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Adaptive gamification framework to promote computational thinking in 8-13 year olds

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Abstract

Computational thinking (CT) skills are necessary to prepare students for the demands and challenges of the modern era. Students require an incentive to acquire any new skill. This can be accomplished by employing gamification, which has been widely used in educational environments and instructional practices to improve student engagement and motivation by including game elements. However, delivering CT to students through gamification is challenging. There is a lack of studies on integrating gamification into CT, especially when it comes to considering student preferences such as learning styles. Besides, according to the reviews, the existing adaptive frameworks do not directly incorporate gamification and CT into education. Therefore, the author proposed an adaptive gamified framework that supports adaptive features based on students' dimensions (verbal, visual) using the Felder-Silverman Learning Style Model (FSLSM) to foster CT skills and enhance students' motivation and performance using a modified version of the Moodle platform that supports adaptive learning features. The proposed framework integrates an "adaptive gamification framework" with the "student-centered framework" by adopting the available gamification elements in the "student-centered framework". Additionally, it matches the results with the proposed conceptual model that investigates the relationship between gamification and CT in the field of education to provide adaptive gamification and learning features. Furthermore, the results of the work indicated that the use of gamification had a positive impact on students in terms of motivation and performance, as the game elements contributed to increasing children's desire to retake the tests and thus improved the performance of students.

KEYWORDS: Adaptive, Computational Thinking, E-Learning, Gamification, Game Elements, Learning Style, Moodle, Motivation.

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1. Introduction

The rapid advancement of technology has necessitated the acquisition of new skills, which will help the next generation in meeting the requirements of the modern era, as reflected by the future of work and national advancements. Over the past years, many researchers have sought ways to help young people foster creativity and understand the consequences of technological advancements. One way to do this is by fostering computational thinking skills in schoolchildren. Many advanced countries have found that computational thinking education, as a consequence of the growth in international education policies in different countries, is very important to the future work and competition of their people and their national development. As a result, advanced countries acknowledge the importance of developing the computational thinking skills of children in early childhood (Buitrago Flórez et al., 2017). Computational thinking (CT) is considered to be a major skill for the 21st century that must be developed by future generations. It has been built as a significant 21st-century skill focused on data representation, algorithmic design, and pattern recognition. It is also considered to be a cognitive skill to apply computer science thinking processes in STEM disciplines and to apply them more to different daily problems and events (Hooshyar et al., 2020).

However, fostering CT in school students presented some difficulties. Educators, in particular K-12

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teachers and scholars, have not clearly identified how to educate students (Hsu et al., 2018). Over the past years, experts have been focusing on finding details on how to include appropriate and best materials and tools, either for all users or based on user-specific characteristics such as knowledge level, education, or learning style. Besides that, researchers have highlighted the importance of using programming to enhance CT skills. Children can use their creativity to control computers to solve problems via programming (Ching et al., 2018). However, programming languages are professional in nature (such as C, C++, and Java), which makes it very difficult for beginners, especially schoolchildren, to learn because of poor teaching methods, low levels of interaction with students, and a lack of interest (Kazimoglu et al., 2012).

In order to systematically encourage the CT skills of learners, several educational tools have been created to help students understand the logical reasoning of processing and to further support students' intuitive understanding of CT. There have been several ways that teaching aids have been used to improve the interest of schoolchildren in learning computational thinking from a young age (Kazimoglu et al., 2012). Among these tools gamification has been used to improve the learning process and encourage creativity. Gamification can be defined as the implementation of game elements in non-game contexts in order to involve people in a wide range of tasks (De Sousa Borges et al., 2014).

Over the past few years, the usage of Gamification strategies in educational contexts has increased because of the fact it has been shown to enhance the motivation and engagement of the learner. However, because the effectiveness of gamification in these contexts depends on appropriate design to prevent unwanted outcomes, many input variables must be taken into account by gamification researchers. Examples of these variables include student characteristics (such as demographic, psychological, and cognitive data) and game components that will be used to gamify the mission (Nurul and Mohamad, 2018; Toda et al., 2019). In addition, the application of Gamification does not necessarily reach the desired outcomes in educational contexts. This can happen because of many factors, such as a lack of interest in gaming or generic strategies that do not take user profiles into consideration. So, in order to implement Gamification efficiently, it must be adaptable to each user. This can be done by understanding the needs of the target audience and defining learning objectives, building strategies, and identifying available resources (Lopes et al., 2019).

Therefore, this paper investigates the effect of applying adaptive gamification to stimulate computational thinking while children aged 8-13 learn programming in the Scratch language on a modified version of the Moodle e-learning platform.

The rest of the paper is organized as follows: Section 2 discusses related work. while Section 3 offers the methodology. Section 4 shows the discussion. Finally, section 5 shows conclusion.

2. Related work

The fundamental concept of the study is provided in this part, which includes concepts related to the development of computational thinking abilities, gamification, and the use of gamification in eLearning systems and adaptive gamification are presented.

2.1 Computational Thinking (CT)

Computational thinking (CT) is an ability for the 21st century that must be developed by future generations. CT's primary goal is to develop the ability to use computers and algorithms to improve creative, critical thinking, and other skills and it facilitates the process of learning and development by decomposition (breaking problems or issues into pieces), pattern recognition (pattern observation, trends, and regularity), abstraction (identifying general rules), and design of algorithms (evolving step-by-step problem-solving instructions) (Vlahu-Gjorgievska et al., 2019).

In order to describe CT, many attempts have been documented. However, most of the definitions are ambiguous as there are no standard concepts. For instance (Swaid and Suid, 2019; Wing, 2006) described CT as "the thought processes involved in the formulation of problems and their solutions such that the solutions are represented in a manner that an information processing agent can effectively perform". Likewise, (Barr and Stephenson, 2011) described CT as "an approach that can be applied with a computer to solve problems". They proposed the term "operational definition" of CT to describe the problem solution strategy which incorporates a variety of aspects. These aspects are as follows: i) Formulate an issue in such a way that it can be solved using a computer or other instrument. (ii) Arranging and logically evaluating results. iii) The abstracting of data in the context of models and simulations. iv) Automation of the solution by algorithmic steps. (v) Defining, evaluating, and applying a potential approach to accomplish the most productive set of steps and resources. vi) Generalization and application of solving problems measures to solve a variety of issues in different fields of activity (Agbo et al., 2019).

CT concepts have also been offered by other people and research groups. Yadav et al.(2016) identified the function of CT as follows: "the essence of computational thinking is to break down complicated problems into more familiar-managed sub-problems (problem decomposition), to use a sequence of steps (algorithms) to solve problems, to analyze how the solution is transferred to related problems (abstraction), and finally to decide if a computer can help us solve such problems more effectively (automation) ". In general, CT can be concluded as a method that uses the ability to identify problems and solve them as a solution by implementing technologies or methods.

Recently, a growing interest in CT education in K-12 schools and its role in boosting children's thinking and digital abilities has emerged. In response to this need, CT and programming have become an essential element of the school curriculum in many nations in recent years (Angeli and Giannakos, 2020). However, for K-12 educators and educational scholars, computational thinking is relatively new. Teachers and scholars have just started efforts to enhance and integrate CT in students, and few research studies have concentrated on computational thinking in kindergarten and elementary school (Ching et al., 2018). Additionally, considering the level of knowledge and education, some CT concepts can be applied to kindergarten level, and others are often considered too advanced for children because of their age and critical thinking abilities.

Over the past years, there have been a few examples of the curriculum framework recommended for the promotion of CT in education. For example, Computer Science Principles (CSP) represent a framework of standards on which computer science courses in high school can be designed. Other CT practices defined by (CSTA, 2017) concentrate on a few main concepts which may also include applications such as coding, debugging, and modelling. Angeli et al. (2016) also presented a framework to introduce computational thinking concepts to children between the ages of six and twelve. The framework defined a set of skills to promote CT: (1) abstraction, (2) generalization, (3) decomposition, (4) algorithmic thinking, and (5) debugging. Furthermore (Grover and Pea, 2013; Duncan et al., 2017; Kuo and Hsu, 2019) proposed frameworks that concentrate on CT core concepts.

According to the above review, it is clear that CT should be developed at early ages. In addition, by analyzing the existing frameworks, it has been observed that the top five skills that were highlighted by researchers were abstraction, algorithmic thinking, problem-solving, pattern recognition, and decomposition, and it became clear that the concept of CT is often based on thinking types such as algorithmic thinking, and design based. Also, the study showed that there are concepts that are suitable to be taught for higher education level only but not for kindergarten level and there are also concepts that can be learned by all levels due to the effect of age factor and the logical thinking skill level.

2.2 Gamification

Many studies have shown that the combination of educational games into the K-12 curriculum contributes to increasing students' concentration, motivation to learn, and good behaviour. They further indicated that gamified learning activities intended to promote computational thinking skills have a positive effect on student accomplishment (Tatar, 2019).

Several frameworks for Gamification have been designed that discuss various elements and components of the process of Gamification design. For example, (Wongso et al., 2015) proposed an educational framework focused on linking Gamification and Web 2.0 social characteristics with five steps: study, design, development, implementation, and evaluation into e-learning systems. However, no empirical validation was presented by the researchers. Another example, (Kotini and Tzelepi, 2015) developed a student-centred gamification framework focusing on computational thinking, and the game elements used were related to the topic and ideas that the students needed to learn. Yet, there is still a lack of empirical validation, and the components were strongly connected to computational thinking concepts, which may have hindered other areas from embracing them.

Klock et al. (2015) proposed a conceptual model that can be used for gamifying eLearning platforms to improve student engagement in their research researchers used 14 game elements. However, the researchers did not investigate whether the model succeeded in improving student engagement. Toda et al. (2018) proposed a teacher and instructors' framework on how to use gamification. However, they did not provide verification of the game's elements. Klock et al. (2019) provided a framework for user-centred Gamification in the educational setting, incorporating personal, functional, psychological, temporal, playful, implementable, and evaluative aspects. However, the game elements were not validated.

In conclusion, it can be seen that none of the frameworks mentioned provide any sort of validation or knowledge on how these elements could be incorporated within the context of the game elements that were used in the framework. In addition, there is a lack of frameworks that integrate computational thinking with gamification as there is only one framework related to computational thinking introduced by (Kotini and Tzelepi, 2015).

2.3 Adaptive Gamification

Adaptive Gamification can be defined as a strategy that seeks to maximize the expected goals of individuals by prioritizing their needs and preferences in a gamified world. Adapting gamified systems to each individual enables engagement, allows problem-solving on specific topics, and allows users to accomplish their objectives more effectively (Lopes et al., 2019). One of the strengths of adaptive models is that instructional activities are provided for each student that concentrate on student needs and knowledge. Using adapted game characteristics with motivation and involvement in the education process will improve the learning benefits.

Among researchers, the development of adaptive Gamification has created immense interest (Rozi et al., 2019). Gamification appears to be more effective with a consistent framework design. Therefore, an integrated Gamification framework design was presented by some researchers. For instance, (Hassan et al., 2019) introduced a framework that describes students' learning types on the basis of their interactions with the system and provided an adaptive approach that helps motivate learners (internally and intrinsically) to accomplish their learning objectives according to their identified learning dimensions. Their findings showed that adaptive game elements and activities matched to learners' learning dimensions might considerably boost aspects such as motivation, course completion, engagement, and interaction in an E-learning course. Their research, on the other hand, did not give any feedback to participants. Also, students were not motivated by the system to make up for the tasks that they missed. Another example (Filipcik and Bielikova, 2014) presented an approach to student engagement using dynamic score calculation in a web-based education system. However, their framework focused only on student activity and ignored student knowledge and personality. In addition, it did not provide any support to learn or teach CT and focus on extrinsic motivation only. Böckle et al. (2018) suggested a developed framework that may be used to guide the systematic development of adaptive Gamification applications.

Based on the available studies, it can be noted that there is a lack of gamification frameworks that focus on educational contexts. Furthermore, there is a lack of studies that incorporate computational concepts with adaptive gamification systems. Moreover, the author believes that incorporating adaptive gamification can help in the development and cultivation of computational thinking ability in early age by increasing students' motivation and engagement, which in turn increases student performance.

3. Methodology

To accomplish the objectives of the research, a research framework was conducted as presented in Figure 1. The framework presents the working procedure of the research and starts with gathering all the information that can be used to formulate domain problems that involve CT skills and gamification. Then the information was examined and analyzed. Both subjects were then mapped into each other by developing a conceptual model in order to investigate the relationship between them and their unique criteria. Next, the framework of (Hassan et al., 2019) and the student-centered framework were selected and integrated together by mapping the common elements between the frameworks. At the creation stage (2nd integration stage), the resulting conceptual model with the integration of the selected frameworks was used to create an adaptive gamified eLearning platform that can provide students with different learning activities and materials based on their preferences. At the implementation stage, the proposed framework from the previous stage was implemented using a modified version of the Moodle eLearning platform proposed by (Ishak, 2016). The modified version enhanced the Learning Management System (LMS) features to automatically generate adaptive courses based on the adaptation features. At the final stage, an evaluation of the effectiveness of the created platform was conducted through workshops and experiments.

3.1 The Proposed Conceptual Model (1st integration stage)

The main objective of this stage is to develop a unique conceptual model that integrates the computational thinking domain with gamification to investigate the relationship between them in the education section. The development process went through three stages. In the first stage key elements of CT were defined through examining and reviewing existing research related to computational thinking. Information about computational thinking was gathered and organized and analyzed from the literature review and based on it the author has divided the CT into four main dimensions (core concept, field of development, educational level, and educational tools/activities), with each containing its own elements.

In the second stages, key elements of gamification were constructed based on existing studies that analyze gamification in education and depending on the recent taxonomy presented by (Toda et al., 2019). The taxonomy used consists of 21 elements of Gamification for the field of education. In their work, the game components commonly used by Gamification frameworks focusing on educational contexts were defined and analyzed. They then analyzed the game features explored by a behavioral Games-centered framework and took them as a baseline. The taxonomy was validated by 19 experts through an online survey in the field of Gamification and education (most of the experts were also lecturers and professors), achieving the overall acceptance of its elements, principles, and meanings. Based on the available taxonomy provided by (Toda et al., 2019) and with help of two existing studies complementing their own research (Toda, Klock et al., 2019; Toda, Armando M., 2019) that analyzed Gamification in education, in addition to the study assistance provided by (Kusuma et al., 2018) which analyzed gamification models in education that have been applied in four field applications: general, STEM, history, and language, the author constructed key elements for Gamification in order to identify its criteria and characteristics.

In the third stage, key elements were mapped together to create the conceptual model by matching the common components of both domains as both subjects can be implemented in different fields and can be applied to different ages and different knowledge levels. Additionally, the two domains are related to learning activity where in the CT domain, CT skills can be delivered using different learning activities. In the gamification domain, learning activities can be gamified to provide an interesting learning process; this can help to increase student engagement and motivation, which may lead to improved student performance. Figure 2 depicted the proposed conceptual model.

3.2 The Proposed Adaptive Gamification Framework (2nd integration stage)

The main objective of this research is to develop an adaptive gamification framework to promote CT skills among students aged 8–13 in Iraq. To guide CT

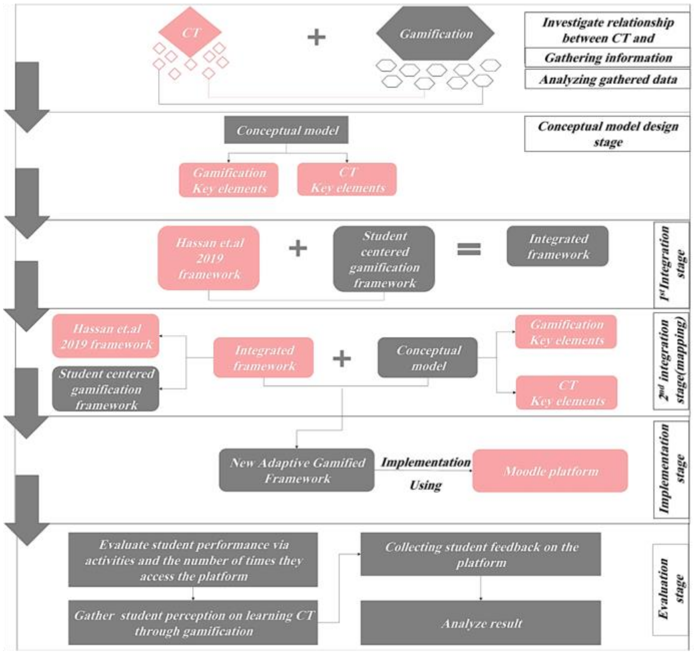

Figure 1 - Research Framework Design.

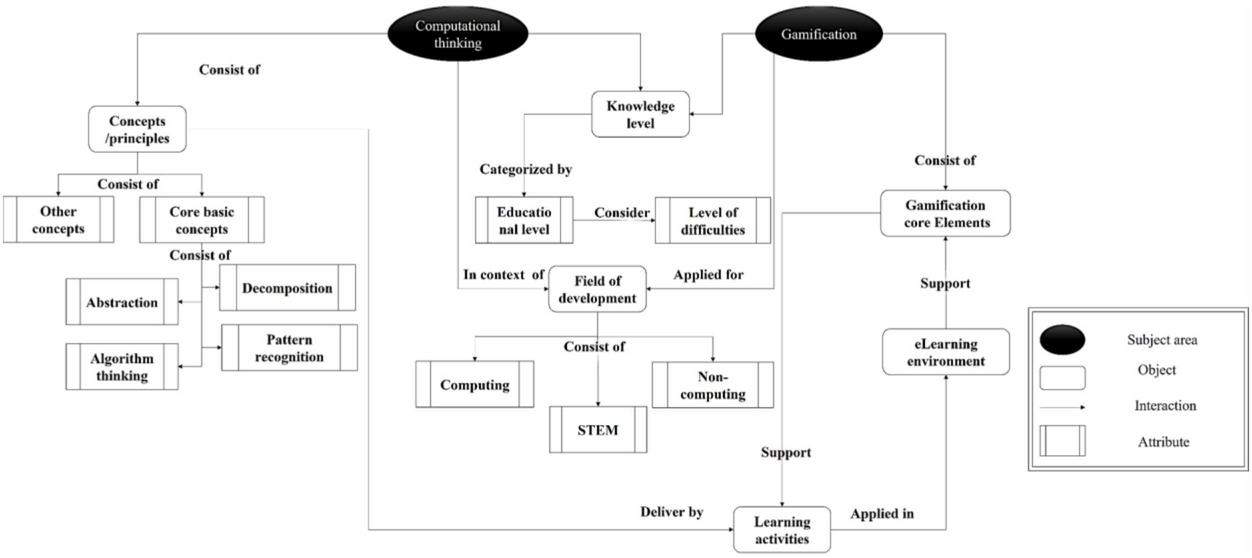

Figure 2 - The Proposed Conceptual Model.

learning and to enhance motivation, a new type of CT framework was needed, one that could fulfill students' needs by providing them with appropriate materials based on their learning style and improve motivation towards learning. To visualize the new integrated framework, the author adopted the framework presented by (Hassan et al., 2019), which allows us to provide adaptive features to students and adaptive gamification environments to increase motivation. In addition, the author adopted the elements available in the "student-centered" framework and integrated them with the (Hassan et al., 2019) framework to support computational thinking skills. The main reason for this is that the gamification features presented in the (Hassan et al., 2019) framework was not adapted to support computational thinking; hence, there was a need to find gamification elements capable of supporting CT that can be achieved by using the "student-centered" framework that provides gamification elements that are compatible with CT and is based on constructivist learning theory, which is compatible with the Moodle platform that uses the same theory. Furthermore, the author has matched the new integrated framework with the proposed conceptual model to match key research concepts to provide an adaptive gamified learning framework that leads to the development of computational thinking skills. The mapping process is depicted in Figure 3. The result of the mapping process will create an adaptive framework to enhance computational thinking skills.

3.3 The Implementation of the Proposed Framework (Implementation Stage)

The proposed framework was implemented using a modified version of Moodle which enhanced the LMS

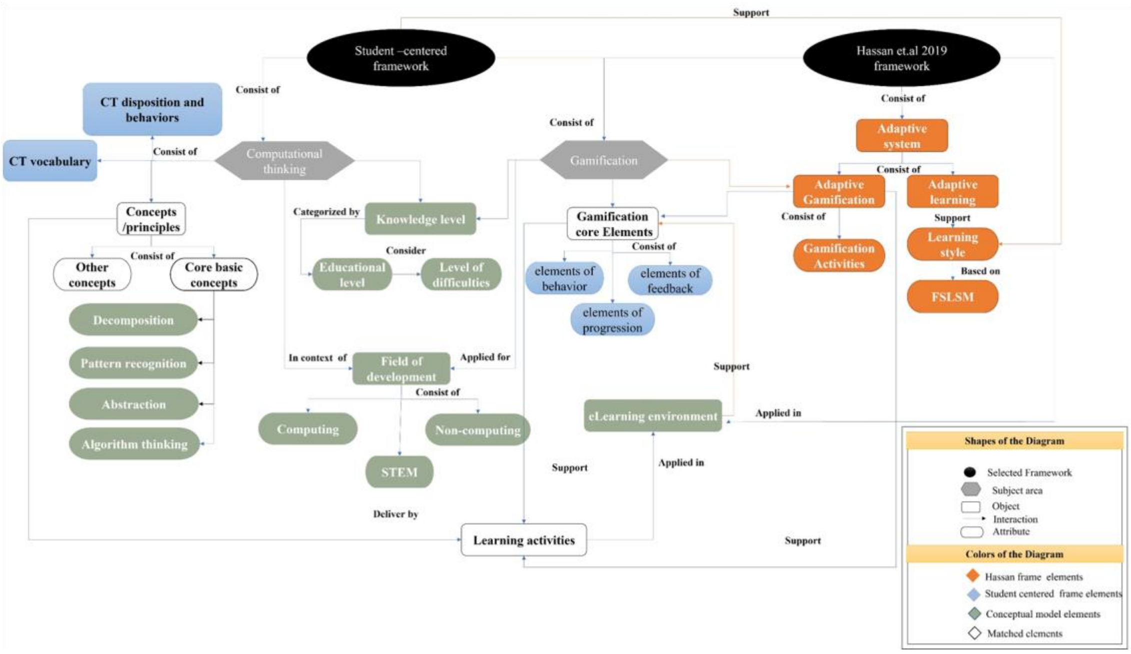

Figure 3 - The proposed adaptive framework.

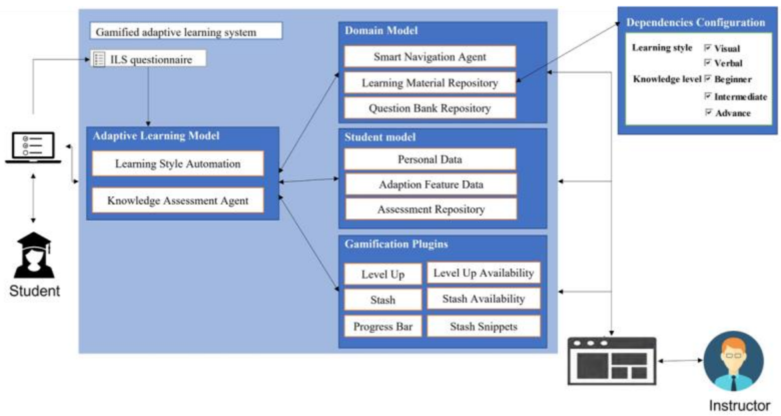

Figure 4 - The Proposed System Framework using Moodle.

features to automatically generate adaptive courses based on the students learning style for visual and verbal learners using Felder-Silverman Learning Style Model (FSLSM) and was customized to provide adaptive gamification features to support student engagement and motivation. Figure 4 illustrates the system architecture of the proposed framework implemented through Moodle platform.

The modified version of Moodle consists of three primary modules which interact together to provide adaptive features. First, the adaptive model which includes rules and techniques that continuously interact with the domain model and the student model for adaptive performance. The model contains two main components; the learning style automation which includes rules for calculating ILS questionnaire answers that are given by students to determine whether a student is a visual or verbal learner using the range [-11, +11] to define learning style, and knowledge assessment agent which are responsible for defining students' knowledge level.

Second: The student model which serves as a repository of student information. Third: The domain model which acts as a repository for storing curriculum and domain information in order to facilitate course delivery. It consists of three parts: the smart navigation agent, the learning materials repository, and the question bank repository. The Smart Navigation Agent added to the Moodle platform for adaptive functionality. Meanwhile, the Learning Material Repository and Question Bank Repository serve as databases for storing course materials and assessments.

In addition, the platform was customized in order to provide an adaptive gamification feature by adding a set of plug-ins that support gamification which consists of Level up! Level up! Availability, Stash, Stash availability, Stash snippets and progress bar to provide a gamified learning environment. The gamification elements were chosen to suit the requirements for learning CT skills and to correspond with the experts' theory which includes (levels, points, progression (leader border), teamwork, feedback, challenge, and goals).

Furthermore, the proposed framework provides learning activities that are appropriate for the student's knowledge level and focus on the CT core concepts (decomposition, pattern recognition, abstract, algorithm thinking) using a scratch programming language. The system provides a computational thinking and programming course, which was designed as a game where each concept of computational thinking skills was considered as a level and the students were asked to go through all the levels and learn the concepts of computational thinking through scratch. Additionally, they could only get to the next level if they finished all the contents of the level they were in and collected all the hidden items in that level.

Figure 5 depicts the implementation steps of the system using Moodle.

Figure 5 - Moodle Setup Stages.

3.4 Experimental Result (The Evaluation Stage)

Two case studies were conducted throughout this research to evaluate the performance of the proposed system in terms of students' motivation and performance. The participants of both experiments were students aged between 8-13 from Iraq. A total of 18 students of both genders were asked to join a five-day workshop to introduce them to the fundamentals of computational thinking and programming and they were randomly distributed among two groups (Adaptive Gamification Group and Non-Adaptive Gamification Group). Both groups were given the same learning materials, however the visual learners were provided with more graphic materials while the verbal learners were provided with more textual materials. Pre- and post-questionnaires were used as the instruments for gathering the demographic of the students and measuring the student's understanding and satisfaction before and after the training. Quizzes were used to evaluate student performance. Data for this study was collected using the automated scanning provided in Moodle and was analyzed using descriptive analysis methods.

Students learned CT Skills such as decomposition through scratch by constructing a new sprite and applying a set of different instructions to the same character. They also learned how to add motion and sound to the sprite. Moreover, pattern recognition was developed by understanding repeating actions. In addition, customizing sprite attributes resulted in the development of abstraction. Finally, with the design of games such as the catching game and the virtual pet game, algorithm thinking has evolved. Figure 6 illustrates the syllabus for the course provided in the workshop.

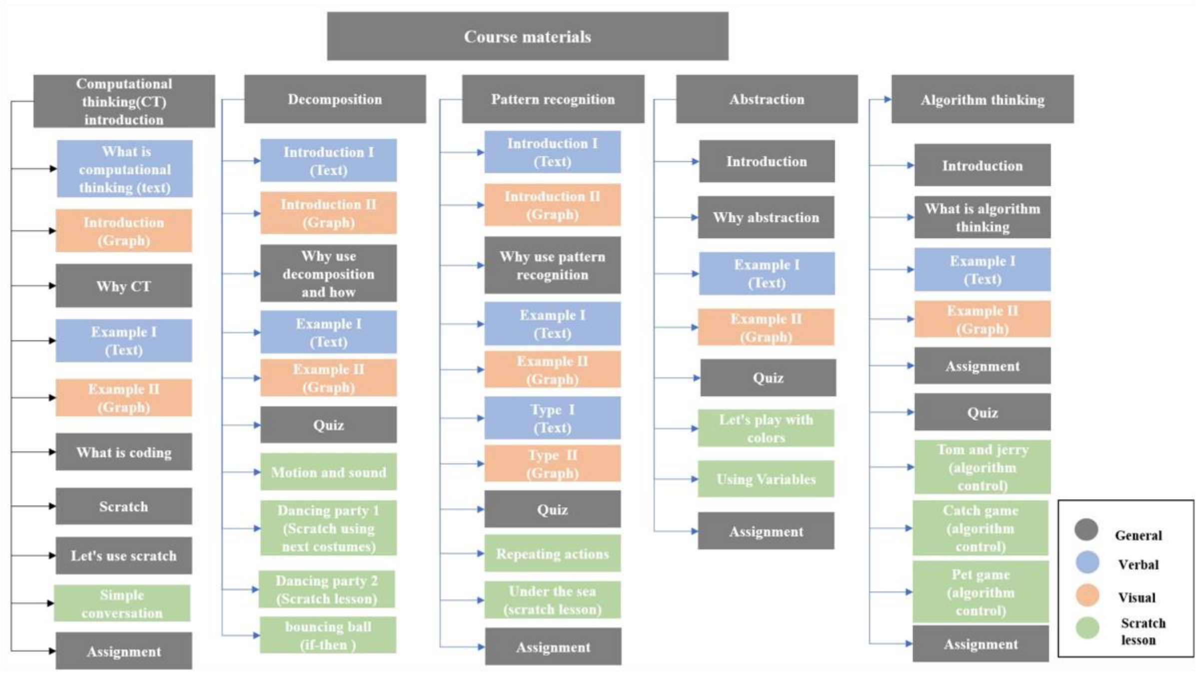

Figure 6 - Course Syllabus.

In Experiment (I), eight (8) students from group-A (Non-Adaptive Gamification) were enrolled in an E-learning course on computational thinking and programming. The author offered a system with an adaptive feature experience, but the system was not equipped with an adaptive gamification experience. Students will first login into the system; after that they are required to answer the ILs questionnaire. Then the Learning Style Automation will identify the student's learning style dimensions (verbal, visual) and the Knowledge Assessment Agent will identify the student's knowledge level (beginner, intermediate, advanced). Then, through the Smart Navigation Agent, the system will provide students with suitable learning materials based on adaptation feature data.

In Experiment (II), ten (10) students from group B (Adaptive Gamification) were asked to enroll in a gamified E-learning course in computational thinking and programming. This course was offered using the proposed adaptive gamification framework, which provides gamification elements based on the learning dimensions of each student. This course was designed as a game where each concept of computational thinking skills was considered as a level. The course consists of four levels and at each level, a student is required to find elements and get points to reach the next level by completing the level materials. Visual students were provided with gamification elements such as progress bars, levels, badges, points, and goals, teamwork, and feedback. In addition, the content was presented using flowcharts, graphs, diagrams, mind maps, and videos. Meanwhile, verbal students were provided with points, and challenges, teamwork, feedback, and the content were presented using the textual form.

The result of students' motivation for both groups can be seen in Table 1. For the analysis, the author calculated the descriptive statistics of the questionnaire and used a 5-point Likert scale and forced-choice items. The results indicate that both groups were motivated to learn more about the topic. In addition, all participants in group B preferred to learn through gamified courses rather than traditional courses. Also, all participants in group B believed that the elements of the games matched their learning personalities.

Furthermore, the result of the students' performance can be seen in Table 2, and it indicates that the students have a better performance using the proposed system as it can be seen that there is a clear difference between the mean scores of both groups (34.13 for group A) and (67.72 for group B). In addition, Figure 7 shows that group B's quiz results are better than group A's results, which in turn means group B performs better than group A. In addition, the majority of students who did take the quiz in group B (more than 50%) had the motivation to retake the quiz to increase their scores while the rest of them had Internet connection problems. The main reason for this is the gamification features, in which all materials were restricted, and students were required to answer some of the questions in order to obtain the game elements that would help them advance to the next level.

Question	Answers	Group A statistics				Group B statistics			
		Mode	Median	Mean	Std. Deviation	Mode	Median	Mean	Std. Deviation
This e-learning helps me achieve my learning objectives.	Rating: 5 4 3 2 1	4	4.00	4.14	0.690	4	4.00	3.89	0.92
I found it easy to understand the subject structure.	Rating: 5 4 3 2 1	4	4.00	4.00	0.577	4	4.00	4.22	0.66
I feel confident to complete this subject based on the knowledge or skill presented.	Rating: 5 4 3 2 1	4	4.00	4.43	0.535	4	4.00	3.89	0.92
Do you prefer traditional or gamified courses?	• Traditional • Gamified	-	-	-	-	2	2.00	2.00	0.0
How would you evaluate the impact of the insertion of game elements in educational contexts?	• Positive • Negative	-	-	-	-	2	1.00	1.00	0.0
The gamification elements mostly matched my learning personality	Rating: 5 4 3 2 1	-	-	-	-	2	2.00	2.00	0.0

Table 1 – Students' motivation results.

Group Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Group A	8	34.1375	37.44020	13.23711
Group B	10	67.7200	37.45047	11.84288

Table 2 - Students' Performance Results.

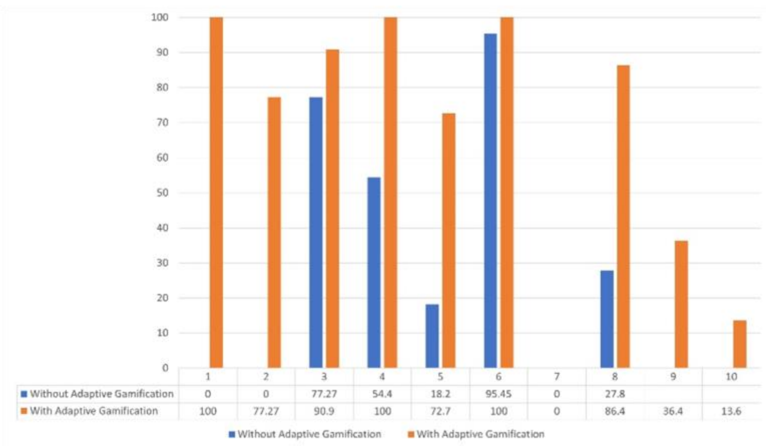

Figure 7 - Students' Performance Results.

4. Discussion

In this work the search went through two phases: in the first phase the author has proposed a conceptual model which identifies the relationship between the domain of gamification and the domain of computational thinking. The conceptual model can help to understand how to use gamification in the education section to support the learning process of computational thinking. In the second phase the author has proposed an adaptive gamification framework to foster CT skills among school children aged between 8-13. The proposed framework provided an adaptive feature (learning materials and gamification elements) based on student learning style (verbal learners and visual learners) using Felder Silverman Learning Style Model (FSLSM).
The main reason for selecting verbal and visual learners only is that many studies have indicated that students recall knowledge better when it is given visually and verbally. These methods assist students of all ages in

better managing their learning objectives and achieving academic success. Moreover, visual forms account for 75 percent of the information processed by the brain. Furthermore, visual information is more effective at establishing itself in the minds of students (Raiyn, 2016). In addition, scholars have found that individual preferences for multimedia materials based on visual and verbal cognitive patterns may influence learners' emotions and performance (Chen and Sun, 2012). Therefore, the visual / verbal dimension was chosen to measure students' preferred input position in the current study.

The proposed framework was implemented using a modified version of Moodle platform proposed by (Ishak, 2016) which provides adaptive learning materials and was customized to provide adaptive gamification features automatically to the enrolled students. Visual learners were provided with 7 game elements such as (progress bars, levels, badges, points, and goals, teamwork, and feedback),while verbal learners were provided with (points, and challenges, teamwork, feedback). Levels can increase students' intrinsic motivation while points, progress bar and badges can measure students' performance and show students' progress and identify their achievements. Teamwork can contribute to the development of positive learning results. Challenges and goals make the learning procedure more exciting and entertaining for the student ,while feedback helps students when they meet difficulties or fail to accomplish a particular activity.

Two study cases were conducted to evaluate the proposed system and the findings indicate that using gamification in learning CT can play a positive role as it contributes to increasing student motivation and engagements which are the basics for learning any new skills and in turn increase students' performance.

5. Conclusion

The proposed framework was primarily designed to encourage kids between the ages of 8 and 13 to learn and develop computational thinking skills through scratch programming language. These abilities can enable students to keep up with the demands and challenges of the new era. However, the process of learning any new skills is based mainly on student engagement and motivation. For this reason, the author proposed an adaptive gamification framework that provides students with appropriate learning materials based on their learning style and improves students' motivation towards learning using adaptive gamification through Moodle platform. The results demonstrated that selecting learning materials and game elements based on student preference can play a positive role in increasing students' motivation and performance. The results indicate that students were motivated to continue learning the subject. In addition, they were motivated to retake the quizzes which in turn can increase students' performance. In future, the system can be extended by taking more adaptive features into consideration.

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