Toward Teaching Kids in Arab Countries Programming Skills: A Case Study

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Abstract
Teaching children to code has gained popularity in recent years, with many schools and institutions now providing tools and programs to get young learners started with computer programming. High-level programming languages, such as Python, Java, and C Sharp (i.e., C#), are often used in these educational contexts due to their simplicity and versatility. This article discusses the benefits of teaching children to code with highlevel programming languages and offers tips and strategies for effectively introducing these concepts to young learners. Through hands-on activities and interactive lessons, children can gain valuable skills and knowledge to serve them well in their future academic and professional endeavours. A case study has been conducted to show that children in Arab countries can learn coding skills effectively when they are taught using interactive and hands-on methods.

Keywords: E-learning, Distance Learning, Children Learning, Teaching Children to Code, Software Engineering, HCI, C#, Coding Skills

Introduction

Educators and researchers have recognized the importance of teaching children how to write code in recent years. Coding skills are increasingly in demand in the job market and are essential for success in various fields, including technology, engineering, and data science [Resnick et al., 2009]. Additionally, learning to code can help children develop essential problem-solving abilities, critical thinking, and creativity skills [Papert, 1980,Wing, 2006].

Evidence suggests that teaching kids to code can have broader benefits, such as promoting teamwork, collaboration [O'Shea and O'Keeffe, 2016], and increasing students' engagement, motivation and drive in their studies [Law et al., 2016].

The relevance of teaching kids to code lies in the numerous benefits it can provide for their cognitive development, future career prospects, and overall well-being. There are many reasons why teaching children how to code can be beneficial and motivating. Some of the potential motivations for teaching kids to code include the following:

1. Developing problem-solving skills: Coding requires children to break down complex problems into smaller, more manageable tasks and to think critically and creatively about how to solve those problems. This can help develop their problem-solving skills, which are helpful in various contexts.

2. Encouraging creativity and innovation: Coding allows children to create and build software and applications, which can be very rewarding and creative. It also encourages them to think outside the box and develop innovative solutions to problems.

3. Preparing for future careers: The demand for skilled software developers is high and is expected to grow in the coming years. Teaching kids to code can help prepare them for careers in technology and other fields that require coding skills.

4. Promoting teamwork and collaboration: Many coding projects involve working in a team, which can teach children the value of cooperation and teamwork.

5. Building confidence and self-esteem: Completing a coding project can give children a sense of accomplishment and boost their confidence and selfesteem.

1.1 Research Motivation

There is a growing recognition of the importance of teaching kids how to write code. This includes teaching them the technical skills needed to write and debug programs and helping them develop problem-solving, critical thinking, and creativity skills. This literature review will discuss some possible benefits of teaching kids how to write code. The benefits below motivate conducting this research and case study:

1. Academic Benefits One of the main benefits of teaching kids how to write code is that it can help them excel academically. For example, research has shown that students who learn to code perform better in math and science [Weintrop et al., 2016]. This is likely because coding involves using logical thinking and problem-solving skills, which are also important in these subjects.

In addition, coding can also help students develop their computational thinking skills, which involve breaking down complex problems into smaller, more manageable parts and using abstractions and algorithms to solve them [Wing, 2006]. These skills are increasingly important today and can be applied to various academic and professional fields.

2. Social Benefits Teaching kids how to write code can also have social benefits. For example, it can help them develop teamwork and collaboration skills, as they often work in groups to complete coding projects [Weintrop et al., 2016]. This can help kids learn to communicate effectively with others and work towards a common goal.

In addition, coding can also help kids develop leadership skills, as they may be responsible for leading coding projects or teaching others how to code [Weintrop et al., 2016]. This can help kids learn to take on leadership roles and be more confident in their abilities.

3. Professional Benefits Finally, teaching kids how to write code can also have professional benefits. For example, the demand for skilled coders is high, and knowing how to code can open up many career opportunities [Weintrop et al., 2016]. In addition, coding can also help kids develop skills that are highly valued in the workforce, such as problem-solving, critical thinking, and creativity [Weintrop et al., 2016].

Teaching kids to code can be a motivating and rewarding experience that helps them develop valuable skills and prepares them for success in the future.

1.2 Research Question and Hypothesis

In this research, we try to answer the following research question:

RQ1: Is it possible to teach kids in Arab schools how to code using a high-level programming language? Is selecting C# appropriate to prove the research assumption?

We hypothesize that "Arab kids have the ability and skills to learn and utilize high-level programming languages to address complex problems such as arithmetic operations".

In this research, we conducted a case study to investigate the effectiveness of teaching children how to code using a high-level programming language. The study involved a group of young learners who participated in a series of coding lessons and activities over several weeks. Our findings suggest that children can learn coding skills effectively when they are taught using interactive and hands-on methods and that they can apply these skills to solve problems and create new projects.

2. Background

Teaching children to code has gained increasing attention in recent years, with many schools and organizations offering programs and resources to help young learners get started with computer programming. Coding education is a way to improve problem-solving and logical thinking skills, strengthen communication and collaboration skills, and increase creativity and innovation. In addition, high-level programming languages like Python and Java are often used in educational contexts due to their simplicity and versatility.

Research has shown that coding education can benefit children, including improving problem-solving and logical thinking skills, strengthening communication and collaboration skills, and increasing creativity and innovation [Bryant et al., 2016,Margolis et al., 2017].

Several studies have investigated the effectiveness of teaching children to code. A study by [Smith et al., 2019] found that children who participated in a coding program significantly improved problem-solving skills and computational thinking. Similarly, a study by [Johnson and Williams, 2018] revealed that children who learned to code demonstrated increased creativity and innovation in their problem-solving approaches.

In addition to the cognitive benefits, teaching children to code can have positive social and emotional impacts. A study by [Kim and Park, 2017] found that children who participated in a coding program reported increased self-confidence and motivation and improved social skills such as collaboration and communication.

One of the challenges in teaching children to code is choosing an appropriate programming language. High-level programming languages, such as C#, Python and Java, are often used in educational contexts due to their simplicity and versatility [Weintrop et al., 2016]. However, there is an ongoing debate about the most effective language for teaching children to code. Some studies suggest that more visually oriented languages may be more effective for young learners [Barker et al., 2018,Hockemeyer et al., 2019].

In addition to the choice of programming language, the teaching methods and strategies used can also impact the effectiveness of coding education for children. Research has shown that hands-on, interactive approaches are particularly effective for engaging and motivating young learners [Kelleher et al., 2015]. Project-based learning, in which children work on real-world problems or create their projects using their coding skills, has also been found to be an effective way to teach children to code [Wing, 2006].

The literature suggests teaching children to code can promote cognitive and social-emotional development. Educators need to utilize interactive and hands-on methods and provide support and guidance to help children succeed in their coding endeavours.

3. The Research Methodology

Design science research methodology (DSRM) is an approach to studying and solving problems involving iteratively designing, creating, and testing prototypes or solutions to address the issue. This approach is often used in fields such as computer science, engineering, and management, where the goal is to create new technologies, systems, or processes that can be applied in practice [Aljawawdeh, 2019]. DSRM focuses on the development and evaluation of innovative solutions to real-world problems. DSRM aims to create and evaluate new designs or artefacts that can be used to improve the functioning of organizations, systems, or societies [Hevner et al., 2004].

There are several steps involved in the design science research process, including:

1. Identifying the problem: The first step in DSRM is to identify a specific issue or challenge the research aims to address.

2. Developing a design: Once the problem has been identified, the next step is to develop a design or artefact that addresses the issue and meets the identified needs.

3. Evaluating the design: The design is then evaluated through empirical testing or other methods to determine its effectiveness and potential impact.

4. Refining the design: Based on the evaluation results, the design may be refined and improved to address the problem and meet the identified needs.

5. Disseminating the results: The results of the DSRM study, including the design and any insights or lessons learned, are then disseminated to the broader community through publication in academic journals or conference proceedings.

This process is then repeated as needed until a satisfactory solution is found. Fig. 1 shows the phases of the DSRM process model. The process model be modified to meet the requirements of this research attempt.

3.1 The Adoption of DSRM

To adopt this method to teach kids to write code, the following steps have been followed:

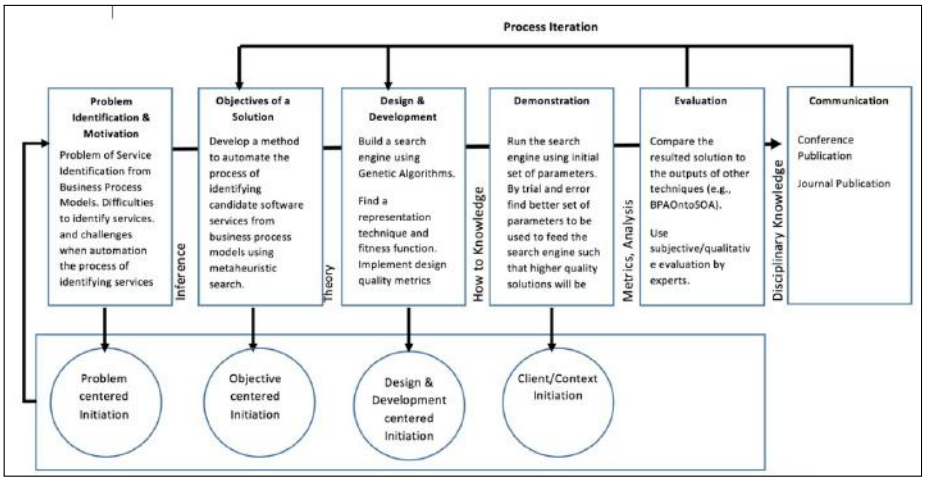

Process Iteration
Problem Identification & Motivation
Problem of Service Identification from Business Process Models. Difficulties to identify services. and challenges when automation the process of identifying services
Inference
Objectives of a Solution
Develop a method to automate the process of identifying candidate software services from business process models using metaheuristic search.
Theory
Design & Development
Build a search engine using Genetic Algorithms.
Find a representation technique and fitness function. Implement design quality metrics
How to Knowledge
Demonstration
Run the search engine using initial set of parameters. By trial and error find better set of parameters to be used to feed the search engine such that higher quality solutions will be
Metrics, Analysis
Evaluation
Compare the resulted solution to the outputs of other techniques (e.g., BPAOntoSOA).
Use subjective/qualitative evaluation by experts.
Disciplinary Knowledge
Communication
Conference Publication
Journal Publication
Problem centered Initiation
Objective centered Initiation
Design & Development centered Initiation
Client/Context Initiation

Figure 1: DSRM Framework Adopted to Teach Kids How to Code
[Peffers et al., 2007,Aljawawdeh, 2019]

1. Identify the topics we want to address and select an approach. For example, choose the issues that help kids learn how to write code and solve some problems engagingly and effectively.

2. Develop clear and concise examples that support the research questions. For example, "How can we design a teaching method that helps kids learn to write code effectively?". That should be examined by monitoring the achievements of the participant kids.

3. Conduct a literature review to understand the current knowledge on the topic. This might include research on teaching coding to kids and studies on effective learning methods in general. This can help to enrich the teaching methods we adopt, and also it helps to learn from previous experiences.

4. Develop a design for a solution to the problem or opportunity. This might involve creating a lesson plan, building a tool or platform for teaching coding or developing a new teaching method.

5. Implement the design and test it with a group of kids. This might involve piloting the teaching method in a classroom or online setting.

6. Evaluate the results and conclusions. This might involve collecting data on the kids' learning progress and analyzing it to determine the effectiveness of the teaching method.

To fulfil the previous steps, a set of lessons have been prepared using C# language, and the lesson plan and materials have been reviewed by experts who work with kids to ensure that they fit the level of these young children. There are a few reasons why C# might be a good choice for teaching kids to code: • C# is a high-level programming language, meaning it is easier to read and write than low-level languages like C or assembly. This can make it more accessible for kids starting to learn to program:

- C# is a universal language that can be used to build various applications, including games, web applications, mobile apps, and more. Kids can use C# to create exciting and relevant projects.

- C# has a large and active community of developers, so many resources are available to help kids learn the language and get support when needed. • C# is a statically-typed language which checks for errors before the code is run. This can help kids learn good coding practices and avoid common mistakes.

In conclusion, C# is a good choice for teaching kids to code because it is easy to learn, versatile, and has a strong support community.

4. The Case Study: Teach Kids to Code with C#

This section describes the objective of this case study, the learning process of this case study, the experiment design, and the mechanism to transfer knowledge to young learners.

4.1 The Intended Learning Objective

In this case study, kids will learn topics from basic programming skills until they learn how to write a simple application, such as a calculator program, using a C# desktop application. They will also learn how to test their code and display the results.

4.2 The Learning Process

For the case study, the following steps have been conducted:

- *Step 1: Introduction to Programming*
  Before kids begin writing code, it's essential to introduce them to the basics of programming. This might include concepts such as variables, data types, loops, functions, and controls such as Buttons, TextBox, Labels and Panels. Many examples

and exercises have been used to help kids understand these concepts and how they can be applied to solve problems.

- *Step 2: Designing a simple calculator application*
  Next, kids must decide what they want their calculator to do. This might include basic arithmetic operations such as addition, subtraction, multiplication, and division and more advanced features such as square roots, logarithms, or trigonometric functions. In our experiment, the main focus was on basic arithmetic operations.

  Once kids have decided on the features they want to include, they should design a flowchart or pseudo code to outline the steps their program will follow. This will help them think through the logic of their program and make it easier to write the code.

- *Step 3: Writing the code*
  With a clear plan, kids can begin writing the code for their calculator program. They should start by writing the program's basic structure, including any necessary functions and loops. Then, they can add the code to perform the specific calculations they want.

- *Step 4: Testing and debugging*
  As kids write their code, they should test it frequently to ensure it works as expected. This might involve running the program, manually checking the results, or writing additional code to test specific features. Kids encountering errors or unexpected results should use debugging techniques such as print statements and error messages to identify and fix the problem.

- *Step 5: Displaying the results*
  Once the calculator program works correctly, kids can add code to display the results in a clear and easy-to-read format. This might involve using print statements to show the results in the terminal or creating a graphical user interface (GUI) to display the results more visually appealingly.

- *Step 6: Refining and improving the program*
  Kids can continue to refine and improve their calculator program by adding additional features, optimizing the code for speed and efficiency, or making the program more user-friendly. They can also use their program to solve real-world problems or create interactive simulations.

4.3 Experiment Design

To conduct the proposed case study, the following materials were needed:

- Computer with an integrated development environment (i.e., IDE) installed, i.e., Visual Studio 2022 IDE was used.

- Material and examples were prepared to support the learning process.

A group of twenty kids participated in this experiment, and intensive training for five weeks was conducted to teach the kids the prepared materials and prepare them to write real-life applications. The age of kids ranges from eight to fourteen years old. The kids have sufficient skills to use the personal computer and are fluent in arithmetic operations.

The experiment has been conducted on multiple iterations; in each iteration, a chapter of the intended material has been provided, and it ended with a practical exercise.

4.4 Knowledge Transfer Strategy

Many different approaches and methods can be used to teach kids programming. Some general strategies that may be effective include:

1. Use hands-on, interactive activities: Kids often learn best through handson, interactive activities that allow them to explore and experiment with concepts [Kafai and Burke, 2017,Aljawawdeh and Nabot, 2021,Kafai et al., 2015]. Coding activities that involve creating and building software or applications can be particularly engaging for kids [Resnick et al., 2009].

2. Start with simple, visual programming languages: For younger children or those new to programming, starting with simple, visual programming languages can be helpful [Maloney et al., 2012]. These languages use blocks or other visual elements to represent code, which can be easier for kids to understand and work with [Kafai et al., 2015]. Examples of visual programming languages include Scratch [Resnick et al., 2009, Maloney et al., 2012,Kafai et al., 2015] [Kafai et al., 2015].

3. Use examples and projects that are relevant and interesting: Children are more likely to be motivated and engaged when working on relevant and exciting projects to them [Law et al., 2016]. Consider using examples and projects that align with their interests and hobbies [O'Shea and O'Keeffe, 2016,Aljawawdeh and Nabot, 2021].

4. Encourage experimentation and creativity: Encourage kids to explore and experiment with different coding techniques and approaches (Wing, 2006). This can help them develop their problem-solving skills and creativity [Papert, 1980].

5. Provide support and guidance: It's important to provide kids with the support and guidance they need as they learn to code [Law et al., 2016]. This might include providing resources and materials, answering questions, and offering feedback and encouragement [O'Shea and O'Keeffe, 2016].

6. The key to teaching kids programming is to provide a supportive and engaging learning environment that encourages exploration, experimentation, and creativity [Wing, 2006]. Fulfilment of the previous steps will help to collect data and do the analysis.

5. Results and Analysis

There are a few different criteria that you could use to evaluate whether kids have learned a C# course:

1. Understanding of the fundamental concepts of programming: Can the student explain the basic concepts of programming, such as variables, loops, functions, and control structures?

2. Ability to write, compile, and run C# code: Can the student write simple programs in C#, using the correct syntax and following best practices for code organization and style? Can they debug their code and identify and fix errors?

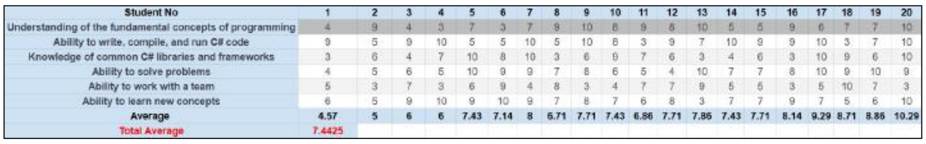
3. Knowledge of shared C# libraries and frameworks: Does the student understand how to use standard libraries and frameworks, such as the .NET framework and the System namespace, to perform tasks such as input/output and data manipulation?
4. Ability to solve problems: Can the student analyze a situation and design and implement a solution using C#? Can they use appropriate data structures and algorithms to solve problems efficiently?

5. Ability to work with a team: Can the student collaborate with others on a programming project, using version control and other tools as needed? Can they communicate effectively with their team members about their code and project design?

6. Ability to learn new concepts: Does the student have the ability to learn new programming concepts and technologies on their own, using online resources and other materials?

Each participating student was examined against each point; the evaluation process included tests, tasks and direct personal questions to measure the student's understanding of the material. Each point has been evaluated from 0 to 10. Fig. 2 shows the table of results, in which the result of each student ranges from 0 to 10 against each Intended learning objective. Note that the average achievement of the intended learning objectives (ILOs) was 74%, and many kids achieved higher values in some outstanding goals. There were some weaknesses in achieving some objectives. Still, the reasons behind that refer to the complexity of some topics, lack of teamwork skills, short time of the course, and sufficient background of all kids, which makes it difficult to solve some of the milestone tests. Fig. 3 shows a graphical visualisation of the results.

Results show that teaching kids to program with high-level programming language is challenging but worthwhile. Gains from this experiment are promising and encourage teaching kids more technical topics in the future while monitoring their progress and performance.



Student No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Understanding of the fundamental concepts of programming	4	9	4	3	7	3	7	9	10	8	9	8	10	5	5	9	6	7	7	10
Ability to write, compile, and run C# code	9	5	9	10	5	5	10	5	10	8	3	9	7	10	9	9	10	3	7	10
Knowledge of common C# libraries and frameworks	3	6	4	7	10	8	10	3	6	9	7	6	3	4	6	3	10	9	6	10
Ability to solve problems	4	5	6	5	10	9	9	7	8	6	5	4	10	7	7	8	10	9	10	9
Ability to work with a team	5	3	7	3	6	9	4	8	3	4	7	7	9	5	5	3	5	10	7	3
Ability to learn new concepts	6	5	9	10	9	10	9	7	8	7	6	8	3	7	7	9	7	5	6	10
Average	**4.57**	**5**	**6**	**6**	**7.43**	**7.14**	**8**	**6.71**	**7.71**	**7.43**	**6.86**	**7.71**	**7.86**	**7.43**	**7.71**	**8.14**	**9.29**	**8.71**	**8.86**	**10.29**
Total Average	7.4425																			

Figure2: Tableofresults

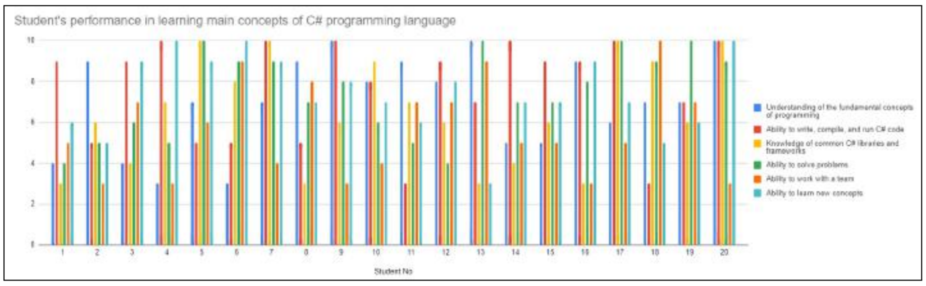


Figure3: ChartofResults

6. Conclusion

This article presents a case study on the methods and techniques for teaching kids how to code using the programming language C#. This article answers the research question and supports the hypothesis by presenting a case study on the effectiveness of using C# to teach kids how to code.

The results of this case study suggest that using C# to teach kids how to code can successfully introduce them to the fundamental concepts of programming. The case study demonstrated that kids could learn C# and create simple programs, indicating that they could grasp and apply the material practically. These findings are promising because they suggest that C# can be an effective tool for teaching kids how to code and that kids can learn programming skills at a young age. These results pave the way for further research and development in coding education for kids. 74% of the learning objectives have been fulfilled.

In conclusion, learning how to code with C# can be a fun and rewarding experience for kids. Following the steps outlined in this case study, kids can learn fundamental programming concepts and start creating simple programs. As they continue to practice and build on their skills, they will be able to tackle more complex projects and continue to grow as coders. With patience, persistence, and a little creativity, kids can learn to code with C# and open up a world of possibilities for their future.

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