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Workshop Proposal: K-12 Interactive Classroom and Outreach for Computer Science Concepts Without a Computer (RESUBMISSION)

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This workshop covers a series of computer science (CS) activities intended for elementary teachers and outreach practitioners. The exercises do not require a computer, use inexpensive, everyday materials, and introduce third through fifth-grade students to a variety of CS concepts, including (1) binary numbers, (2) ASCII code, (3) Caesar Cipher, (4) looping, (5) algorithm writing, (6) message transmission, (7) computer networking/topology, and (8) computer security.

Learning Objectives for Workshop: By the end of this workshop, attendees should be able to:

1. Explain each activity and present them to students
2. Explain that binary is the language of a computer (i.e., letters, numbers, and symbols have a representation in binary)
3. Explain the purpose of encryption in modern networking to students
4. Explain the basic concept behind Public-Key Encryption to students

Brief Description

Children use electronic devices daily (especially after online learning during the pandemic) but have little knowledge of the computer science (CS) concepts behind these devices. This workshop will introduce elementary teachers to various CS concepts and provide recommendations for integrating them into their existing curriculum. The hands-on activities were created and tested in 3rd, 4th, and 5th-grade classrooms and allow the students to practice two critical engineering professional skills: (1) problem-solving skills and (2) teamwork. Additional instructional guidance and suggestions are provided for working with children from pre-kindergarten through first-year college students. Each fifteen to twenty-minute activity can be presented separately or taught in a suggested sequence to create a one or two-hour presentation. Materials available to workshop participants give instructions for putting together a budget-friendly CS kit, including all needed materials. Most of the supplies are a one-time investment, and the suggestions are given for a range of replenishable materials.

Significance

There has been a significant focus for teachers to include more STEM (Science, Technology, Engineering, and Math) at all pre-college educational levels requiring elementary and middle school teachers to educate students in unfamiliar concepts. Unfortunately, these teachers often have limited experience creating learning materials for STEM concepts [1, 7, 8, and 9]. This workshop uses a "CS kit" to provide teachers a solid starting point to integrate CS concepts into their already existing curriculum [7].

Activities Outline:

1. Binary, Octal, and Hexadecimal Initial Keychains [2, 5, and 6]
2. Introduction to Encryption: Caesar Cipher (and other substitution ciphers)
3. Basic Networking, Message Passing, and Security with Party Hats and Candy (with Public-Key Encryption) [2, 5, and 6]
4. Network Topology and Problem Solving [3, 5, and 6]

5. Preview of Basic Programming Concepts [2, 3, 4]
6. Preview Extension Binary Activities [5 and 6]

The workshop session facilitators will present the activities using online active learning techniques. The first four activities will be covered in detail, with attendees being lead through the entire exercises. After each lesson is completed, workshop presenters will provide hints, tips, and tricks, answer questions, provide information on additional background material, and preview extension activities on the topic. Finally, activities 5 and 6 will be previewed and demonstrated for participants.

Workshop Presentation Schedule

1. Introduction, Purpose, and Agenda
2. Activity 1: Binary Bracelets, Flip Signs, Caesar Cipher
3. Activity 2: Message Passing, Basic Networking, & Problem-Solving
4. Activity 3: Loops: Music and Paper Bags, Control a Robot, and Program a Dance
5. Introduction of Additional Advance Activities
6. Online Resources, Q & A, Wrap-up

Past Workshops

This workshop has been conducted with 12 people at an ASEE Annual Conference [10]. Anecdotally, we received positive feedback from conference attendees. In addition, people have accessed and downloaded documents from the provided Google Drive.

CS Kits

The "CS kit" contains everything a teacher would need to provide instruction, including:

- Background material on the topic at the teacher level
- Student appropriate background material
- Instructions to present material within the classroom or a teacher script for the activity
- Class time hands-on activities
- Student evaluation materials (i.e., quizzes, tests, homework)
- Frequently asked question (FAQ) sheets
- Outside resources for additional information
- Related activities/materials
- Learning objectives
- Budget and detailed shopping list (i.e., quantities, cost, reusability, alternatives, etc.)
- Instructions for creating a classroom CS kit

The written materials are available via a Google drive:
https://drive.google.com/open?id=1PSCmzyeQsl7e1vUhfBsaIfXRb94j5lcb

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