The Role of Computer Games in Teaching Object-Oriented Programming in High Schools - Code Combat as a Game Approach

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Abstract: - Computer games are an effective approach that enhances student's motivation and innovation. Many modern teaching strategies have been implemented in the process of teaching different subjects such as learn to do, explore to learn, cognitive and meta-cognitive learning, and gamification. Gamification is an effective approach to make a positive change in students' behavior and attitude towards learning, to improve their motivation and engagement. This paper presents the role of computer games in enhancing high schools computer science students' motivation and engagement through gamification. It's illustrated the implementation of Code Combat as a teaching model for teaching object-oriented programming (OOP) which considered a tough topic in the computer science field. Code-Combat is a gamification platform that uses games elements to make coding interesting and engaging for students. It consists of different levels, where each level covers a specific topic in computer science and structures based on object oriented methodology such as(variables, conditions, loops and recursion).

Key-Words: - Gamification, motivation, high school students, Code Combat, object-oriented programming.

1 Introduction

Teaching strategies in the 21st century are shifting rapidly, many modern strategies have been implemented in the process of teaching different subjects such as learn to do, explore to learn, cognitive and meta-cognitive learning and gamification. Currently, computer games have globally integrated into the teaching process for a variety of subjects in high schools due to the burgeoning computer applications and software around the globe. Therefore, it is mandatory to highlight the importance of the integration of gamification teaching strategies with the computer science high schools' curriculum to propose an efficient, effective, and valuable educational gamification approach for the computer science teaching process in the high schools; which companies between the pedagogical wise and the teaching wise.

Gamification is a concept which aims to increase user experience and engagement with a system, while education is an area with a high prospective for application of this concept [1]. It is important for computer science teachers to make their teaching more interesting and avoid making it tough and boring. From my view of point, computer science teachers focus on the technical side on the CS subjects and emphasis on algorithmic thinking by using traditional teaching strategies and complicated exercises as well.

Computational thinking is a set of skills for problem-solving based on computer techniques [2]. Scratch, which is a computer programming online game considers a gamification strategy that can be designed and used for different pedagogical and teaching objectives. Alice is a block-based programming environment used to create 3D model games. Several similar coding games are used to enhance students' computational thinking skills where interest, enjoyment, and learning are met together.

High schools' curriculum in computer science is one of the struggling curricula nowadays. A curriculum that presents different CS subjects as pure technical subjects reflects most of the student's high difficulties in understanding its topics. Therefore, several students withdrew from the CS track and do not continue studying it. Computer science teachers report that they do not feel properly prepared to fulfill their job tasks due to missing qualifications [3] . Most of the CS teachers concentrate on the technical perspective of the contents without implementing

pedagogical perspective in the teaching process as well as lack of using modern teaching skills.

Gamification is an effective approach to make a positive change in students' behavior and attitude towards learning, to improve their motivation and engagement [4]. There are three main approaches to integrating games into the teaching curriculum of computer science which are: Playing-games, educational games (game-based learning), and gamification. Playing games are digital interaction that are fun and rewarding. They offer a simulated environment that enhances students' motivation toward learning. Game-based-learning is an approach where games are designed to support the learning objectives. Gamification uses the elements of a game into educational subjects or topics to meet one or more of the objectives.

CodeCombat is a gamification platform that uses games to make coding interesting and engaging for students. One of the CS topics which consider as difficult for many of the students is recursion. CodeCombat has a game track that illustrates this topic where students play several missions that were designed on recursion's knowledge and concepts. The game offers an enjoyable and engaging environment for the students.

2 Literature review: teaching computer science in high schools

The process of integrating pedagogical perspective and the computer science technical perspective is an important issue in the CS teaching field in high schools. The pedagogical perspective is defined as the pedagogical content knowledge (PCK) which is the practical knowledge that teachers use in the context of the classroom that contains the most useful ways of representing and formulating the subject that make it comprehensible to others [3]. The PCK consists of content dimensions that include: subject and curriculum-related issues, teaching methods and use of media, learner related issues, teacher-related issues, and issues of the education system. The subject dimension consists of two main factors, the first factor is the teacher's knowledge which includes knowledge about the topic and principles in the subject area. It reflects the degree of the teacher's understanding of the topic and the strengths of the topic's contents. The second factor, teacher's ability to implement the subject's contents and the standard of teaching computer science in the class. This includes the lesson's structure and plan, class activities, class assessment, and the distribution of the theoretical part and the practical part. At this level, the degree of implementing teaching tools among the lesson parts (introduction, explanation, activities, and assessment). The second content dimension, teaching methods, and use of media which illustrate the teaching strategies adopted by the teacher for teaching different topics. Besides, the visual aids tools are used to simplify and clarify the contents, enhance the students' understanding, and increase their motivation in the class. The third dimension is the learner-related issue which deals with the students' errors and misconceptions. Does the teacher differentiate between student's errors and misconceptions? The teacher must have the ability to guide the student to identify his\her errors and clarify the needed and related assessment producer, as well as, the diagnosis and treatment of the student's misconceptions. The teacher-related issue concentrates on teacher's professional development in teaching computer science which includes new teaching strategies, new concepts, and 21st-century teaching tools. The issues in the educational system are the fifth dimension which illustrates the adopted curriculum, school type, school infrastructure, and the evaluation process. The five dimensions are clarifying pedagogical content knowledge (PCK) which is considered a core aspect for teaching computer science.

Three principles processes in the (PCK): planning, reaction, and evaluation. As a computer science teacher, believing in the subject itself and the teaching and learning in the subject and data security and privacy are mandatory. Several researches have shown that CS's students lack motivation towards studying the subject. Therefore, teachers must enhance their enthusiasm and efficiency in teaching computer science. Computer science teachers lack a clear understanding of the PCK, teacher's beliefs, and motivational orientations in computer science. Refine and describe in detail the three aspects is a must to reduce the CS's teachers lack.

The teachers' beliefs are epistemological beliefs about the computer science area, beliefs about teaching skills and strategies, learning in the subject, and beliefs about security and privacy. Epistemological beliefs are the nature of knowledge and the process of learning. Beliefs about teaching and learning are divided into two types, the first type is transmissive-oriented beliefs in which learning content is transferred from teacher to learners. The second type is constructivist-oriented which knowledge is individually and actively created. Since students should become aware of the use of media and computer systems, beliefs about security and privacy must be adopted by CS's teachers.

Teachers' motivation is a core value in teaching computer science. Teachers should enhance their students' motivation and enthusiasm. Therefore, teachers must present a high level of interest in teaching computer science topics. This level of interest can be increased by the teachers' profession, experiences, and teaching skills.

The research's methodology is the empirical approach where several interviews were conducted with 23 computer science teachers' experts who holds a computer science degree in teaching CS. The interviews adopted the critical incident teaching (CIT) approach which describes crucial situational demands in a job and behaviors in these situations that differentiate between ideal and poor job performance. The teachers in this research were challenged with problem-based teaching scenarios. The problem-based scenarios tested the teachers' abilities to create an ideal solution for different types of scenarios. Scenarios were a combination of pedagogical content knowledge, teachers' beliefs, and motivational orientations. For instance, one of the scenarios of the (PCK) was as follows: teaching object-oriented programming (OOP) topic is one of the crucial topics in CS, you as a teacher have to build a lesson plan to teach your students this topic and make them able to write their first program using classes and objects. Two questions were asked for the teacher in parallel with building the lesson plan, the first one is: how would you proceed to plan the lesson so that your students can actively acquire the learning objectives? What are the difficulties concerning the planning of the lesson that can or might occur in this situation? And which didactical concepts, methods, and media do you use for preparing the lesson plan? The other scenarios aim to address four categories: beliefs about the subject and its teaching and learning, beliefs about data security and privacy, motivational orientations, and teacher efficacy.

The research results were as follow: teachers' pedagogical content knowledge dimensions, teachers were able to represent computer science tasks and learning content in different ways, interpret and apply relevant curricula for planning computer science lessons, apply activation methods to control and promote learning processes in computer science, ensure the learning success of their students during working on the computer, adopt their teaching methods, contexts, content representations, and material to the different requirements that occur due to the diversity of computer science students, adopt their courses and lessons to specific learning difficulties in computer science, continue in their professional development process during their whole career development as computer science teachers,

adjust their computer science courses and lessons to the constraints of the specific educational system.

The results of teachers' beliefs and motivational orientations as for its five categories as follow: teachers are convinced that superordinate strategies and principles make up the subject computer science and are relevant to all sections of the subject. Teachers are convinced that students are learning in an autonomous way and by critically approaching computer science contents. Teachers have a critical and evaluative attitude toward dealing with computer science systems. Teachers positively experience their teaching in computer science and convey joy and enthusiasm to their students. Teachers trust in their abilities to deal with the contents of the subject, in particular concerning innovation and aspects of the legal framework.

It is important for computer science teaching quality to examine teachers' competencies. The research has presented an approach on how to examine this type of competency where several principles must be tested to reflect the degree of teachers' competencies. In Israel, teaching computer science in high school needs enhancement approaches for both curriculum and teachers' quality and abilities as several local researches presented. The main issue is the lack of pedagogical perspective skills for many CS teachers were teachers focus on the technical perspective side more than the pedagogical side which leads to difficulties in understanding the topics by the students.
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2.1 Gamification in teaching computer science

One of the important strategies to enhance the quality of learning of students and increase their engagement and impression by providing an enjoyable environment is gamification. It has a vital role in clarifying CS topics especially difficult topics such as (OOP concept, inheritance, and recursion).
The term gamification has occurred recently in parallel with the rapid development of smart devices and computers. Both smart devices and computers have been presented with high quality of graphical interfaces and performance which increases its users all over the world. The huge development in hardware equipment of smartphones and computers increases the development of high quality, graphics, animation, and performance of games. Thus, the demand curve of games has been raised obviously in the last five years. The increase is in gamers' demand and gaming developers. Due to the high demand for gaming especially by younger ages, pedagogical

questions have been raised. One of the important questions is: How to use games in education? How to make education interesting? etc.

Gamification in education is an educational approach to motivate students to learn by using game elements in a learning environment [4]. Many studies have been conducted on gamification as a teaching strategy for different schools' level and subjects around the world. Researchers have been conducting several researches on gamification because it provides an alternative to engaging and motivating students during their learning process. From a pedagogical perspective, it is important to develop different strategies and approaches to increase students' motivation for learning to enhance their academic level and understanding of concepts and knowledge.

Research papers in gamification in education presented that there is a lack of gamification usage in education. One of the main reasons for that is gamification technology is not popular in the world. Under this concept, there are three educational approaches: gaming, educational games, and gamification. Gaming is the playing game that can be directed to enhance students' thinking skills such as Minecraft. Playing games also used to increase students' enjoyment and engagement in the learning process without having any curriculum objectives or goals. The educational games strategy is an approach where a set of curriculum objectives are specified and the main goal of it is to reach those objectives through playing games. The Gamification approach is where the educator uses the games' elements to create a platform where students understand the concept and knowledge through playing games. This type of game is not as a regular game, but it contains some of the game's elements. For instance, this type of game does not have the win/lose functions.

Gamification has one main object which is making education more interesting. Fogg's behavioral model (FBM) (Figure 1) is a model of three factors: Motivation, Ability or simplicity, and Triggers which are used to understand the behavior in general (Fogg, 2018). Gamification concentrates on student's motivation to reach a desired behavioral change.
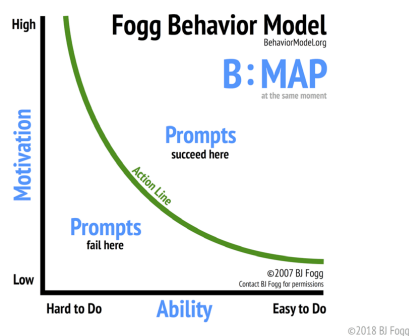
Figure 1 Fogg Behavior Model

The usage of the game's elements to produce a gamification model are used as extrinsic and intrinsic to enhance student's motivation. Educator must understand the game's elements to create a gamification model. Each element has a meaning and its integration must be equivalent to the concept of the subject. Game's elements example such as offering rewards which is a kind of extrinsic motivation. Badges, requirement should have difficulty. Points and levels should consist of challenges. Where other elements offer a collaboration platform where a student can show his/her achievements in public with other students. The main goal of using the game's elements is to increase student's engagement and satisfaction.

The Gamification approach needs to meet the curriculum objectives to achieve its goals. The structure of the game and design must be relevant to the subject's content. The immediate and instructive feedback loops offer a clear understanding of the learning process through the game phases. At this point, the teacher can highlight the student's strengths and weaknesses points which clarify the teaching map for each student.

Student engagement and learning enhancement can be met by implementing the gamification approach. Engagement where students are more interested in learning, enjoying the classes, increasing the level of collaboration, and swilling the student-teacher interaction. The degree of attention, curiosity, and passion for students enhanced by implementing the gamification approach.

Indeed, there is a need for more research to explore the use of gamification at different school levels for different curriculum and subjects. The new researches must identify the effectiveness of gamification on students' motivation and academic progress at certain subjects especially the difficult ones. Some of the important topics of future researches are approaches in creating effective gamification content, the effects of gamification on students' academic progress, the role of gamification in teaching computer science tough topics and using gamification strategy as a pedagogical and learning strategy at different school levels.

2.2 Teaching computer science with motivation

Teaching computer science researchers have presented that computer science as a subject in both school and university level is a difficult subject which needs a high rate of concentration and studying hours. Its difficulty is one of the major reasons why many students withdraw from this topic and do not

continue studying it. When a computer science student faces this type of difficult subject and the teacher or lecturer is using the traditional way of teaching, the student will lose motivation and interest in continuing to study this subject. Motivation and interest are essential factors for students to continue studying such a subject.

New teaching strategies have been developed by educational experts to improve and enhance the degree of students' interest and motivation by increasing the level of students' engagement and proposed variety of interactive teaching ways that feel fun in difficult subjects. Computer science is one of the difficult subjects that students need to have more engagement to develop their knowledge and skills rapidly. Students are willing to learn and understand computer science topics via video games where time-consuming challenges, frustration, and hard topics are applicable for intangible rewards and achieving accomplishment. Therefore, the research proposed an approach to gamify computer science learning to reach the level of engagement as video games do.

Between 40-50% of computer science, students at school level or/ university level do not continue their studying and transferred to other studying areas, where one-third of computer science students worldwide do not pass the introductory computer science courses[5]. Thus, computer science educators and researchers are working on changing the learning experience in how they can make the learning of computer science is more enjoyable and attractive for their students. Gamification is one of the changing strategies where students can be engaged in the learning process and to have a constructivist role in the class and feel more interested in learning. Gamification offers a stress-free way, an enjoyable environment, and a more motivation approach that generates more effective learning outcomes and objectives achievements.

A proposed game has been developed to examine the level of engagement and motivation of students who study computer science. The game was designed using the game engine Unity3D and the C# programming language with three integrated CS concepts. The game consists of two levels, the first level introduces the stacks and queues topics in the data structure subject. The level explores the basic methods of adding and accessing data. The second level presents the sorting algorithm technique " selection sort" (Figure 2) where the student plays the game to sort the data from start to finish. At each level, introduction information is given on the specified concept followed by several interactive actions where the student will have free space in

playing the game to achieve an enjoyable time while learning the concept. Both levels are concluded with an assessment evaluation which consists of five true or false questions to evaluate the learning process of this game.

Figure 2 Selection sort screen

The game scene as in figure 2 has several components, on the top-left, it shows the tracking process of the selection sort algorithm where the student can understand the current value to be sorted. On the top-right, there is some information about the concept such as algorithm meaning, integers value meaning, and a definition of an array. That information considered as the help part while the student is playing the game and clarify the important topics under the main concept of the scene. At the bottom of the screen is an explanation of the selection sort steps which presents a clear explanation for the student. The main character of the game is a robot where the player can control to complete the sorting process. The robot must be guided to the list of the boxes which hold the array numbers that need to be sorted. For each box, there is an index number that reflects the indexing in the array.

The selected several game elements such as the robot and its control by the keyboard, the graphics, the boxes, the background, and the theme. The student understands the selection sort by using the game elements in an enjoyable and engaging platform.

The research presents a survey method to gather feedback from the selected students who played the game. The survey consists of 15 questions about computer science teaching strategies, difficult topics, gaming as a teaching strategy, and their experience in playing the demonstration of the selection sort game. The results show that students are more motivated through games (figure 3).
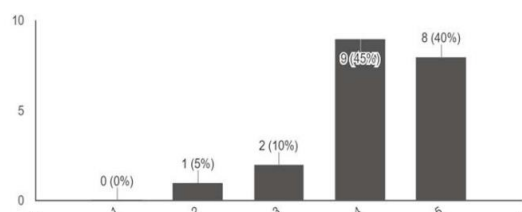
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Figure 3: 9th survey question. 85% of respondents agree or strongly agree

In addition, 95% of respondents agree or strongly agree that learning through games makes difficult concepts more approachable (figure 4).
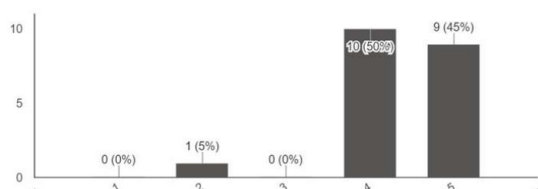

Figure 4 Learning through games makes difficult concepts more approachable.

Also, 85% of respondents agree or strongly agree that the game is a fun and interactive way to learn (figure 5).
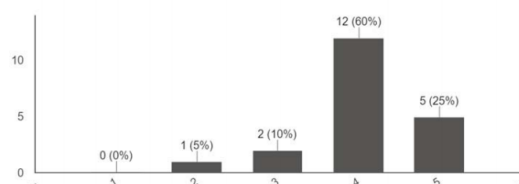

Figure 5 This game offers a fun and interactive way to learn

From the overall survey, it is obvious that a high percentage of the students agreed to the value and benefits of gamification especially in clarifying and understanding difficult concepts in computer science. Also, the high impact of engagement and motivation offered by the gamification strategy on the students of computer science.

As a demonstration, the game has shown the importance of the gamification approach in teaching and learning computer science subjects, especially the difficult concepts in the field. The game provides an engagement environment and enhances the students' motivation for studying computer science. There is a need to build and create more gamification games to simplify more difficult topics. Researchers around the world are working on that topic and there are important results that have been shown which strengthen the role of gamification in teaching and learning computer science, but the field still needs more research and approaches on that.

3 Code Combat as a teaching game

Gamification is an integration of game elements and game thinking in activities that are not game[4]. Game elements are users, challenges/ tasks, points, levels, badges, and ranking of users. Users are the players of the game, in our study the users are the students where they have to achieve specific goals that represent the concept's objectives and they have to get to the stage win. The winning stage is reached by completing the learning activities which make them interact with the educational content. The challenges and tasks are the concept's objectives where students must achieve to understand the concept's topics and knowledge. The points illustrate the progress of the students and give an impact on the student milestones. The levels are the pointer where the student's level of understanding and progress. Badges are the rewards for ongoing levels and actions. The ranking is the overall achievement of the student.

To develop a gamification content that presents the learning objectives in a game model, the following main steps must be conducted:

1. Determination of learners' characteristics

It is crucial to identify and carefully understand the characteristics of the students to create the best-fit approach to ensure a high rate of engagement and motivation environment. One of the key success factors in creating the approach is to know the students' skills abilities to interact with the game approach. If the game's tasks were easy or difficult for the students, this will result in demotivation of them and negative outcomes. Thus, it is mandatory to identify the students' abilities and skills.

2. Definition of learning objectives

Learning objectives must define clearly. It is an initial step of creating the game approach to define the learning objectives of the content. Each content must have determined objectives that meet the overall objectives of the curriculum.

3. Creation of educational content and activities for gamification

Three essential objectives must be met while creating educational content, interactive, engaging, and rich in multimedia. All the activities must be designed customized to the content objectives and have multiple performances, feasible for all students, increasing difficulty level, and have multiple paths.

4. Adding game elements and mechanisms

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Learning objectives and tasks are integrated with the game elements to finalize the gamification approach. CodeCombat is a game that teaches programming to learners of different ages. It considers as a gamification approach model which used to teach programming concepts for schools' students. CodeCombat is a game that helps to introduce some of the concepts in computer science and the coding languages of Javascript and python. 88% of students who play CodeCombat want to pursue more programming education[6].

It is an online game where the student controls a hero by writing real code to complete different tasks and missions. It provides a coding platform in a game format on which students learn coding while they are playing and enjoying the game (Figure 6). There is immediate reaction while the student is playing such as error notes, help messages, and guidance (Figure 7).
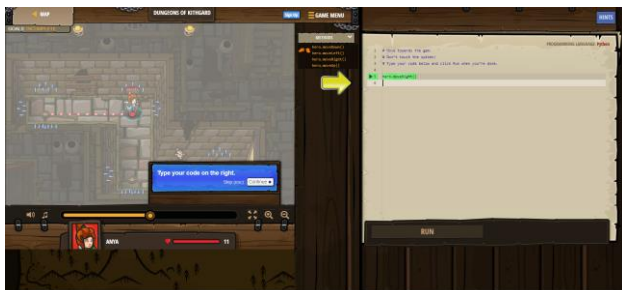

Figure 6 Starting Page of Code Combat

Figure 7 One of the levels of Code Combat

The game sessions cover the following concepts and topics:

1. Beginner Concepts
    a. Basic syntax
    b. While loops
    c. Arguments
    d. Strings
    e. Variables
    f. Algorithms
2. Intermediate Concepts
    a. If statements
    b. Boolean comparison
    c. Nested conditions
    d. Functions
    e. Basic input handling
    f. Basic game artificial intelligence

3. Advanced Concepts
    a. Event handling
    b. Conditional while loops
    c. Object literals
    d. Parameters
    e. Vectors
    f. Math library operations
    g. Recursion

Each session is structured into four parts, introduction, basic concepts, self-training, and discussion. A student starts the session by reading a short introduction about the session and the concepts covered in this session. At this level, the teacher interacts with the student and discusses the necessary topics and essential information which is considered as the basis for the concepts and the game instructions. The game consists of the main game elements mentioned in the previous section of this paper and involved analysis and understanding of problems, identifying, and evaluating possible solutions, generating algorithms, implementing solutions in the code, testing, and debugging. The live execution of the code on the game screen is applicable while the student is coding which enhances the engagement and motivation of the student.

Usually, the introductory part takes about 10-15 minutes and the actual game takes from 40 – 50 minutes. The student practices the self-learning method while playing with help and guidance from the teacher. The research shows that students who were selected as the research targeted group are motivated and excited about playing the game and they have felt the challenge which increased their motivation and engagement.

The CodeCombat as a game is usable and easy to use and understand (figure 8). It is considered one of the motivated teaching games for computer science programming concepts. It simplifies for teachers and students the learning process of coding and programming and engages more students to like and love coding. It prepares students for the real programming world.

Figure 8 a stage of the game

For instance, a lesson plan for teaching fundamental concepts "Basic syntax" consists of: Basic command in Python such as (hero.moveRight()). Teacher clarify the definition of object(hero) and its function (moveRight), then apply the code on the game compiler screen to trace the output of this line of code. Teacher then continues in the different basic syntax concepts by adapting the teaching strategy learn to do. After completing each concept, teacher assigns a challenge for students to practice the syntax code and get a full understanding of it. Teacher tracks the students progress and highlight students' errors and misconceptions. Different strategies can be implemented while students work on their challenges such as group work, peer to peer, collaboration, sharing, cooperation, individually and exploring. Teacher in the initial classes must have full understanding of the academic and skills ability of the students to manage and control the teaching process professionally and to reduce risk of negative impact on the students. A negative impact might exist if the teacher assigns irrelevant challenges to the students' ability. Therefore, teacher must understand the students interests and computer abilities to ensure a positive impact on the students. The students abilities must be at the level of basics computer skills.

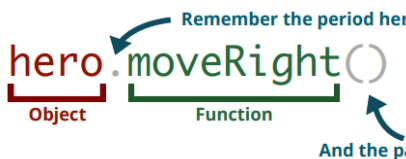## 4 Teaching object-oriented programming with code combat

Teaching object-oriented programming is an essential concept for computer science students. It is a programming paradigm based on an object which is the core part of a complete software or application. The development of an application depends on separating its part to objects to simplify the workload and to increase the level of control and management of the development process. The OOP concept is one of the computer science concepts where students face difficulties to understand since it is given in the first chapters of the CS field. Thus, the student who did not understand it well usually does not complete it in the computer science college. Therefore, computer science educators must use alternative teaching strategies to teach OOP and one of the effective strategies is the gamification strategy.

CodeCombat offers different computer science concepts in game-based learning where teachers can use the game's elements to teach students in an engaging environment. The game has multi-levels where each level covers several concepts of computer sciences curriculum. For instance, the first level

covers introductory concepts such as syntax, sequence, objects, and methods.

The game illustrates objects as the building blocks, they are things or characters that can perform actions. In the game, your hero is an object. The actions an object performs are called methods.

The student will interact with the coding blocks and methods easily. For example, to make the robot perform an action, students have to call a method. Write a dot after your object name, then have the class decide what the first action should be. After the dot, write the method name using camel case followed by empty parentheses. Like:
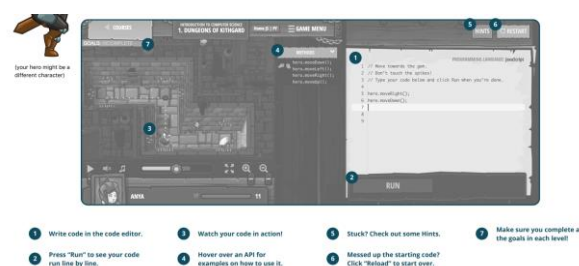

Figure 9 student guidance screen

The CodeCombat game offers several guidance materials and lesson plans for teaching computer science concepts on their website. There many educators and schools around the world are using the CodeCombat gamification approach in their curriculum and learning process. Researches have shown the effectiveness of CodeCombat in teaching computer science concepts and the role of it in simplifying the difficult concepts and increase the engaging and enjoyable educational environment. Due to its usability, CodeCombat offers an ideal platform for teaching object-oriented programming concepts. It offers complete games' elements that attract students' interest and complete support while playing.

5 Conclusion

Teaching computer science in both schools and universities still considered a difficult topic by the students since a high percentage of the educators are teaching computer science concepts in the traditional ways and do not implement any new teaching

strategy where engagement and motivation are applicable. It is not enough for computer science to have technical knowledge only but also pedagogical knowledge and modern teaching strategies. Thus, educators have to strengthen themselves in new engaging and motivating teaching strategies by participating in pedagogical training courses, teaching strategies workshops, and must constantly updating their knowledge in the computer science field to enhance students' abilities and knowledge.

Gamification is a teaching strategy where game elements are used to create an educational game that is rich with engaging elements and a motivational environment. Teaching by gaming offers an enjoyable platform where students interact with different levels of challenges and actions. The challenges add to the students' feeling the insistence of completing the missions and achieve the learning objectives.

CodeCombat is a learning platform that teaches students the programming concepts in game-based format. It offers an engaging and motivating environment. It simplifies difficult concepts such as OOP, inheritance, nested loops, and recursion. The platform is used by many educators and students around the world and researchers have shown the benefits of implementing it in the computer science curriculum in schools and universities.

I encourage computer science, educators, in Israeli schools and universities to adopt the gamification approach and strategy in teaching computer science concepts and do conduct researches on their experience of using this approach.

This research has emphasized the linkage between the importance of motivation and the students' abilities to understand the Object – Oriented programming concepts. It is important to enhance the computer science students' motivation in teaching computer science topics. The codecombat game introduces an enjoyable teaching environment that improves the level of understanding for all students. Its sessions and parts offer equivalent missions and challenges for different students' abilities. It provides difficult computer science concepts as game elements.

For future works, quantitative research will be conducted in Palestinian high schools which teach computer science and proposed a new approach to integrating gamification in the computer science curriculum.

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