A Replicate Study: Adoption of a STEM Outreach Program in Kuwait

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Abstract:
The K–12 computer science (CS) curriculum in Kuwaiti public schools primarily focuses on computer literacy and secondarily on programming. However, students must understand computational thinking (CT) before learning to code, meaning CT concepts must be incorporated into the Kuwaiti curricula to increase student learning. Utilization of a STEM outreach program would introduce CT concepts to Kuwaiti school children to prepare them for future academic and professional CS challenges. This paper examines complications that occur when a STEM outreach program from the United States was translated and adapted for use in Kuwait, including obstacle resolution, and then compares concept comprehension between Kuwaiti and US students. This study focused on a STEM outreach program for 6th–9th grade students with no previous CS skills. The program's micro controllers' curriculum was used to test students' capabilities for learning CT concepts, the program was translated into Arabic, and its schedules were adjusted to ensure that these changes did not alter the study significantly. Pre- and post-program self-efficacy surveys measured students' comprehension of CT concepts, but because this was the first time Kuwaiti students were introduced to this type of assessment, the students were confused about some of the concepts. Additionally, the students' acumen for the survey was highly influenced by their culture. Despite these barriers, results showed that student CT improved overall. Although a statistical comparison showed that scores from the United States were higher than the scores from Kuwait, Kuwaiti females scored statistically higher than US females for CT abilities. Therefore, the investigation concludes that the STEM outreach program effectively promoted CT concepts in Kuwait.

Introduction

The objective of computational thinking (CT) is to increase computer science (CS) knowledge so that students can take what they learn in the classroom and laboratory and apply that knowledge to the modern workplace. Early CT exposure is critical for future educational outcomes because it helps students understand the connection between current learning and future application. Introducing children to valuable STEM experiences, starting at a young age, has been shown to improve science literacy, promote critical thinking, develop problem solvers, and empower the next generation of innovators, creating new outcomes that strengthen the economy **[1]**.

Not all countries, however, acknowledge the need for STEM education. For example, although Kuwait, a small country in western Asia, ranks 57th (of 189 countries) on the Human Development Index (HDI), with a score of 0.808 (or very high human development), the country ranks among the lowest in human development for Arabic/Persian Gulf countries **[2]**. CS curriculum in Kuwaiti K–12 public schools fails to prepare students for the 21st century workforce because it primarily focuses on computer literacy not CS concepts **[3]**, and instead of utilizing project-based learning, the CS curriculum relies on written exams, in which 70% of the grades are based on theoretical content **[4]**. Schools in Kuwait are either public or private since the educational system does not allow home-schooling nor online schooling **[5]**, and approximately 12% of the total Kuwaiti population is 14 years of age or younger **[6]**. Educational reforms in Kuwait are necessary to prepare students to shape modern societies. Some beneficial approaches include after-school programs, STEM contests, design and building, and summer programs. Kuwaiti students must participate in out-of-school programs to increase their CT since the public-school curriculum contains limited programs to support CT education. Because most STEM curriculum programs are developed in non-Arabic countries, suitable curriculum must be developed for the Arabic region **[7]**.

This study utilized the STEM outreach program, Mighty Micro Controllers (MMC), for 6th–8th grade students with no previous CS skills. The program increases student learning by implementing fun, hands-on CS activities, such as building circuits by programming Arduino Uno microcontrollers using Scratch and offering brief exposure to text-based programming. MMC, which has been implemented since 2016, has effectively improved students' CT skills **[8]**. This study used the MMC curriculum to test students' abilities to learn CT concepts in Kuwait, address and reduce barriers to successful transfer of western STEM programs to the Arabic region, and compare learner outcomes between the two regions.

This research utilized the educational system suggested by Wim Veen **[9]**, with modifications to the model and other STEM factors **[10]** to suit learners in Arabic/Persian Gulf regions. For example, the language and religion of the original MMC program was altered to minimize cultural barriers: the materials were translated into Arabic while maintaining the basic terminology, and the workshop was segregated into three gendered classes (i.e., boys, girls, and a mixed group). The results were promising for knowledge gained and increased CT abilities. Although overall scores from the United States were higher than scores from Kuwait, Kuwaiti females scored statistically higher on CT concepts than Kuwaiti male and US participants. MMC learners in both countries showed confidence in project building, and their scores in Kahoot confirmed their gains, especially for US students. That after controlling the barriers, the replication of the STEM program to Kuwait engaged the students and taught them CT and that served our goal.

Background and Related Work

Computational Thinking

Seymour Papert, who was the first to define CT in the *International Journal of Computers for Mathematical Learning*, is considered the world's foremost authority on how innovation can increase learning and showcase science in a variety of contexts **[11]**. In 2006, Wing described CT as a "fundamental skill for everyone" **[12]**, expanding this definition four years later to include "the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent" **[13]**. Her expansion emphasizes the role of programming in CT; a significant body of research has proven this definition. Comparatively, the Royal Society defined CT as "the process of recognizing aspects of computation in the world that surrounds us, and applying tools and techniques from Computer Science to understand and reason about both natural and artificial systems and processes" **[14]**. Brennan and Resnick, further defined

CT in terms of concepts, practices, and perspectives **[15]**. Weese and Feldhausen used the two mentioned studies to incorporate CS principles into a preferred CT set **[16]**.
Table **1** contains the CT lists adopted for this paper.

Table 1. CT Concepts and Related Computer Science Principles

Abbr.	Description
ALG	**Algorithmic thinking** – sequence of steps that complete a task, including operators and expressions
ABS	**Abstraction** – generalized representation of a complex problem, ignoring extraneous information
DEC	**Decomposition** – breaking a problem into small, manageable parts that can be solved independently of each other
DAT	**Data** – collection, representation, and analysis of data[6]
PAR	**Parallelization** – simultaneous processing of a task[6]
CON	**Control flow** – directs an algorithm's steps when to complete
IAI	**Incremental and iterative** – building small parts of the program at each step instead of the whole program at once
TAD	**Testing and debugging –** performing intermediate testing and fixing problems while developing
QUE	**Questioning** – working to understand each part of the code instead of using code that is not understood well
USE	**Reusing and remixing -** making use of other people's work and resources to solve a problem

STEM Outreach Program

The Mighty Micro Controllers (MMC) program, designed by Weese and Feldhausen, focused on teaching students CT within the context of coding microcontrollers using Arduino Uno and block language. The program utilized hardware and software to successfully engage participants, using models to create and program simple circuits and then conduct problem-driven exploration to develop open-ended projects. Students were able to utilize their prior knowledge while learning the fundamental principles of circuit building, electricity, and signals. In addition, pair-programming was used to improve student communication skills. To minimize the potential of overwhelming students with new concepts, the students observed illustrations and practiced unplugged activities to become familiar with the ideas. For example, students studied a figure that showed marbles rolling in a hoop to explain electricity and then had to sort the strongest and weakest resistors by plugging the resistors into a blinking LED circuit to determine the relationship between LED brightness and resistor strength. The weak resistor showed a bright LED, while the strongest resistor displayed no light.

Each lesson in the MMC was designed to highlight the microcontroller's software for specific CT skills. Students trained to read circuit diagrams by plugging the expected pins on the Arduino board; most circuit activities in MMC are comprised of LED lights and buttons. Ultrasonic sensors were introduced within the Arduino IDE, and text-based programming language was used to teach students how to reflect the Scratch structure. As a result, students learned to correlate how the blocks programming corresponds to real-world coding. On the last day of the program, students utilized all previous lessons to draft and build a final project design [17].

Related Work
To our knowledge this is the first replicating research study to investigate transferring CS STEM programs from Western countries to countries in the Gulf Cooperation Council (GCC).

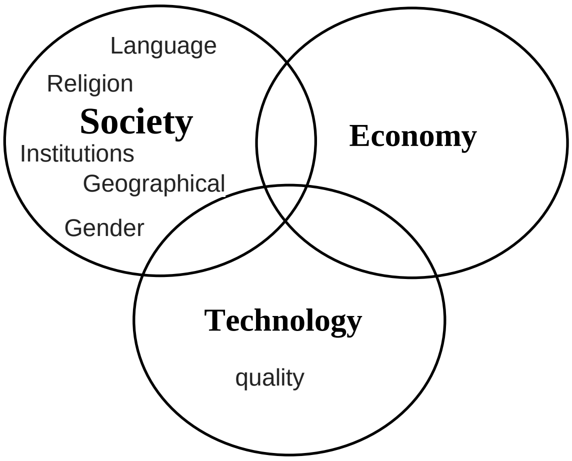

Figure 1. Factors that Influence the Educational System [9]

Factors Influencing STEM Programs in GCC Countries

The Arabian also known as (Persian Gulf) is well known for its unique demographics and geographical and cultural backgrounds. Residents of Kuwait, Bahrain, Saudi Arabia, the United Arab Emirates, Oman, and Qatar share common habits, traditions, religion, and language. These countries became even more united since the GCC was created in 1981 to promote and advance educational needs [18]. Although educational development has varied in each country, as a whole, the countries exhibit common features [19]. CS and integrative technology have been the fastest growing educational trends since GCC was created and many obstacles have been overcome during the past three decades in regards to CS implementation in these countries [20]. Recent rapid technological developments have provided modern notch information that has consequently created challenging educational dilemmas. Young people are now growing up with smart gadgets that pervasively influence how they perceive the world. Dr. Veen derived factors for and suggested an educational system to meet the needs this generation and future knowledge-intensive generations. The three interdependent, parallel factors are sociocultural, economical, and technological [9]. This study complemented the three factors with sub barriers that are specific to GCC countries in particular and CS programs in general [10] [21] [22] [23], as shown in Figure 1.

Society
Because GCC countries share the same language and cultural practices, patterns of societal effects on technology are easily traceable. Individuals are influenced by their surrounding social life, beginning at home, where parents allow or prohibit use of certain technologies in their households. For example, some parental authorities impose limits on interaction with the opposite sex until a certain age, as well as subsequent segregation and prohibited interactions, even in school. Segregation of the sexes is more prevalent in these societies after kindergarten.

Gender: As mentioned, gender segregation is prevalent in GCC countries due to cultural traditions and customs. Some private schools, however, implement coeducation. In spite of educational segregation and strict views of female roles in society, female achievements in science and mathematics are higher than males throughout all GCC countries, according to UNESCO [24].

Language: Although Arabic is the official language of GCC countries, the entire region began adapting sciences in the English language because translations of modern sciences became difficult. English has become a global language for sciences, and so learning English has become a priority in this region. However, the existence of Arabic at some point or compatibility is a must for non-English users/uses.

Religion: Because 99% of the total population in GCC countries belong to the Islamic faith, most legal systems in the region are based on the religion of Islam, meaning that the implementation of any technological advancements must be regulated by Islamic rules or align with Islamic faith regulations.

Social Institutions: Social institutions can include any gathering of people to achieve a common goal, including families, organizations, and mass media, as well as governmental and non-governmental institutions, all of which can positively or negatively impact the implementation of STEM curricula.

Geographical: GCC has a desert climate while facing a body of water from at least one side. The general climate of this region includes high temperatures during the day and calmer nights, especially in the sandy areas. Because of the heat, some region ban working in open areas in the afternoon.

Technology

Quality Technology has become an essential component of modern teaching. However, the rate of technological advancement is faster than the rate of STEM program implementation in schools. By the time a technology is integrated into classrooms, including familiarizing teachers and students, it has already become outdated.

Economy

Populations of GCC countries are comprised of a variety of economic stratifications, including the very wealthy and a majority of middle and low socioeconomic classes. Despite the general wealth in the region, minimal financial resources are allocated for STEM implementation or training.

Method

Instruments

This study used a self-efficacy survey to measure student learning of CT. The survey questions were categorized as problem-solving, computer programming skills, computer programming practices, and computer programming impact. All questions were measured using a five-value Likert scale: strongly disagree, somewhat disagree, not sure, somewhat agree, and strongly agree. as shown in Table 2. The survey also collected information about student participation in STEM and prior CS knowledge. An online pre-survey was administered before any STEM teaching process, and the post-survey was given on day four after the projects were finished. Students played Kahoot daily to measure their understanding, and parents were able to review their children’s feedback and ratings throughout the program.

Table 2. Self-Efficacy Survey Questions and Related CT Skills [16]

	five-value Likert scale: strongly agree, somewhat disagree, not sure, somewhat agree, and strongly disagree عندما أحاول أن أحل مشكلة تواجهني When solving a problem		
1	create a list of steps to solve it	اقوم بعمل سلسلة من الخطوات للحل	Algorithms
2	use mathematics	اقوم بعمل عمليات حسابية	Algorithms
3	try to simplify the problem by ignoring details that are not needed	اقوم بتبسيط المشكلة عبر ازالة الاشياء الغير مهمة منها	Abstraction
4	look for patterns in the problem to create an efficient solution	ابحث عن الانماط فيها	Abstraction
5	break the problem into smaller parts	اقسم المشكلة الى اجزاء اصغر	Problem Dec
6	work with others to solve parts of the problem in parallel	اقسم المشكلة الى عدة اجزاء اصغر ، حتى يتمكن مجموعة من الاشخاص بحل تلك الاجزاء المتفرقة بوقت واحد	Parallelization
7	look how data can be collected, stored, and analyzed to help solve the problem	ابحث في كيفية تجميع البيانات و تخزينها ثم اقوم بتحليلها حتى يتسنى لي حلها	Data
8	create a solution where steps can be repeated	اخلق حلا يمكن من خلاله تكرار الخطوات	Control Flow
9	create a solution where some steps are done only in certain situations	اخلق حلا بحيث لا يتم عمل اي خطوة حتى تتم تلبية بعض الشروط	Control Flow
	I can write a computer program which...أستطيع كتابة برنامج يقوم ب		
10	runs a step-by-step sequence of commands	يعمل خطوة وراء خطوة	Algorithms
11	does math operations	يقوم بعمليات جمع وطرح	Algorithms
12	uses loops to repeat commands	يستخدم ال LOOP لتكرار العمليات	Control Flow
13	takes input from a user	يستجيب لضغطة زر .. على سبيل المثال	Control Flow
14	only runs commands when a specific condition is met	يقوم بتشغيل اوامر عندما تحصل بعض الشروط	Control Flow
15	runs commands in parallel	يقوم بعمل اكثر من شيئ في آن واحد	Parallelization
16	uses messages and other information to talk with different parts of the program	ارسل رسائل وبيانات بين أجزاء البرنامج	Abstraction
17	can store, update, and retrieve data	يقوم بحفظ و تحديث واسترجاع القيم	Data
18	uses custom functions	يستخدم custom functions	Abstraction
	When creating a computer program I...عندما أكتب برنامج فإني		
19	make improvements one step at a time and work new ideas in as I have them	اقوم بتطوير اجزاء بسيطة ابني عليها	Inc. and It.
20	run my program frequently to make sure it does what I want and fix any problems I find	اقوم بتشغيله مراراً لاتكد انه يقوم بما اريد واصلح اي خطأ ان وجد	Testing and Debugging
21	share my programs with others and look at others' programs for ideas	اشاركه مع زملائي لاخذ رأيهم فيه	Reu/Rem,
22	break my program into multiple parts to carry out different actions	اقوم بتجزئة البرنامج الى اقسام متعددة للقيام بمهام مختلفة	Problem Decomp.
	التأثير Impact		
23	I understand how computer programming can be used in my daily life.	اعلم انه يمكن استخدام البرمجة في حياتي اليومية	Questioning
24	I am confident I can use/apply computer programming to my field of study.	استطيع ان اكتب برامج يساعدني في موادي الدراسية اللأخرى	Questioning

Design

This replicate study compared student learning and engagement with CS and CT in the United States and Kuwait. The United States has offered the MMC program every summer since 2016, while Kuwait offered the program one time in 2019. Each country was a group (i.e., USA and KW), and the tasks were identical for both groups. The research was carried out over four 3-hour sessions for three weeks, excluding daily break time. On the first day, before any material was taught, students completed a survey about CT, and students played Kahoot after each session to test their knowledge about the material. Students retook the CT survey on the last day of the program. The workshops were identical to MMC lessons, with only minor changes and translations for the KW group. Parents were asked to share their children’s impressions and feedback about the lessons. Additional information is included in the STEM outreach program section of this paper.

Replication Strategies

This research utilized a replication study to empirically reinforce results by clarifying issues and extending generalizability. The researchers determined generalizability for various subjects, races, locations, and cultures, embracing the factors that influence STEM programs in GCC countries. The initial research occurred at Kansas State University in the United States, and the replication occurred at Kuwait University in Kuwait. A total of 165 students participated, including (n = 100) students from the United States and (n = 65) students from Kuwaiti. US participants were comprised of 67% male and 33% female subjects from the Summer STEM Institute in 2017 and 2018, while Kuwaiti participants included 52% male and 48% female subjects from the Little Engineer workshop in 2019. Although the United States requires no designation between gender in educational registering, Kuwait's program was divided into female, male, and mixed sections. The Kuwait workshops accepted students in grades 6–8, while workshops in the United States accepted students in grades 7 and 8 only. Kuwait participants comprised 53% of private school students (84% used scratch before), and 47% of public-school students (65.6% did not use scratch before). Private school students are any learners who attend two years or more under the private education system starting from grade one. The same investigator conducted both studies with different number of assistants (Kuwait had 5 and USA had 3). The difference between the two countries are due to the transformation factors such as language, religion, institution, and gender. The programs occurred in the universities' laboratories with all necessary software and hardware, and study protocol was approved by both universities' research compliance authorities. Table 3 shows the differences and similarities between setting and sampling of the two countries.

Table 3. Setting and Sampling of the Replication Study

Country	***USA***	***KW***	**Country**	***USA***	***KW***
#Sample	100	65	**Timing**	Morning	Afternoon
Male - Female	M:67% F:33%	M:52% F:48%	**Grades**	7th–8th	6th–8th
Diversity	Yes	Only Kuwaiti	**Location**	University Laboratory	University Laboratory
Years	2017–2018	2019	**Language**	English	Arabic - English
Term	Starbase summer camp	Little Engineer summer workshop	**Instructor**	1 CS instructors 1 CS assistant 2 assistants	1 CS instructors 1 CS assistant 4 assistants
Period	Four 3-hour sessions	Four 3-hour sessions	**#student/ workshop**	18–20	23–25

Results

This study analyzed student interactions in the STEM program to understand barriers that arise from adopting the program in Kuwait. The following research questions were considered:

RQ1 What are the factors that influence transferring and teaching STEM programs in Kuwait?

RQ2 Does the STEM program improve students' CT abilities in Kuwait?

RQ3 What are the similarities and differences between Kuwaiti and US student performances when they are taught STEM (MMC)?

T-tests and descriptive statistics were calculated from pre- and post-program self-efficacy surveys and Kahoot quizzing. If a student only participated in CT surveys, their answers were only used in those survey data sets. However, if a student completed all the surveys, all their responses were included in all data sets. This study created ten groups: KW (all participants from Kuwait), USA (all participants from the United States), USA-Male, KW-Male, USA-Female, KW-Female, W-USA (Male and female participants from USA), W-KW (Male and female participants from Kuwait), W-F, and W-M, where W refers to the MMC knowledge score.

What are the factors that influence transferring and teaching the STEM program in Kuwait?
The primary factors that impacted the replication study were language, religion, institution, geographical, technology and gender. Because the MMC program was designed in English, multiple obstacles arose when trying to teach it in the Arabic region. Parents were asked to indicate the preferred language for their children. Arabic (slang) was typically used to deliver the MMC while maintaining English words of the concepts. Likewise, translation sometimes made it harder to understand. For example, kids are familiar with the word "loop," but using the Arabic translation "المكرر" would be confusing to them. Public school students preferred the questions in Arabic, while private-school students favored English. Thus, all surveys were presented in both languages to satisfy all students (Table 3). In addition, some YouTube videos were replaced with Arabic videos with English subtitles or the facilitator described the video content.

Not only did the educational systems influence the teaching medium but they also influenced their technology background. The 6th graders' ability to complete the lessons tasks was similar between the public and private schools. However, 7th and 8th students' projects were distinct; the majority show more basic projects and needed more help comparing to the private's school students. We suspect the causes behind the difference are the language barrier and the STEM background. 6th grader knowledge of circuits and electricity were alike; both public and private were not familiar and showed similar reactions. Plus, older private schoolers learned the concepts before, and some of them even were familiar with robotics.

Religion and traditions comprised the second major factor that impacted this replication study. Because parents did not want their girls to be in a group with a mix of both genders, the class was divided into male and female sections. A nonessential change of class timing was also made in the MMC so that parents could drop off or pick up their children after finishing afternoon prayers. Besides the climate, noon was more agreeable than the morning where the temperature reached 140 ˚F in summer 2019. In addition, this study promoted the MMC by preemptively describing the program and its success in the United States since Kuwaiti society respects prestigious universities. Parents of the participants were given a booklet describing the workshop to stoke excitement, and as an incentive, students who attended every day were refunded their registration fees.

Students also encountered obstacles while they were taking the self-efficacy survey. Because this was the first time Kuwaiti students had participated in this type of assessment, some students were confused about the structure and expectations of the survey questions. For example, one part of the survey asks students to rate six sentences that began, "When solving a problem, I...". Students were confused as to why they needed to provide different answers for one question, and they were unsure how to evaluate it as right or wrong. In general, Kuwaiti students do not freely answer questions nor are they specifically asked their opinions. Instead, they often respond to questions in unison at school, using words taken directly from textbooks issued by the ministry of education, where students have memorized the information for the sets of annual examinations. Rating is not part of the educational system in Kuwait. Furthermore, since they were beginning coders, many students struggled to see the connection between the questions and coding.

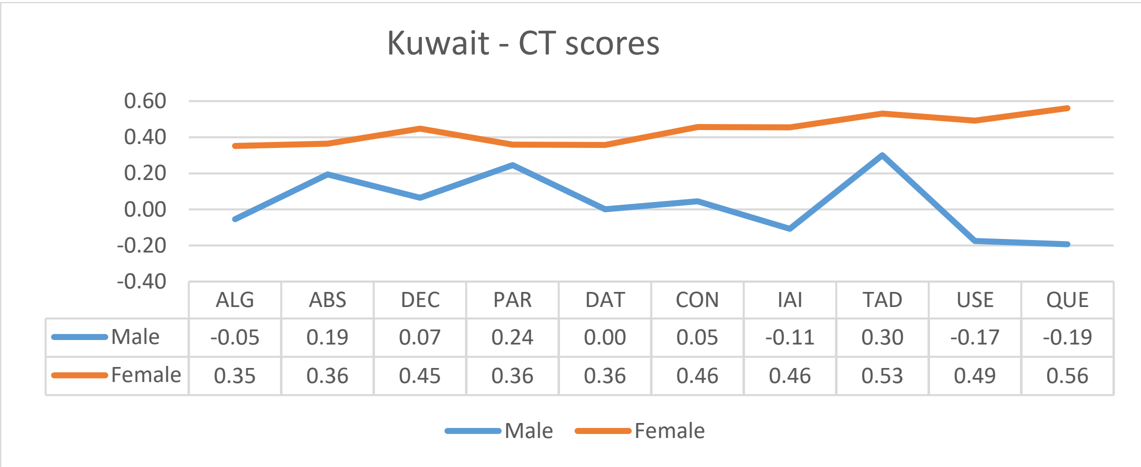

Figure 2. KW Self-Efficiency Scores of CT Abilities

Does the STEM program improve students' CT abilities in Kuwait?
Figure 2 shows that students' CT abilities improved in almost all the concepts. Notably, questioning (QUE) and testing and debugging (TAD) scores showed significant increases, potentially due to the social factor since the competition between teams was very high and students wanted to prove their knowledge, especially in the gender-segregated sections. Female participants exhibited a similar trend between reusing and remixing (USE), control flow (CON), and incremental and iterative (IAI). Algorithm (ALG), abstraction (ABS), parallelization (PAR), and data (DAT). Decomposition (DEC), however, was not significant, which was potentially due to the students needing to employ high levels of thinking. The project results from the last day of the program showed a big chunk of code or identical to what was taught in the previous sessions, potentially indicating that students were not taught to divide their work. Obvious gains in student self-efficacy with CT skills were observed for females but not for males. According to UNESCO, females from this region always show higher engagement overall with education [24]. Male scores did not show any statistical significance, so the effect size could not be compared between genders.
Table 4. Comparisons of the Knowledge Score Outcome Table 4, however, compares the knowledge scores of the two genders. Participant scores were statistically significant between the W-F group (m = 16.58, SD = 4.05) and the W-M group (m = 13.77, SD = 3.58), with p = .006, an effect size of -.02. Future research will provide additional data.

Table 4. Comparisons of the Knowledge Score Outcomes

Countries	*W-USA*	*W-KW*	*W-F*	*W-M*
Mean	17.03	15.20	16.58	13.77
Variance	15.68	16.39	16.38	12.81
SD	3.96	4.05	4.05	3.58
P-Value	0.046		0.006	
Effect Size	0.647		-1.022	

Table 5. Comparisons of CT Skills

Skill	USA	KW	USA-Male	KW-Male	USA-Female	KW-Female
ALG	0.33	0.14	**0.56**	-0.05	*0.34*	*0.35*
ABS	**0.73**	*0.28*	**0.61**	0.19	**0.62**	*0.36*
DEC	0.24	*0.25*	*0.34*	0.07	*0.42*	*0.45*
PAR	*0.44*	*0.30*	**0.54**	*0.24*	*0.39*	*0.36*
DAT	**0.56**	0.17	**0.66**	0.00	**0.63**	*0.36*
CON	*0.31*	*0.24*	*0.32*	0.05	*0.43*	*0.46*
IAI	*0.33*	0.16	*0.28*	-0.11	*0.23*	*0.46*
TAD	*0.25*	*0.41*	*0.21*	*0.30*	*0.21*	**0.53**
USE	0.20	0.15	*0.28*	-0.17	*0.05*	*0.49*
QUE	0.19	0.16	0.49	-0.19	*0.23*	**0.56**
# Students	100	65	67	34	33	31
Pre-Mean	3.61	3.46	3.71	3.55	*3.65*	3.35
Post-Mean	3.89	3.76	4.06	3.59	3.98	3.95
SD	1.06	0.79	1.05	0.82	*1.03*	0.67

The effect size ($\boldsymbol{post - pre / stdev}$) is noted as small, medium, and large; bold font indicates a medium effect (.5), and italicized font indicates small effect (.2). Statistically significant results are shaded based on associated p-values (<0.05).

What are the similarities and differences between Kuwaiti and US student performances when they are taught STEM (MMC)?

Analysis of study results confirmed that the replication of the MMC program between the United States and Kuwait produced a similar trend and gains for CT concepts and program knowledge (Table 5). A comparison of scores showed that USA demonstrated more significant effect sizes in ABS, PAR, and CON, but KW showed higher gains in TAD skills. Results of the remaining CT skills were ambiguous. As shown in the table, USA-Male exhibited higher scores in all CT concepts than KW-Male for the one with a significant p-value. Scores for the CT concepts of DEC, IAI, TAD, and USE scores were not statistically significant. In contrast, scores for KW-Female were slightly less in some concepts and higher in ALG, CON, and TAD than USA-Female, while USA-Female scored higher in ABS, DAT, and PAR. Scores for the CT skills DEC, IAI, USE, and QUE were not significant.

For gained knowledge, Table 4 shows that students in both experiments grew more confident with programming and building LED circuits on their own, The T-test resulted in higher knowledge scores for USA than KW, but evaluation of the gained knowledge between the two regions showed that improved scores of participants were more statistically significant for the USA group (m = 17,03.9, SD = 3.96) than the KW group (m = 15.20, SD = 4.05), where t(56) = 2.04, p = .046, and medium effect size d = 0.647. Thus, results showed that all participants learned fairly from the program.

Limitations

Although this study is limited to one region, it could have similar results for neighboring Arabic countries. However, knowledge backgrounds of residents in other countries may differ slightly. Another validity is participants baseline and educational environment lead to different CS and English background, and that are seen in their interaction through the program. In addition, Arabic speakers in the program required extra time to grasp the program's concepts to make sense for learners because of the language barrier.

Conclusions

The replication of the pilot study in Kuwait was a unique experience that offered valuable insights. Positive insights included the high rate of acceptance and participation in both countries, while negative insights included unexpected obstacles that needed to be avoided or remedied. Language barriers and concepts need to be given ahead of time to save time since the concepts are new and require further explanations to make sense to the students. In addition, traditions and religious aspects should be accounted for, including minor adjustments to suit various people groups. Overall, the results revealed a promising start with many positive indicators. Further investigations should be undertaken in this field on a larger participant group in neighboring GCC countries.

Acknowledgments

We thank Khalid Alselmi, our organizer and facilitator in Kuwait, as well as the students who assisted with our program. We thank Professor Kassem Saleh, head of the Information Science department at Kuwait University, for permitting us to use their lab and equipment.

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