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Developing an Instructional Unit from a History Textbook Based on Computational Thinking and Its Impact on the Development of Students' Systems Thinking Skills

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Abstract: Although the current study was implemented in a developing country, the methodology that was followed, the context, and its variables can be internationally applied and generalized, as the content knowledge of any history subject, locally or internationally, consists of concepts, events, and complex problems and issues. This study aimed to investigate teaching a developed instructional unit from the history textbook, based on computational thinking, on students' systems thinking. A quasi-experimental design was followed to achieve this main objective. After confirming their validity and reliability, the instructional materials (developed module) and the Systems Thinking test were prepared and used. The participants were 100 tenth-grade students selected using random sampling. Data collection was analyzed using the appropriate statistical analysis. The findings revealed statistically significant differences (at $\alpha = 0.05$) in students' scores in the Systems Thinking test in favor of the experimental group, attributed to the developed unit. It was also shown that there were statistically significant differences (at $\alpha = 0.05$) in students' scores in the Systems Thinking test attributed to the gender and the interaction between the gender and the developed unit in favor of male students. This study can add value to international literature by suggesting a developmental model for the content of school curricula, especially the history curriculum. This model targets enhancing the learners' higher-order thinking skills, enabling them to solve the issues they are studying at the highest levels of thinking and mental self-regulation. Accordingly, learning will be catalyzed, which is consistent with the demands of the digital era.

Keywords: developed instructional unit, computational thinking skills, Systems Thinking skills, history, teaching.

基于计算思维的历史教科书开发教学单元及其对学生系统思维能力发展的影响

摘要：尽管目前的研究是在发展中国家实施的，但所遵循的方法、背景及其变量可以在国际上应用和推广，因为任何历史学科的内容知识，无论是本地的还是国际的，都由概念、事件和复杂的问题和问题。本研究旨在调查基于计算思维的历史教科书开发的教学单元对学生系统思维的教学。遵循准实验设计来实现这一主要目标。在确认其有效性和可靠性后，准备并使用了教学材料（开发模块）和系统思维测试。参与者是使用随机抽样选择的100名十年级学生。使用适当的统计分析分析数据收集。研究结果显示，学生在系统思维测试中的得分存在统计学上的显着差异（α=0.05），有利于实验组，这归因于开发的单元。它还表明，学生在系统思维测试中的得分存在统计学上的显着差异（α=0.05），这归因于性别以及性别与发达单位之间的相互作用，有利于男学生。这项研究可以通过为学校课程，特别是历史课程的内容提出一个发展模式来增加国际文学的价值。该模型旨在提高学习者的高阶思维能力，使他们能够以最高水平的思维和心理自我调节来解决他们正在研究的问题。相应地，学习将得到催化，这与数字时代的需求是一致的。

关键词：开发教学单元，计算思维技能，系统思维技能，历史、教学。

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1. Introduction

Due to the rapid changes and developments in technology and the cultural openness resulting from the digital revolution in the current era, multiple challenges have emerged and been imposed on education with its different institutions. That urges the reconsideration of the applied systems, operating methods, and aspects, as the utmost goal of education extends beyond transferring knowledge and information to students. Instead, education should develop students' diverse thinking skills and styles by enhancing their higher-order thinking skills. Consequently, they can construct knowledge-based thinking in all its forms.

Early studies confirmed that developing thinking skills can prepare students to cope with life changes and demands. It is also essential to perform their roles properly as active citizens who can deal effectively with social issues and participate in community services. This importance was also previously asserted that developing learners' mental abilities and thinking skills can confidently confront social and economic changes [1, 2]. Thus, learners can overcome the problems they encounter with open-mindedness and a well-informed mentality. Besides, developing thinking skills is distinguished from other cognitive processes, as it is more complex and demands diving deeper into the phenomena and attitudes in all fields. That leads to addressing such phenomena through producing new knowledge and information which are more objective and comprehensive.

Developing students' thinking skills at different levels has become a fundamental demand according to [3], who regarded the main goal of teaching thinking as improving learners' mental abilities. That is supposed to help their inquiry and research skills to overcome social issues and pass life obstacles. Consequently, their knowledge and knowledge structures might expand and be enriched. For this goal, sufficient attention should be given to teachers' content knowledge and experiences.

One of the key subjects contributing to stimulating thinking is Social Sciences, particularly history, since studying history requires a thorough understanding of the present and past to be interpreted and used in future prediction. The main challenge that has emerged due to the rapid growth in knowledge is the future prediction, which raises concerns regarding the type of historical knowledge that must be introduced to students. The presentation of this historical content knowledge in textbooks and the most appropriate teaching methods and techniques can be utilized to trigger learners' thinking and encourage more than memorizing the historical facts that may underestimate their thinking [4].

Therefore, it is confirmed in the current study by the researcher that the provision of the historical content knowledge should spring from the main objectives of teaching history, and it should give more attention to developing the various historical thinking skills. Additionally, teaching methods and techniques should be aligned with such objectives. They should consider students' characteristics to prepare them to use the acquired skills in different life situations. In a sense, one of the main goals of teaching history is to develop students' higher-order thinking skills, which may be reflected in their academic and life skills accordingly.

Despite this fact, teaching history is still confined to memorization and information retrieval, which hinders learners' mental skills [5]. It was also asserted that the teaching methods and techniques adopted in presenting the historical knowledge need to be introduced based on planning, organization, sequence, and precise synthesis so that history can be taught with systematic planning that promotes Systems Thinking.

Systems Thinking promotion is one of the higher-order cognitive skills according to [3], which indicates open-mindedness that stems from a holistic cognitive awareness of all aspects of any problems or situations confronted by individuals. It also involves a thinking pattern that starts from the holistic approach to finding the connection with the parts of the situation and finding relationships between the different parts of the overall situation. Therefore, systems Thinking is regarded as one of the essential goals that learners can achieve during studying or discussing historical issues. Formulating the historical lessons into forms of problems encourages exclusive thinking patterns to be solved. Thus, it can be stated that the relationship between teaching History and Systems Thinking is proven, especially the historical events demand precise inquiry, observation, and examination. As a result, students can have a thorough organization of the correct and incorrect facts based on the historical circumstances and reality in which events have occurred. Accordingly, logical evaluations and conclusions can be drawn.

Using the Systems Thinking Approach in a planned and systematic method to introduce historical knowledge would enhance organized and structured learning that may improve the Systems Thinking skills. Thus, the interdependence between teaching History and Systems Thinking was confirmed.

Systems Thinking has been defined widely in the literature. In [6], for example, Systems Thinking is clarified as "the process of considering the holistic aspects of the situation or problem to understand the whole system and solve such problems accordingly". Additionally, based on [7], Systems Thinking is "a specialized language and tools utilized to process the most complicated problems in life, and it is also a method to understand the situation through focusing on the whole aspects of the system instead of focusing on the separate components only" [7].

On the other hand, [8] introduced Systems Thinking as “a set of analytical combined skills used to improve learners’ ability in identifying and understanding the situation, as such skills work in harmony as a holistic system” [8].

Upon close analysis of the previous definitions of Systems Thinking, it can be concluded that this type of thinking has a role in developing students' higher-order thinking skills, such as relationship recognition skills, systematic analysis, synthesis, and evaluation skills. In addition, these skills can shape a holistic vision of any issue or problem students may encounter without missing any of the components.

The interest in developing Systems thinking skills was justified and regarded as fundamental for developing students' ability to form mental constructs that enable students to think in a holistic method. This method considers all the components of any issue in an organized way instead of having a limited perspective. Consequently, teaching needs to move beyond memorization to focus more on comprehension, application, analysis, synthesis, and evaluation, resulting in more retention of knowledge in long-term memory.

Thus, developing Systems Thinking skills has been considered one of the scientific methods used to understand historical issues and problems. The problem can be investigated thoroughly by considering all its components in unity, not in isolation. Hence, Systems Thinking can enable the learners to suggest legible solutions in a holistic and comprehensive vision of any issue, taking into account all the elements. Accordingly, learners can start identifying the real causes of problems to promote their analysis, synthesis skills, and creativity.

Teaching Systems Thinking skills through teaching history might enhance learners' mental abilities and stimulate their thinking since memorization and retrieval of knowledge alone cannot guarantee a high quality of education. It rather requires organized and meaningful education and ongoing training on Systems Thinking through learning different historical issues and through analyzing, discussing, and evaluating them in a holistic and systematic method. One effective method can be re-constructing the lessons to trigger analysis, abstraction, pattern recognition, prediction, evaluation, and generalization.

That demands re-constructing the methods of teaching historical content knowledge, presented in strategies that stimulate thinking and promote the different historical skills. For example, some methods are called computational thinking skills that imply analysis, abstraction, pattern identification, evaluation, prediction and generalization. Hence, the thinking pattern of Systems Thinking skills (recognition of relationships, analysis, synthesis, and evaluation) align with the computational skills and are in harmony, paying attention to the components and similar in extracting causes and effects in a systematic and organized method, in concluding and in analyzing the problem after being divided into its components. In other words, the analysis steps of computational thinking pass through the same Systems Thinking processes that depend on the analytical, synthesis, and evaluative abilities.

Investigating computational thinking skills is one of the current trends. This term, first used in 1996, also was addressed in 2006, defined as "a skill and method of problem-solving that develops the analytical abilities of the individual" [9]; "a set of concepts and processes of thinking that promote analyzing and solving problems in the different disciplines" [10]; "similar to the method computer scientists use in thinking" [11].

Additionally, [12] regarded computational thinking as "a formulation of problems, logical organizing, and analysis of data, representing data through abstraction and automatization of the solutions". In [13] it is stated that computational thinking consists of combined skills to solve problems creatively, and it is not related to the computer exclusively. Instead, it includes analysis, abstraction, pattern identification, evaluation and generalization, and logical thinking and collaborative problem solving" [13]. In other words, it can be confirmed that computational thinking is a set of complementary thinking skills that can be used to solve a problem, and it implies analysis, abstraction, pattern recognition, evaluation, prediction, and generalization.

Concerning the effectiveness of integrating the computational thinking processes in teaching and learning, it was asserted by some researchers [1, 2] that such skills should be acknowledged as an essential skill that supports students in dealing with problems. They can also enable them to use logical regulation and analysis and represent through abstractions. Besides, this type of thinking assists in automatizing solutions through algorithmic thinking, which can support computational thinking as an effective means of learning. It was also specified as a complex skill comprised of "analysis, abstraction, pattern recognition, prediction, evaluation, and generalization". Thus, these practices have been vital in modeling, deducting, and problem-solving.

Another research [14] indicated that students nowadays are influenced to work in the computing fields, as they need to use computing in their daily lives. Computing is not only related to computers and technology. Instead, this field includes critical thinking and problem-solving skills. According to [15], one of the key factors that may support the significance of using computational thinking is its vital role in solving problems. Students can use it to analyze, reflect, deduct, suggest solutions and generalize certain conclusions on similar problems that may emerge. Consequently, students' analytical abilities may improve, and their understanding of the historical issues will be widened. That also may lead to more information retention, and students can become more motivated to learn history as it becomes more appealing to them.

Regarding integrating computational thinking in school education, [1] asserted that many international organizations and bodies have highlighted computational thinking. Many training workshops have also been held to provide computational thinking skills and how they can be integrated into curricula. Moreover, several conferences have been held to present, discuss and share experiences related to the latest research and studies. In addition to that, multiple articles and studies have been published about the concepts and skills of computational thinking, such as Carnegie Mellon, Computing at School organization, ICTE association, and ACARA organization. Besides, [16] pointed out that computational thinking aims to create students' positive attitudes towards developing their analytical thinking to solve their problems properly. Computational thinking can also develop students' confidence in coping with the complexity of problems consistently, enabling them to solve problems and discuss different issues. Undoubtedly, this comes in line with the historical issues presented in curricula.

Based on the recommendations stated in conferences and workshops, it was declared that it is possible to integrate computational thinking skills into the educational content. That extends beyond using computers and technology to present the concepts and content knowledge. According to [17], computational thinking is "a method of thinking by humans, not computers", since computers do not have imaginative thinking like humans. Thus, it is important to effectively invest in these skills to solve human problems. In the same context, the demanded skills for dealing with the historical problems and issues presented in textbooks are consistent with such a perspective. The learners can identify the problem, examine data, and develop a plan to implement and evaluate to achieve the target goals. That can be followed by generalizing the same deducted solutions to similar situations.

Upon close analysis of the multiple definitions of computational thinking, the researcher believes in the possibility of designing historical content knowledge based on computational thinking skills. Thus, designing and developing a unit in history based on the prescribed skills may contribute to developing students' thinking. Teaching this History unit on developing students' Systems Thinking skills can be measured after being taught to students in Jordan. In examining the previous studies, it was noted that a sum of studies has discussed computational and Systems Thinking. As for studies pertinent to computational thinking, it was observed that there are many studies investigating these skills using different research methodologies. Some of them followed the quasi-experimental design to examine the effect and effectiveness of certain programs and activities and the effect of the learning environment on developing computational skills.

Other studies, for example, implemented some computational programs and revealed a significant effect of such programs on developing students' computational thinking [18].

Additional studies investigated the effect of using non-conductive computing activities on developing students' computational thinking skills [19, 20]. Meanwhile, some descriptive studies focused on describing the relationships between these skills and other skills [20]. Furthermore, Systems Thinking has been discussed as a dependent variable in most studies based on the researchers' search, using the quasi-experimental design to examine the effect of different educational programs and strategies on developing Systems Thinking skills [21].

Upon a critical review of the previous studies, the researcher can conclude that the studies investigating developing instructional content following computational thinking skills were limited, particularly in teaching history. However, it is regarded as one of the fields that demand such skills immensely. Thus, the current study was distinguished as it can be regarded, at least in the Arab countries, as one of the first studies aimed at investigating the combination of all these variables.

2. Statement of the Problem

The researchers and practitioners noted it in the educational field that the content knowledge of the History subject is introduced to enhance only memorization and retention of knowledge. Accordingly, teaching strategies in history are affected by traditional methods that teachers tend to use that do not promote students' thinking. Besides, the motive of the current study emerged based on the recommendations of the previous studies, such as [22], in which the researchers stressed the importance of conducting more studies related to computational thinking and how it could be integrated into different subjects that enhance thinking.

Based on the previous literature, it can be concluded that the scientific research and studies on developing Systems Thinking skills in teaching history were few. Therefore, this study targeted developing students' Systems Thinking skills by developing and implementing a teaching unit based on computational thinking from a History textbook in Jordan.

3. Questions of the Study

The main question that guided this research was:

1. What is the effect of the developed instructional unit based on computational thinking on developing the Systems thinking skills of tenth-grade students in history?

The two sub-questions were:

a. Are there any statistically significant differences ($\alpha = 0.5$) in students' performance in the Systems Thinking test, which can be attributed to instructional units (the developed and the conventional)?

b. Are there any statistically significant differences ($\alpha = 0.5$) in students' performance in the Systems Thinking test, which can be attributed to the gender and the interaction between gender and the instructional unit (the developed)?

4. Significance of the Study

The results of the current study may be beneficial for the National Center for Curriculum Development, the Directorate of Training in the Ministry of Education, the supervisors of history, and the teachers they supervise.

5. Procedural Definitions of Terms

5.1. Systems Thinking

Operationally, Systems Thinking skills in the current study referred to identifying simple relationships among a system's components and analyzing, synthesizing, and evaluating. After being taught in the developed instructional unit, these skills were measured by analyzing students' responses to the Systems Thinking test.

5.2. Computational Thinking

Operationally, the computational thinking skills adopted in the current study were related to a range of skills which are analysis, abstraction, pattern recognition, evaluation, prediction, and generalization. These skills were selected to develop an instructional unit, and they were presented to students using different learning resources. Besides, the effect of these skills was measured on developing students' analysis of the historical issues, decision-thinking, and Systems Thinking skills.

6. Method and Procedures

A quasi-experimental design was followed to measure teaching in the developed unit in the current study. A quasi-experimental design can measure the cause and effect relationships between two or more variables [23]. This design consisted of two groups: experimental and control.

The population in the current study included tenth-grade students (males and females) in History classes in schools affiliated with the Directorate of Northern AL-Aghwar in Jordan. The population consisted of 580 students in the academic year of 2019/2018. These students were in 16 schools divided into 21 sections. The participants were 100 students from tenth grade divided randomly into two groups. The Control Group consisted of two sections from the tenth grade (male and female). Each group had 25 students. It was taught in Unit Four in the History textbook (The Era of Revolutions and the Great Arab Renaissance) in tenth grade. The Experimental Group consisted of two sections as well. It included 25 male students and 25 female students from grade ten. This group was taught according to the developed unit extracted from the same textbook unit based on computational thinking.

6.1. Instructional Material: The Developed Unit

Based on computational thinking skills, the developed instructional unit was established after consulting the previous literature and studies. The embedded skills were analysis, pattern recognition, evaluation, prediction, and generalization. The original activities in Unit Four were rephrased to provoke more identification of the similarities between the components of the problem and to develop students' prediction by finding connections with the previous knowledge rather than being tied up with the knowledge constructs to evaluate the effectiveness of the problem the suggested solutions. The final step in computational thinking skills was generalization and utilizing it to solve the problem. Then, it can be used with other similar problems. That has been accomplished by embedding the different learning resources in the developed unit to suit the skills and rephrasing the learning outcomes using consistent procedures that include different types of objectives (cognitive, affective, and motor skills) with preserving the general intended learning outcomes.

Additionally, the content validity of the developed unit was confirmed by being given to 18 educators specialized in the educational field and others who are specialists in social studies curricula and methods of teaching and have contributed to developing curricula, especially for history.

6.2. Study Instruments - System Thinking Test

The Systems Thinking test consisted of 14 items that covered the Systems Thinking skills: Systematic patterns recognition, analysis, synthesis, and evaluation. The test items were prepared after analyzing Unit Four in the History textbook of tenth grade. Students' performance on the test was evaluated using certain rubrics for each skill. In addition, this instrument was checked for its validity and reliability using standard scientific methods.

7. Results and Discussion

In this section, the results have been displayed according to the research questions.

First Question: Are there any statistically significant differences (α = 0.5) in students' performance in the Systems Thinking test, which could be attributed to the instructional unit (the developed and the conventional)?

In order o answer this question, the means and standard deviation and the adjusted means and standard deviation of the scores of tenth-grade students (control and experimental groups) in the Systems Thinking test were extracted (Table 1).

Table 1 Means and standard deviation and the adjusted means and standard deviation of the scores of tenth-grade students in the systems thinking test (E = experimental group; C = control group)

		Pre-test		**Post-test**			
Skill	**Grp**	**Mn**	**Std. Dev**	**Mn**	**Std. Dev**	**Adj'd**	**Err**
Systematic Relationship ID	E	3.20	1.1	11.08	1.10	11.05	.278
	C	2.22	.76	3.50	2.32	3.53	.278
Systematic Analysis	E	1.92	1.1	10.94	1.17	10.71	.255
	C	1.66	1.0	3.30	2.11	3.53	.255
Systematic Synthesis	E	2.02	1.1	10.90	1.07	10.69	.163
	C	1.60	.90	3.20	1.36	3.41	.163
Systematic Evaluation	E	1.44	1.1	4.66	1.21	4.41	.199
	C	1.22	.82	2.40	1.51	2.65	.199
Total	E	8.58	2.16	37.58	3.8	37.01	.553
	C	6.48	1.95	12.36	3.9	12.93	.553
		7.53	2.30	24.97	13.23		

Based on Table 1, it is obvious that there are observed differences between the means and the adjusted means of students' scores in the Systems Thinking test in favor of the experimental group who were taught based on the developed unit following the computational skills. In order to reveal the significance of such differences, the Accompanying One-way Analysis of Variance (ANCOVA) analyzed the score of each skill and the total score. Table 2 displays the results.

Table 2 The results of accompanying one-way variance analysis (ANCOVA) of students' scores in the systems thinking test per skills

Source	**Sum of Square**	**DF**	**Mean Square**	**F**	**Sig**	**Eta Square η^2**
System Relationship Recognition	1055.23	1	1055.23	319.3	.000	.773
Systematic Analysis	962.12	1	962.12	345.9	.000	.786
Systematic Synthesis	987.40	1	987.40	867.3	.000	.902
Systematic Evaluation	58.259	1	58.259	34.410	.000	.268

It is obvious in Table 2 that there are statistically significant differences (at α=0.05) in tenth-grade students' performance in the Systems Thinking test in favor of the experimental group, as *F=848.406* with a statistical significance (0.00). That indicates a positive effect on the developed unit's systems skills.

7.1. Discussion Pertinent to the First Question

7.1.1. Systematic Recognition of Relationships

The current study results revealed significant differences in the systematic recognition of relationships as a Systems Thinking skill among students as the mean score reached 11.80 in favor of the experimental group. This result can be attributed to the developed unit. These skills may have promoted students' analytical thinking and enhanced their ability to identify and understand the relationships between ideas and concepts. First, it has been achieved through analyzing the historical issues and problems in its main and sub-components then these components may have been synthesized into ideas and visual diagrams.

Practically speaking, while developing the instructional unit, different activities were embedded to promote students' practices related to the Systematic recognition of relationships. For example, students in the experimental group were asked to fill in a systematic conceptual map regarding the rise of the Industrial Revolution in Britain and the growth of the modern colonialism phenomenon. Another activity was related to identifying the relationship between the Great Arab Revolution and the establishment of the Emirate of Eastern Jordan. Students were exposed to a systematic map and asked to implement and practice it. Therefore, these activities may have contributed to developing students' skill of relationship recognition between systems since abstraction is one of the main skills of computational thinking that participates in formulating the problems into computational steps to be solved.

7.1.2. Systematic Analysis Skills

The results also revealed statistically significant differences in students' systematic analytical thinking skills attributed to the developed unit in favor of the experimental group. Accordingly, according to

Systems Thinking, students were able to suggest appropriate solutions for the problems. That contributed to developing students' analytical thinking skills through extracting main and sub-systems, inducting conclusions, and recognizing the patterns of relationships. Furthermore, presenting activities in the developed unit that triggers reflection, for instance, was one of the implemented activities in the developed unit, as students were asked to formulate a suitable concept for the Industrial Revolution on a systematic map that demanded recognition of patterns and relationships. Thus, students' systematic constructs may have been developed to improve systematic analytical thinking, enabling them to identify the real causes of the historical problems and issues from a holistic perspective.

Hence, the logical presentation of the concepts and information in the developed unit may have enabled learners to identify the relationships between ideas by specifying the stream of ideas that led to exact conclusions. That comes in line with computational thinking principles that enhance the analysis of relationships using different thinking patterns, such as deduction, induction, and recognition of patterns and relationships [24]. Consequently, these skills may have been developed among students, particularly as they were put in situations that provoked their thinking to form systematic schemes independently, and they became more motivated accordingly [25].

7.1.3. Systematic Synthesis Skills

The results revealed statistically significant differences in students' systematic synthesis skills attributed to the developed unit. The mean reached 10.90 in favor of the experimental group since it was presented based on higher-order thinking skills and problem-solving. Thus, the included activities and skills enhanced students' problem-solving skills by systematically and logically connecting facts.

Besides, the maps used during the implementation based on computational thinking may have guaranteed diverse activities and presentations of the concepts of the content knowledge. It has been achieved by urging students to turn in a report related to systematic prediction as to the main skill of computational thinking [26]. Accordingly, students' systematic synthesis skills have been developed.

7.1.4. Systematic Evaluation Skills

The results in the current study demonstrated statistically significant differences in students' systematic evaluation thinking attributed to the developed unit, as the mean score was 4.66 in favor of the experimental group. This result can also be attributed to the developed unit since the evaluation skills were emphasized. It has been conducted by exposing learners to a learning experience to evaluate the relationships between the components, provide a comprehensive diagnosis, recognize the relationships between the abstract concepts, identify the different patterns restructuring flexibly, predict in light of the previous knowledge, and determine the new knowledge. The significance of the evaluation skill was confirmed according to computational thinking, as it can develop the Systems Thinking skills [27].

This result is again attributable to the developed unit, as students started to focus on identifying data and suggesting and interpreting the solutions logically. Accordingly, students' Systems Thinking may have been developed through being asked to find effective solutions to historical issues. In addition to that, students' mental processes, such as drawing conclusions, analysis, synthesis, and evaluation, may have been triggered by suggesting organized conceptual maps and extracting decisions accordingly.

7.2. Discussion Pertinent to the Second Question

Are there any statistically significant differences ($\alpha = 0.5$) in students' performance in the Systems Thinking test, which can be attributed to the gender and the interaction between gender and the developed instructional unit?

In order to answer this question, the Accompanying One-way Analysis of Variance (ANCOVA) of the post-test results of tenth-grade students in history was used according to the gender, group, and the interaction between them. Table 3 displays the results.

Table 3 Results of the accompanying one-way analysis of variance (ANCOVA) of tenth-grade students' scores in the system thinking test per gender, group, and the interaction between them

Source	Sum of Square	DF	Mean of Sum Square	F	Sig.	Eta Square η^2
Group	15901.21	1	15901.21	1131.79	.000	.921
Gender	68.890	1	68.890	4.903	.029	.048
Group* Gender	146.410	1	146.410	11.555	.001	.107
Error	1362.810	97	14.050			
Total	17332.91	99				

Based on Table 3, it is obvious that these are statistically significant differences (at $\alpha = 0.05$) in students' mean scores in the Systems Thinking test according to the group with a significant value of F = 1131.792, which is a significant value that indicates the presence of an effect from the developed unit. It can also be stated that this effect was large as Eta-square ($\eta 2$) explained (0.921%) of the variance (predicted) in the dependent variable, which was the developed unit. It is also obvious that significant differences (at α = 0.05) attributed to the gender as F = 4.903. Additionally, there were statistically significant differences attributed to the interaction between the group and gender as F = 11.555 with a statistical significance of (0.001).

In order to determine beneficiaries of differences, adjusted means and standard deviations (of errors) were extracted according to the group and gender. Table 4 illustrates the results.

Table 4 Adjusted means and standard deviation of tenth-grade students' scores in the systems thinking test per group and gender

		Adjusted Means	Error
Group	Experimental	37.58	3.753
	Control	12.36	3.890
Gender	Male	25.80	12.199
	Female	24.14	14.266

The results in Table 4 indicate statistically significant differences in the Systems Thinking skills between groups in favor of the experimental group exposed to the developed unit. These results (at α = 0.05) can again be attributed to the effect of the developed unit based on computational skills in the History textbook of grade ten. Furthermore, the results favored the experimental group as the mean score was 37.58, whereas the mean score of the control group was 12.36. As for the gender differences in developing Systems Thinking, the findings reveal significant differences (at α = 0.05) attributed to the gender as F= 4.903, which indicates that there is an effect of gender in favor of male students.

This result can be attributed to the developed unit. The presented materials and activities affected male students more than female students since studying wars and revolutions may have been more appealing for males. Besides, the results revealed significant differences (at α = 0.05) attributed to the interaction between group and gender, as F = 11.555.

That is because the holistic thinking implied in Systems Thinking may have urged the finding of connections between the different components with recognizing the interactive relationships between them. That may have provoked Systems Thinking, particularly when students raised critical questions and generated more practical ideas. Regardless of the differences in the contexts, subjects, and gender, the current study results are consistent with most previous studies which demonstrated the effectiveness of integrating Systems Thinking in teaching.

8. Conclusions

Even though this study has been conducted in a developing country, the methodology followed and the variables apply to other contexts worldwide since the historical events have the same development. For example, it is possible to develop content knowledge of history in any environment following Computational Thinking Skills demonstrated in this investigation. Thus, the real contribution and novelty of the current study is its importance and scarcity in developing content knowledge of all the curricula in general and history in particular.

In the current study, a developmental model and a recent design for content knowledge of the school curricula were suggested, which can be a main source of learning that comprises other sub-learning sources that are regarded as the highlight of teaching and learning activities in classrooms. These sources have been rearranged, organized, and presented to take into account the major cognitive structures in different frameworks and present a systematic structure that facilitates the concepts of learning in general and the simple and complex historical concepts in particular.

The current study is also distinguished as it harmonizes with the demands of the technological revolution that the world is experiencing nowadays. As for the theoretical framework, Computational Skills as a logical and psychological basis in developing and reorganizing the content knowledge were adopted. These skills are highly demanded in contemporary issues that impact the components of the learning and teaching process that lead to enhancing the higher-order thinking skills that promote problem-solving ability.

Besides, the specificity of the current study was in connecting the facts with their relationship in a systematic and logical method, demonstrated in restructuring the teaching unit. Consequently, this study can contribute to the local and international literature by presenting a new model that enhances the different thinking patterns and develops the learners' mental abilities and processes. Additionally, it comes in line with the current and changeable conditions resulting from the world is experiencing, such as the Covid-19 pandemic, which has affected all the social systems, particularly the educational system. Thus, this study proved that rearranging and reorganizing the content knowledge of any subject is possible, leading to encouraging self-learning by programming the teaching subjects. Accordingly, this may achieve the educational goals through promoting distance and self-learning, which are anticipated to be the future of teaching and learning.

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