle, Jeanne. Recommended for middle school to adult.

3. Coding Club series by Chris Roffey. 2013. Cambridge University Press. Titles include: Level 1: Python Basics; Level 1: Programming Art; Level 2: Next Steps; and Level 3: Building Big Apps. Using a clearly explained, step-by-step layout, this series guides readers to create games and experiment with programming. $15.00 each
4. Coding For Kids For Dummies by Camille McCue. 2014. For Dummies. Teaches code in small projects using MicroWorlds EX, which is based on Logo programming language. Grades upper elementary and up. $29.99 includes 35-day free trial of MicroWorlds EX and 70% off of the purchase of MicroWorlds EX, which is $99 for a single user license.
5. Connected Code: Why Children Need To Learn Programming by Yasmine Kafai. 2014. The MIT Press. A professional reading resource for educators, Connected Code explains coding as a literacy for all children.
6. Hello App Inventor! Android Programming For Kids And The Rest Of Us by Paula Beer and Carl Simmons. 2014. Manning Publications. Introduces readers to mobile programming with illustrations and fun instructions to make projects. Ages 9 and up. $39.99/print purchase includes free ebook version
7. Hello, World! : Computer Programming For Kids and Other Beginners by Warren Sande. Manning Publishing. Recently updated and revised. Purchase of print version includes free ebook version. Ages 12 and up.
8. Help Your Kids With Computer Coding. DK Publishing. 2014. This title provides well-illustrated, step-by-step instructions for teaching kids computer coding with Scratch and Python. $19.95
9. Invent To Learn: Making, Tinkering, and Engineering in the Classroom by Sylvia Libow Martinez and Gary Stager, Ph.D. 2013. Constructing Modern Knowledge Press. A professional resource for educators, thoroughly discusses STEM activities, including coding. $34.95
10. Java Programming For Kids by R. Chandler Thompson. 2014. CreateSpace Publishing Platform. Learn how to get started using Java programming. Ages 11 and up. $10.99
11. JavaScript For Kids: A Playful Introduction To Programming by Nick Morgan. 2014. No Starch Press. This titles uses step-by-step instructions and illustrations to teach how to create projects. Ages 9 and up.
12. Kodu For Kids: The Official Guide To Creating Your Own Video Games by James Floyd Kelly. 2013. Que Publishing. Explains Kodu, a simple visual language, and teaches how to use it to learn problem solving, programming, and game design skills. Ages 10 and up. $29.99
13. Learn To Program With Scratch: A Visual Introduction To Programming With Games, Art, Science, and Math by Majed Marji. No Starch Press. Provides gradual increase in complexity in playing with and manipulating Scratch. Grades 5 and up.
14. Python For Kids: A Playful Introduction To Programming by Jason R. Briggs. 2012. No Starch Press. This title guides readers to the basics of Python with example projects. Ages 9 and up. $34.95
15. Ruby Wizardry: An Introduction To Programming For Kids by Eric Weinstein. 2015. No Starch Press. An illustrated tale that teaches kids how to program using Ruby. Ages 10 and up. $29.95
16. Scratch 2.0 Programming For Teens by Jerry Lee Ford, Jr. 2014. Cengage Learning. From the publisher: “Written especially for first-time programmers, this book’s hands-on approach emphasizes the design and development of programming logic.” Ages 14 and up. $29.99

17. Scratch For Kids For Dummies by Derek Breen. 2015. For Dummies. Teaches the reader how to use scratch for making games and animations. Ages 11 and up. $29.99
18. Scratch Programming in Easy Steps: Covers versions 1.4 And 2.0 by Sean McManus. 2013. In Easy Steps Ltd. An easily understood introductory guide to Scratch. Ages 11 and up. $14.99
19. Super Scratch Programming Adventure: Learn To Program By Making Cool Games! by The LEAD Project. 2014. No Starch Press. Learn programming basics by making video games. Ages 8 and up. $24.95
20. Teach Your Kids To Code: A Parent-Friendly Guide To Python Programming by Bryson Payne. 2015. No Starch Press. A guide for parents and teachers for teaching problem solving and basic programming using Python. $29.95

IX. Integrate Hardware and Software - Sites

These resources are available through the Internet to expand the coding experience.

1. miniBloq - miniBloq is an open source graphical programming environment to interconnect Multiplo™, Arduino™, and other physical computing devices through coding. Examples provide programming to control robots prepared through Arduino and other assembled systems. Requires experience with coding and the assembly of systems. The programming environment is suitable for students prepared to integrate experiences in devices and C programming. PC required.

2. Sparkfun Learn - Sparkfun Learn is a collection of resources that allows users to start projects, refine skills with tutorials, and find materials for teaching physical programming. Most resources require the user to own or have access to hardware to complete projects. Sparkfun.com is the parent site to Sparkfun Learn where resources can be purchased. The Sparkfun family is a one-stop site for physical computing.

3. Arduino.cc – Popular open-source electronic prototyping system with easy-to-use hardware and software to create interactive electronic projects. A core computing system for innovating a wide range of computer projects including robots, controllers, and communication systems that have become commercial products.

4. Rasberry Pi -A $35 credit card sized popular computer developed to promote the teaching of basic computer science. Integrates hardware and software into a basic computer operating system.

5. Lego Mindstorms – Kits containing hardware and software to create programmable robots. Originally developed as an educational tool the kids are used by professionals with embedded software using Java and C.

X. Integrate Hardware and Software – Books

1. Arduino Workshop: A Hands-On Introduction With 65 Projects by John Boxall. 2014. No Starch Press. Starting with an overview of the Arduino, this title progresses through various concepts to create hands-on projects. Ages 14 and up. $29.95
2. Raspberry Pi For Kids For Dummies by Richard Wentk. 2015. For Dummies. Teaches readers to set up, trouble shoot, and operate the Raspberry Pi. Ages 11 and up. $29.99
3. Raspberry Pi Projects For Kids by Daniel Bates. 2014. Packt Publishing. This title shows users how to create applications with hands on projects including games and electronics. Ages 14 and up. $23.99

XI. Integrate Hardware and Software - Articles Available in Libraries

1. “Life With Raspberry Pi.” Sansing, Chad. *School Library Journal* 59.8 (2013): 34. The article reviews the Raspberry Pi (RPi) computer.
2. “Raspberry Pi.” Toth-Chernin, Jan. *Knowledge Quest* 43.3 (2015): 74-75. Journal article describing a librarian's experience with Raspberry Pi. Applicable to classrooms. Includes basic information.
3. “What Happens When A Robotics Class Starts The Year With No Robots?” Dobo, Nichole. *Tech Directions* 74.8 (2015): 18-19. Discusses using graphing calculators to teach students the fundamentals of algorithmic thinking to build and program a robot. It highlights an approach to teaching students to learn to how to write a simple code.
4. “Scratch: Computer Programming For 21st Century Learners.” Lamb, Annette, and Larry Johnson. *Teacher Librarian* 38.4 (2011): 64-68. Describes Scratch, a tool designed by the Massachusetts Institute of Technology (MIT) to help students learn how to do basic computer programming.
5. “Scratch: Multimedia Programming Environment For Young Gifted Learners.” Lee, Young-Jin. *Gifted Child Today* 34.2 (2011): 26-31. Describes how Scratch is different from conventional text-based programming languages such as BASIC, Java, or C++, and how it can be used as a creative medium for gifted and talented students to facilitate their learning. (Contains 1 table, 5 figures and 1 footnote.)

XII. Other Coding Opportunities

These resources available through the Internet to support coding

1. EdX - EdX provides free, online courses that allow anyone to learn many disciplines including Computer Science. Many courses are self-paced. General principles can be studied or specific coding languages can be learned. Courses are free. Verified Achievement Certificates are available for a fee.

2. Khan Academy - Online curriculum that teaches JavaScript programming, HTML/CSS, and SQL, in an interactive online environment, plus courses on Algorithms and Cryptography. Includes teaching tools to track student progress.

3. Kodu - Create games on the PC and XBox via a simple visual programming language. Can be used to teach creativity, problem solving, storytelling, as well as programming.

4. Pencil Code - Pencil Code lets beginners be real web real developers, starting with turtle graphics and moving on to HTML5, CSS, and jQuery. Create art, music, games, and stories in Coffeescript and Javascript using a unique switchable editor that lets you work in either blocks or text.

5. CS Unplugged - Fun classroom exercises to teach computer science principles, no computers needed!

6. CS First - Free curriculum from Google that uses online, project-based tutorials for elementary and middle school students and offers free club plans and resources to create an easy computer science entry point for educators and students alike.

7. Code Monkey Island - A board game that teaches kids how to use and master the fundamentals of computer science. It allows 4 people to use concepts like conditional statements, looping, Booleans, assignment operators and more without a computer. Each board game cost $35.

8. **AgentSheets** - AgentSheets is a revolutionary tool that lets you create your own agent-based games and simulations and publish them on the Web through a user-friendly drag-and-drop interface.

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