# Developing a Model for e-Learning Activities Based on Digital Incentives Within the Context of COVID-19 and its Effectiveness in Developing Meta-Cognitive Thinking Among Higher Education Students

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**Abstract—**The COVID-19 pandemic has created many challenges that have affected the efficiency of practicing e-learning activities, and therefore the current study was directed towards developing a model for e-learning activities based on digital incentives, especially gamification-based incentives such as points, badges, levels, and leader boards, to stimulate meta-cognitive thinking processes for higher education students during the pandemic. The quasi-experimental approach was used to compare the two study groups, where the first experimental group used electronic activities based on digital incentives, while the second experimental group used electronic activities without any incentives. The study sample consisted of (60) students from the preparatory year in the computer skills course who are taking the "System Lifecycle" unit, and the study sample was randomly distributed into two experimental groups. A scale to measure meta-cognitive thinking was prepared for the nature of the study unit. The scale included three axes, namely planning, control, and assessment, and each axis might consist of (8) indicators, with a total of 24 indicators. The results showed the advantage and effectiveness of electronic activities based on digital incentives (points, badges, levels, and leaderboards) in developing meta-cognitive thinking skills, whether at the overall level or the level of each of the meta-cognitive axes, including planning, control, and monitoring.

**Keywords—**e-learning activities, digital incentives, gamification, meta-cognitive thinking, COVID-19 pandemic

## 1 Introduction

The Covid-19 pandemic contributed to placing students in most countries of the world under a comprehensive ban, and this led to the cessation of the normal operation of education that required daily attendance at universities, as by the 18th of March 2020 (107) countries announced the complete closure of their educational institutions [1, 2]. The COVID-19 pandemic is one of the biggest crises facing education in the modern history [3]. In the context of the COVID-19 pandemic, it is important to develop

different strategies to ensure effective sustainability in educational environments [4]. The ideal solution to confront the problems resulting from the spread of the pandemic was to rely on communication and information technology in communicating with students and providing educational content [5]. However, the Covid-19 pandemic has formed a new context for educational activities used in learning, as the new context of Covid-19 requires that educational activities be more able to motivate students and make them more engaged in learning in light of the difficulties caused by the pandemic which made the entire learning process from home within a divergent framework in which the teacher loses many of the usual motivational tools he uses in the classroom [6]. As the COVID-19 pandemic has contributed to creating new practices related to the use of digital incentives, especially those that are concerned with the aspect of skills; It is important to test these practices to ensure their effectiveness, as new practices during the pandemic will shape a new future for utilizing technology in education [7]. To ensure continuity of learning despite the total closure of educational institutions, gamification platforms are among the most reliable platforms to support teaching and learning during the pandemic, as they contain many incentives such as points, badges and leaderboards that can relieve the pressures and restrictions that can be To confront the student in the learning process during the pandemic [8].

In the context of the pandemic, all courses at King Abdul-Aziz University in the Kingdom of Saudi Arabia have been converted to digital courses, and all educational activities have been practiced digitally through the (blackboard) system. However, most of the educational activities that were practiced lacked mechanisms such as points, badges, levels, and leaderboards through which students could be motivated to carry out these activities. Students need to have motivating practices while learning via digital platforms due to the psychological stress they may go through because of total isolation and precautionary measures taken during the COVID-19 pandemic [9]. Students of higher education have found themselves in a state of total isolation from the surrounding world and they must practice all educational activities electronically, regardless of the effects that the pandemic has caused to many students such as anxiety and tension [10]. Accordingly, Gamification is one of the most essential tools of motivation [11], the presence of digital incentives such as points, badges, levels, leaderboards, and other elements of digital incentives and their use in non-play-based educational activities to motivate and excite the student towards carrying out learning tasks [12], may work to relieve the pressures and restrictions that may confront the student in the learning process during the COVID-19 pandemic [13], and create a happy learning environment that can create motivation for students to continue the learning process [14].

The use of digital incentives in developing educational activities during the pandemic is based on the ability of these incentives to raise students' cognitive growth rates in addition to enhancing their abilities related to completing educational courses [15, 16]. Digital incentives also help increase student productivity, raise morale, and increase student engagement with the content [17, 18]. Incentivizing activities can also be relied on to release adaptive incentives that promote cooperative learning processes more interactively [19–21]. Also, incentivizing activities facilitate learning, improve student participation, and motivate students to expand their knowledge and develop their cognition [22–24].

There is no doubt that learning in the era of Covid-19 imposed the necessity of paying attention to qualitative variables and learning outcomes related to meta-cognitive thinking [25]. This is since the nature of learning during the COVID-19 pandemic requires the learner to have a great deal of meta-cognitive thinking so that he can take responsibility for his learning and be involved in planning, control, and assessment of this learning process [26, 27]. The meta-cognitive thinking helps the learner during the Covid-19 pandemic to play a positive role in collecting, organizing, integrating, following up, and evaluating information during the learning process. The current study comes as an attempt to develop a model for e-learning activities based on digital incentives during the Covid-19 pandemic, to develop meta-cognitive thinking among higher education students.

Accordingly, the current study aims to investigate the mechanisms that can implement educational activities more effective in improving the meta-cognitive thinking of higher education students during the Covid-19 pandemic through the development of a model for e-learning activities based on digital incentives such as points, badges, levels, and leader boards, so that such model can be used in the context of the COVID-19 pandemic by higher education students. Accordingly, the current study attempts to answer the following research questions:

- (RQ1) What are the meta-cognitive thinking skills of higher education students during the COVID-19 pandemic?
- (RQ2) What is the proposed model for e-learning activities based on digital incentives during the COVID-19 pandemic?
- (RQ3) What is the effectiveness of the proposed model for e-learning activities based on digital incentives in developing meta-cognitive thinking among higher education students at King Abdulaziz University?

The current study also attempts to validate the following hypothesis:

- (H1) There is no statistically significant difference at the level $\leq 0.05$ between the first experimental group that uses e-learning activities based on digital incentives and the second experimental group that uses e-learning activities without any digital incentives in the post-measurement of meta-cognitive thinking

## 2 Literature review

### 2.1 Activities based on digital incentives

The gamification system has produced a set of digital incentives which uses some elements derived from digital games such as points, badges, leaderboards, progress bars, and other game elements called digital incentives, and their employment in non-play-based educational situations (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011; Leclercq et al., 2020). The design of educational activities based on digital incentives means that these activities include objectives, contents, procedures, strategies, and learning activities that learners are motivated to interact with and implement using

only the incentivizing elements within a framework of non-play-based structural procedures [28, 29]. This means that the learner, in his pursuit of achieving the objectives of the educational activity and the implementation of each task in that activity, is linked to predetermined incentivizing elements that the learner obtains upon executing each task according to clear criteria that determine the amount of the learner's entitlement to the incentives. For example, the number of points obtained by each learner varies according to the level of implementation of the learning tasks [30].

Digital incentives include a variety of elements that can be relied upon in developing educational activities, and among the most popular models of digital incentives that can be used in developing educational activities are the following [12, 30–34]:

- Points: A numerical representation that expresses the learner's achievements in carrying out the tasks assigned to him. Points act as strong motivators for learners, as the learner gets points cumulatively in his pursuit of learning tasks. Points give the learner a sense that they always gain something according to their performance.
- Badges: A visual representation of the learner's achievements. Badges are a document of recognition of the learner's efforts in achieving various learning objectives.
- Levels: Levels mean moving from one category to another or from one level to another based on the learner's progress in educational tasks and his achievement of goals that qualify him to join a higher level that imposes new challenges. The levels are an actual translation of the learner's progress in completing the learning tasks.
- Leader boards: A visual representation that shows the ranking of learners compared to each other based on their progress in carrying out the learning tasks.
- Progress Bars: A visual representation of how well a learner has completed the learning stages and tasks as instructed by the tutorial.

The current study is consistent with many other studies that indicated the importance of developing educational systems with digital incentives to achieve a positive impact on learning outcomes, including, for example, the study of Zainuddin, et al. [30], which aimed to compare between ordinary test and assessment systems based on digital incentives. The results showed the effectiveness of electronic testing systems based on digital incentives in developing learners' involvement in the learning process as well as developing their creative thinking. The study of Chen, et al. [35] aimed to develop a participatory reading appendix system based on digital incentives to encourage students to comment on what they read, and the results showed the effectiveness of digital incentives in enhancing learners' performance concerning the quality of their participation in the appendix-based reading comprehension process. In another study by Zainuddin, et al. [36] which was concerned with analyzing (46) research papers between (2016–2019) related to digital incentives, the results of the study indicated the importance of retesting the incentivizing elements within multiple digital applications and platforms to determine their effectiveness and their various effects on learning outcomes. In another study conducted by Legaki, et al. [37] to verify the effectiveness of digital incentives in overcoming challenges in the field of statistical education through the use of points, levels, and leaderboards, and by analyzing the quantitative results of

(365) students. The results showed the effectiveness of digital incentives compared to traditional methods in improving student learning processes.

### 2.2 Meta-cognitive thinking

Flavell [38] defined the concept of meta-cognition as the awareness of an individual of how he learned and how information was acquired and used to achieve goals. Meta-cognitive thinking refers to an individual's awareness of the thinking processes that occur during learning, as well as the mechanisms of their cognition and thinking, how these mechanisms work, and how that awareness develops in the thinking of others [39]. Meta-cognitive thinking refers to the ability to plan for the use of intellectual processes that lead to the production of the required information, and these processes require that learners be fully aware of the steps taken during decision-making, and to reflect on their ideas, and evaluate the productivity of their thinking [40]. Accordingly, meta-cognitive thinking represents the individual's self-awareness of his cognitive processes, and his cognitive construction, employing this awareness in managing these processes through the use of skills: planning, control, assessment, decision-making, and choosing appropriate strategies [41]. Students with higher meta-cognitive thinking have higher levels of learning achievement [42] and self-directed learning skills [43].

The current study is concerned with planning, control, and assessment skills, as basic skills for meta-cognitive thinking, and they can be put forward as follows [44–46]:

- Planning: It is a mental preconceived notion to determine the best ways to accomplish work through various processes, including setting and understanding goals, arranging data, deducing relationships, setting time plans, generating ideas, and predicting results.
- Control: Estimating the extent of progress and achievement that has been made, and whether it is appropriate up to date, through various processes, including organizing ideas, adhering to established plans, avoiding mistakes, overcoming obstacles, continuous review, and summarizing the solution.
- Assessment: analyzing performance, determining the extent to which objectives have been achieved, judging the accuracy and effectiveness of the results, as well as evaluating the appropriateness of the methods used, evaluating how obstacles and errors were addressed, and the effectiveness and implementation of the plan.

Designing educational activities according to levels of meta-cognitive thinking is one of the learning requirements in the era of Covid-19, as the learner during the pandemic bears a great deal of responsibility for his learning, as he must be involved in the planning, control, and assessment of his learning [25]. This is consistent with the results of some previous studies that demonstrated the importance of planning educational technologies and activities according to meta-cognitive thinking models that can prepare the learner to engage in learning processes and events. This can be inferred from the study of Tsai, et al. [47] which focused on developing open learning platforms according to a unified model that integrates meta-cognitive thinking processes with

open platforms technology, to reduce the dropout rates of trainees from these platforms, and the study of Connor and his colleagues [48], which aimed to develop a portable e-book according to a procedural model of meta-cognitive thinking to solve reading comprehension problems.

## 3 Theoretical framework

Although the gamification system is based mainly on external digital incentives, which sometimes have a negative impact on intrinsic motivation, people who perform activities because of extrinsic motivation are often less willing to carry out learning tasks and activities when such motivations are removed [49–51], however, some of the scientific studies that aimed to carry out comparisons between several performances that are linked to extrinsic incentives and those performed without incentives showed that groups whose members receive incentives have better effectiveness in performance and implementation of tasks, as indicated by Wise and DeMars [52], which examined (12) various studies aimed at conducting (25) comparisons between performance with incentive and performance without incentives, and the result showed an effect of (0.6) in favor of the groups that received additional external incentives.

Within the general context of COVID-19, in which learners face great difficulties in achieving educational goals, it is possible to rely on the theory of motivation in employing digital incentives in the development of educational activities. The theory of motivation indicates that external incentives can compensate for the difference between internal incentives and the real level of the learner. The learner may have an internal desire to excel, but his scientific and cognitive abilities and the conditions of the learning environment may not allow this; Therefore, external incentives, in this case, have a major role in motivating the learner towards reaching the desired level [14, 53].

Basic Psychological Needs Theory (BPNT) indicates the presence of a set of factors that makes any activity enjoyable and stimulating for internal motivation, among these factors: Autonomy, Competence, and Relatedness [33, 54, 55]. This is what digital incentives systems provide in educational activities that incentivize independence by giving the learner a sense of will and freedom to carry out tasks, and it incentivizes efficiency by giving the learner a sense of effectiveness in completing tasks and influencing the environment in which he is located, and finally, it encourages the connection that is generated through the learner's building of social relationships with his peers within the learning environment, and his sense of belonging to the groups that are formed during the implementation of the tasks [33, 54, 55].

Also, the behavioral theory refers to behavior as a set of responses resulting from the stimuli of the near external environment, which is either, supported and reinforced so that its occurrence is strengthened in the future, or it does not receive support, so it is less likely to occur [56, 57], which provides an effective rationale for employing digital incentives in the development of educational activities during COVID-19. Also, the incentives that the learner gets through the digital incentives system is very important from the point of view of "Skinner" according to his theory of reinforcement, which

emphasizes that behavior is the product of reinforcement, whereas learning occurs when the correct responses are reinforced, meaning that if the response to a particular stimulus is reinforced in some way, then this response will be strengthened and repeated in the presence of the stimulus [58].

## 4 Methods

### 4.1 Design

The researcher used the quasi-experimental approach based on the experimental design with two experimental groups, where the e-learning activities of the first experimental group were directed through the Talentlms platform (www.Talentlms.com) and based on points, badges, levels, and leaderboards as digital incentives. While directing the e-learning activities to the second experimental group via the same platform, but without activating the digital incentives. The following Figure 1 illustrates the experimental design of the study processors.

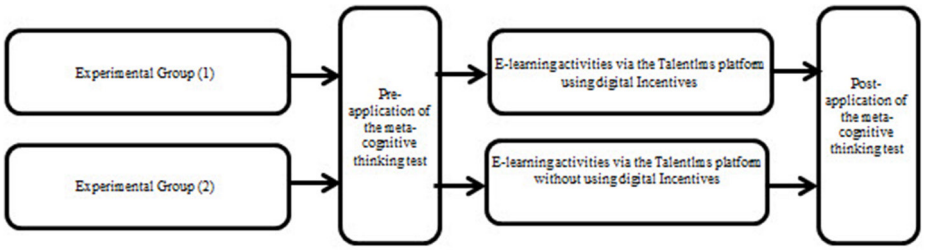


**Fig. 1.** Experimental design of the study processors

### 4.2 Sample

The current research sample consisted of (60) students from the preparatory year at King Abdulaziz University who are studying the "Computer Skills" course in the first semester of the academic year 2021/2022. Students who are proficient in using social platforms and have the desire to participate in the research experience were selected. A questionnaire was distributed to identify the reality of students' use of digital platforms and learning management systems. The students were randomly assigned to the two experimental research groups, with (30) students for each group, after procedures to verify the homogeneity of the groups.

### 4.3 Measures

The meta-cognitive thinking of the current research is related to the planning, control, and assessment of students for their learning in the Communication Skills course during COVID-19. The scale of meta-cognitive thinking under the current research has

been prepared with reference to a variety of scales [59–61], in addition to the nature of learning through gamification-based electronic activities, and the nature of learning in general during COVID-19. The scale included (3) main axes: (1) planning, (2) control, (3) assessment, and each axis included (8) items, (4) positive items, and (4) negative items. The scale was presented to a group of arbitrators to ensure its validity and the appropriateness of the phrases for the preparatory year students studying the communication skills course. The students were asked to rate each item according to the following choices (strongly agree, agree, neutral, disagree, strongly disagree) and score (from 1 to 5, respectively) for positive statements and vice versa for negative statements (items are coded based on a 5-point Likert type scale (from 1 = strongly disagree to 5 = strongly agree)). The stability of the scale was confirmed before implementation, as it reached Cronbach's $\alpha = 0.811$.

### 4.4 Procedures

The current study procedures were carried out according to the stages of the Instructional Design Model (ADDIE), as follows:

**Analysis stage.** The subject of the current study focuses on developing a model of e-learning activities based on digital game incentives to address deficiencies associated with students' meta-cognitive thinking in the context of the COVID-19 pandemic. The content of the topic "System Life Cycle" was analyzed within the "Computer Skills" course, and (12) educational objectives were identified to be implemented through (6) main tasks (analysis, design, development, implementation, documentation, evaluation), and each main task includes (4) educational sub-activities, with a total of (24) sub-activities. Media and content supporting the implementation of e-learning activities identified in videos, presentations, articles, and tests were also identified. The following Table 1 shows the tasks, objectives, contents, and activities of the course, which will be implemented through the incentivized platform.

**Table 1.** Tasks, objectives, contents, and activities within the proposed model

| No. | Main Task | Educational Objectives | Supporting Content Media | | | | Sub Activities |
|---|---|---|---|---|---|---|---|
| | | | Video | Presentation | Article | Test | |
| 1 | **System Analysis** | • To illustrates the main steps of system analysis.<br>• To list the methods and approaches of system analysis. | (4) minutes video | (10) slides Presentation | Article titled "System Analysis" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system analysis.<br>• Write a system analysis report.<br>• Upload a video covering the educational objectives. |
| 2 | **System Design** | • To explain the main steps of system design.<br>• To describe the mechanisms of system verification. | (3) minutes video | (8) slides Presentation | Article titled "System Design" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system design.<br>• Write a system design report.<br>• Upload a video covering the educational objectives. |
| 3 | **System Development** | • To explain the main steps for developing the system.<br>• To describe the mechanisms of testing the system. | (5) minutes video | (9) slides Presentation | Article titled "System Development" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system development.<br>• Write a system development report.<br>• Upload a video covering the educational objectives. |

*(Continued)*

**Table 1.** Tasks, objectives, contents, and activities within the proposed model *(Continued)*

| No. | Main Task | Educational Objectives | Supporting Content Media | | | | Sub Activities |
|---|---|---|---|---|---|---|---|
| | | | Video | Presentation | Article | Test | |
| 4 | **System implementation** | • To explain the mechanisms of implementing the system.<br>• To list the mechanisms of change and transformation. | (4) minutes video | (5) slides Presentation | Article titled "System Application" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system implementation.<br>• Write a system implementation report.<br>• Upload a video covering the educational objectives. |
| 5 | **System Documentation** | • To describe the mechanisms of documenting the system.<br>• To explain the importance of documenting the system. | (2) minutes video | (6) slides Presentation | Article titled "System Documentation" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system documentation.<br>• Write a system documentation report.<br>• Upload a video covering the educational objectives. |
| 6 | **System Evaluation** | • To describe the mechanisms of system evaluation.<br>• To explain the importance of the system evaluation stage. | (3) minutes video | (8) slides Presentation | Article titled "System Evaluation" | A test containing (10) multiple-choice questions | • Create new discussions on digital content.<br>• Answer test questions on the topic of system evaluation.<br>• Write a system evaluation report.<br>• Upload a video covering the educational objectives. |

**Design stage.** The main environment for providing digital incentives-based activities has been identified as the digital incentives platform Talentlms. The TalentIms platform was used because it is one of the most platforms that includes a variety of digital incentives that can be managed through a system for managing incentives, in addition to the possibility of activating or stopping them with each group. The platform is accessed through the official website (www.Talentlms.com), or the Talentlms application for smart devices with an Android or IOS system. According to the digital incentives methods included in the digital platform, the digital incentives are designed based on (4) game incentives, namely (points, badges, levels, and leader boards), and the platform includes multiple options and multiple levels for each incentive, and according to the e-learning activities of the lessons uploaded through the platform., the incentives were designed as shown in the following Table 2:

**Table 2.** Digital game incentives that have been linked to the educational activities system

| Points | Badges | Levels | Leader Boards |
|---|---|---|---|
| • Grants the student (5) points each time he logged into the program.<br>• Grants the student (20) points for completing each digital unit in the program.<br>• The student is awarded (10) points for each correct answer to one of the test questions.<br>• Grants the student (10) points for each new discussion.<br>• Grants the student (25) points for each fully implemented educational activity. | • Grants a badge to the student according to the number of times he logged into the program, meaning one badge after each number of logged times as follows: (4, 8, 16, 32, 64, 128, 256, 512)<br>• A badge is awarded to each student after completing the digital units on the platform, according to the following sequence (1, 2, 4, 6, 8, 12).<br>• Grants a badge to each student after successfully passing the test questions, meaning a badge after answering each number of correct questions in the following sequence (2, 4, 8, 16, 32)<br>• Grants a badge to each student after executing each of the educational activities, meaning a badge after each of the following numbers (1, 2, 4, 8, 16) | Students are placed into levels according to the following:<br>• If the student completes (100) points, his level will be upgraded.<br>• If the student obtains (4) badges, his level will be upgraded.<br>• If the student completes each of the six educational topics, his level will be upgraded. | Three leader boards are created as follows:<br>• A leader board to rank students according to the number of points they have earned.<br>• A leader board to rank students according to the number of badges they earned.<br>• A leader board to rank students according to each student level. |

Also at this stage, the learning strategies that have been designed will be based on promoting meta-cognitive thinking, and among these strategies is the self-planning and control strategy that focuses on helping learners to proceed in an orderly manner in educational activities, solving problems they face, and employing incentives to motivate students to face challenges. A self-generating questions strategy was used, and students were directed towards generating and answering high-level questions, whether in an individual, pair, or group format. Students were directed towards practicing decision-making skills that help increase students' ability to link cause and effect through their conscious choices of certain ways and methods of thinking and the consequences of these choices associated with the implementation of educational activities and their access to digital incentives. The students were directed towards using the assessment and evaluation strategy that is based on directing the students towards obtaining numerical rewards and incentives that reflect their level of performance.

**Development stage.** In the development stage, the supporting digital content was developed and uploaded via the platform (Talentlms), which offered educational videos, some of which were imported through YouTube and then edited to fit the purpose of the educational content, and the production of educational presentations for each topic, and the preparation of illustrated articles also related to educational topics, as well as producing the questions for each test, according to the educational topics shown in Table 2. A digital lesson has been created for each of the six core program topics, uploading digital media for each lesson, creating digital tasks and activities for each tutorial, and activating the management panel for the points system, badges, levels, and leaderboards. This stage included presenting the developed platform to a group of arbitrators to ensure that it can be relied upon in the development of meta-cognitive thinking, and to ensure that the designed incentives are appropriate, as well as to ensure the appropriateness of the digital contents, and considering the results of the formative evaluation, the arbitrators agreed that the incentive platform is appropriate and valid for implementation and fit for the objectives of the study.

**Implementation stage.** The pre-implementation of the meta-cognitive thinking scale was conducted on the two experimental groups to ensure that the two groups are on equal footing. In preparation for the experiment, an introductory session was held – remotely – for the students of the study sample to familiarize themselves with the nature and objectives of the study, what is required of them, how to implement e-learning activities through the digital incentives platform, the nature of work in each of the two experimental groups, and the incentives that are provided through the digital incentives platform, through a rehearsal workshop, and per the empirical requirements of the study, and the strategies that must be implemented with the development of meta-cognitive thinking. With regard to the two experimental groups, the experiment was carried out with each group as shown in the following Table 3.

**Table 3.** The mechanism of actions of the two experimental groups during the implementation of the experiment

| The 1st Experimental Group Talentlms Platform with Activation of Digital Incentives | The 2nd Experimental Group Talentlms Platform without Activation of Digital Incentives |
|---|---|
| The students of the 1st experimental group shall study the proposed educational content presented on the digital incentive's platform, and the students shall carry out all the educational activities, with each task or educational activity linked to the digital incentives. The students have 3 consecutive days for each of the main tasks. | The students of the 2nd experimental group shall study all the digital content and topics presented via the platform, but without any digital incentives, as the incentives system on the platform is closed, and the students in this group perform the same tasks and answer all the tests and watch all the topics just like the first group but without the incentives. Students are required to complete all tasks according to the same schedule as the first group. |

Each group was instructed to adhere to the mechanism of working within the groups, to implement all tasks and activities, and to direct the students towards completing the educational tasks. As opposed to individual tasks, the students were instructed to use the communication tools used within the platform to promote collaborative work on demanding tasks. After completing the study experiment, the study tools were post-approved, the scores report printed and processed using the T-Test to compare between the two experimental groups about the effectiveness of motivational activities in enhancing meta-cognitive thinking skills.

## 5 Results

To validate the first hypothesis, comparing the 1st experimental group that used the Activities with Incentives, and the 2nd experimental group that used the activities without Incentives, in terms of skills of meta-cognitive thinking. T-test was used to identify the differences between the 1st experimental group and the 2nd experimental group. Table 4 shows the results of the t test for the sample of the two research groups.

**Table 4.** The arithmetic mean, standard deviation, and "t" value for the total skills of meta-cognitive thinking

| Group | N | Mean | SD | t | Df | sig |
|---|---|---|---|---|---|---|
| The 1st experimental group (activities with incentives) | 30 | 101.17 | 3.18 | 32.5 | 58 | 0.000 |
| The 2nd experimental group (activities without incentives) | 30 | 73.53 | 3.39 | | | |

According to what is shown in the previous table, there are statistically significant differences between the first experimental group that used activities based on digital incentives (M = 101.17, SD = 3.18) and the second experimental group that used normal educational activities without incentives (M = 73.53, SD = 3.39). (t = 32.5), (p = .000) in favor of the digital incentives group in the overall sum of meta-cognitive thinking skills.

The significant differences between the two experimental groups was also verified concerning the sub-skills constituting meta-cognitive thinking, which are planning, control, and assessment, as shown in the following Table 5.

**Table 5.** Arithmetic mean, standard deviation, and "t" value of the sub-skills of meta-cognitive thinking

| Skill | Group | n | Mean | SD | t | df | Sig |
|---|---|---|---|---|---|---|---|
| Planning | The 1st experimental group (activities with incentives) | 30 | 37.33 | 2.66 | 14.60 | 58 | 0.000 |
| | The 2nd experimental group (activities without incentives) | 30 | 28.83 | 1.76 | | | |
| Control | The 1st experimental group (activities with incentives) | 30 | 34.00 | 1.56 | 18.70 | 58 | 0.000 |
| | The 2nd experimental group (activities without incentives) | 30 | 24.67 | 2.25 | | | |
| Assessment | The 1st experimental group (activities with incentives) | 30 | 29.83 | 1.39 | 30.28 | 58 | 0.000 |
| | The 2nd experimental group (activities without incentives) | 30 | 20.03 | 1.10 | | | |

The previous table shows that there are statistically significant differences in favor of the first experimental group that used activities based on digital incentives, compared to the second group that used activities without any digital incentives in the three sub-skills that consist of meta-cognitive thinking. Whereas the planning skills were in the first experimental group (M = 37.33, SD = 2.66), while in the second experimental group (M = 28.83, SD = 1.76), (t = 14.60), (p = .000) in favor of the first group that used Activities based on digital incentives. The control skills in the first experimental group were (M = 34.00, SD = 1.56), while in the second experimental group (M = 24.67, SD = 2.25), (t = 18.70), (p = .000) in favor of the first group that used activities based on digital incentives. As for the evaluation skills in the first experimental group (M = 29.83, SD = 1.39), while in the second experimental group (M = 20.03, SD = 1.10), (t = 30.28), (p = .000) in favor of the first group that used the existing activities on digital incentives.

## 6 Discussion

The results showed the effectiveness of digital incentives that were used within the study in enhancing the role of e-learning activities in developing learners' meta-cognitive thinking skills, and the sub-skills it includes, including planning, control, and assessment. Digital incentives have been able to encourage students to do associative thinking and make them able to build knowledge by making meaningful associations. In the students' journey to obtain digital incentives, they must develop a blueprint for what they want to reach at the end of learning, which means developing their planning skills, which is one of the most important meta-cognitive thinking skills. Also, the student's keenness to carry out each sub-task to obtain its own incentives makes the learner an

observer and control over everything he earns. Also, the learner receiving incentives in an activity prompts him to make generalizations to new learning situations, which makes the learner review what he has learned and re-judge the accuracy and adequacy of the results, which is reflected in his meta-cognitive thinking skills.

It can be said that the structure of e-learning activities based on digital incentives pushes students towards setting goals before starting to implement any educational task and helps the student to develop various plans to overcome challenges, and because obtaining rewards requires good planning, all of these towards reviewing a variety of files, producing various files, and obtaining multiple opportunities that lead to improving control and monitoring skills. Also, the incentive system of activities provides frequent reviews of multimedia and creates various opportunities for improvement, all of which improve assessment skills. Since points are allocated as rewards for participating in discussions, this has contributed to enhancing students' abilities to interact more with learning groups, and to work on implementing any discussion activities that enhance their ability to get the most points.

Since meta-cognitive thinking is the highest level of mental activity that maintains the individual's awareness of himself while thinking about solving a problem, digital incentives in the current study can be considered one of the effective tools that maintain these high levels of activity at their highest levels. Tsai, et al. [47] show that meta-cognitive thinking is related to categories of mental behavior that may be associated with understanding the problem or situation before trying to find a way to solve it, and this includes planning, follow-up, and monitoring. This is in addition to the link between meta-cognitive thinking and self-control and communication behaviors, as solving a problem requires different roles, from generating ideas, to planning, criticizing, monitoring progress, and supporting a particular idea by directing behavior towards reaching the solution. This makes the important digital incentives that put the learner in a continuous vigil to maintain the gains that he gets and thus add to these gains and get the largest possible rewards. Based on this, Connor et al., 2019 consider that designing educational environments according to the levels of meta-cognitive thinking is one of the requirements for successful teaching and learning, as it is a human capacity that helps to increase awareness of learning and the experience gained [62].

Within the framework of the constructivist theory that emphasizes that learning is an active constructive process rather than a process of acquiring knowledge, learning is the process that supports building knowledge more than contact with knowledge. It can be said that digital incentives can contribute more to putting the learner in a state of continuous activity to build his knowledge, and this activity requires the learner to plan what he will learn and to monitor the extent to which he has planned, as well as the need to evaluate everything he has learned [63–65].

The current result is related to some theories that placed the building blocks for digital incentives, including the motivation theory, which indicates in its content that incentives help create internal motives that motivate the student towards reaching the desired level through various planning processes [53]. According to the theory of self-report, the student, no matter what skills he has, does not work automatically, but there must be incentives that support the student towards continuing to regulate his learning [66–69]. Also, the expected value theory asserts that the student determines his choices based on his assessment of the extent to which the expected results match the behaviors

he practices with the desired results, and accordingly the incentives that the student obtains personally are the value that the student expects to obtain as a result of the performance that he has implemented, which is what drives him to continue practicing the skills that make him at the top of his level [70, 71]. Also, according to the behavioral theory, the behavior must be supported and reinforced to be strengthened and repeated, and therefore, self-regulating learning skills will not continue without support or motivation [56]. This is consistent with the theory of reinforcement, which sees that repeating and improving performance is linked to the presence of incentives [58].

The current result is consistent with what was confirmed by the previous literature in terms of the ability of digital incentives to raise the rates of cognitive growth of students, in addition to enhancing their abilities related to organizing their learning [15]. Also, digital incentives contribute significantly to enhancing students' engagement in learning, thus focusing on and planning all the requirements of the educational task [17]. Also, digital incentives support the processes of cooperation between friends in the same team and improve the mechanisms of joint achievement [19]. Also, digital incentives work on developing thinking and finding various ways to achieve the best learning, which is reflected in self-regulation skills positively [22].

## 7 Limitation

The effect of electronic activities based on digital incentives on metacognitive thinking skills during the Covid-19 pandemic is related to the gamification elements used within the research, which are points, badges, levels and leaderboards, and the effect may change if other elements are used. The application of the experiment was linked to the nature of the general context of the students' study of the computer skills course, and perhaps changing the course and its different educational tasks may not lead to the same results. The Metacognitive Thinking Skills Scale has been linked to the nature of learning during the COVID-19 pandemic across digital platforms and isolation environments, and adjustments to the scale may be appropriate if used outside the COVID-19 context.

## 8 Conclusion

The current study is one of the studies that focused on the development of educational activities in the context of the COVID-19 pandemic by linking these activities to a set of digital incentives commonly used in educational games such as points, badges, levels, and leader boards. The current research direction is one of the main solutions that can be relied upon in developing e-learning environments during pandemics and motivating learners to learn during crises. The results showed the great effectiveness of e-learning activities based on digital incentives in developing meta-cognitive thinking skills and the sub-skills it includes, including planning, control, and assessment. The researcher believes that future research related to the employment of digital incentives through e-learning environments could be more oriented towards developing e-learning management systems according to digital incentives and measuring their impact on

some learning outcomes. As well as examining the role of digital incentives in reducing anxiety and psychological stress associated with learning during pandemics.

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