From Screens to Innovation: Enhancing Creative Thinking through Flipped Classroom Learning in Primary Computer Science Classes

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***Abstract*—The research focused on determining whether the implementation of a flipped classroom pedagogical model would improve the creative thinking skills of students learning primary computer science. Of the 120 students who participated in this quantitative research, 60 made up the experimental group that was exposed to the flipped classroom method while the remaining 60 made up the control group that was taught using traditional methods. To achieve the goals of the research, an entire instructional unit grounded in the principles of flipped learning was developed while creative thinking was measured using the three components of fluency, flexibility, and originality through a pre-test and post-test which served to collect data. The results showed that the experimental group outperformed the control group in all the components of creative thinking which emphasized the value of the flipped classroom in improving the students' creative thinking skills. The flipped classroom fostered a stimulating, constructivist environment that promoted collaboration and deeper thinking. The research argues that computer science classrooms, especially those aiming to foster advanced thinking skills, should embrace flipped learning more and recommends adoption of strategies that support the integration of flipped methods into educational methods and frameworks while encouraging further research on its impact on other cognitive, psychomotor, and social learning outcomes within different educational environments.**

***Keywords*—flipped classroom, creative thinking, computer science education, digital learning**

I. Introduction

Nowadays, learning goes beyond classroom environments and conventional models of teaching, in which the teacher is the only source of information. Modern technologies of education have significantly affected the process of gaining, producing, and using knowledge, leading to noticeable changes in educational goals and the focus of education on developing competence and the ability to work with knowledge in practical, applicative ways [1, 2]. Thus, the conventional learning method is no longer effective in preparing people to adequately perform in rapidly changing, knowledge-based societies [1, 3, 4]. Accordingly, educational institutions ought to focus on promoting higher-level cognitive abilities, such as critical thinking, creativity, and self-directed learning, as basic educational goals [5, 6].

In this regard, the flipped classroom has been identified as a best practice innovation that changes the way teaching happens. In this teaching model, technology is not only a platform for the presentation of lessons but a means to relocate teaching from the classroom to the pre-class environment, while the classroom hours are then used for collaboration, discussion, and problem-solving [7, 8]. Through this teaching practice, the learner becomes an active participant in the knowledge-production process, while the teacher becomes a facilitator rather than a lecturer, aiding inquiry, critical thinking, and higher-order cognitive functioning [3, 4, 8]. Flipped-classroom learning has been observed to improve academic performance, motivation towards learning, and interaction skills among students [9, 10].

One of the most important implications of the flipped classroom is linked to the development of creative thinking skills, which include fluency, flexibility, and originality, helping students produce multiple ideas, look at problems through multiple lenses, and develop innovative solutions [9, 10, 11]. These skills are developed in an atmosphere of exploration, collaboration, and risk-taking, which is naturally in tune with a flipped classroom [11–13]. Through engaging with learning content before class, students will be better equipped to apply, analyze, and engage with creative learning tasks in class [14–16].

Although there has been extensive empirical research on flipped classes, most were conducted in secondary and university institutions and technologically advanced environments [1, 2, 17, 18]. Research on flipped classes in primary education, especially in computer education, has been underrepresented. This has been a significant gap, as computer education requires algorithmic and logical reasoning, as well as creative problem-solving, which are the key features of creative thinking [19–21]. Implementing creativity-promoting methods of teaching at early levels of education can generate extensive knowledge that sustains future education in science and technology [22–24].

Moreover, there still a considerable gap in research on the implementation of flipped classrooms in Jordan, where inconsistency in digital technology infrastructure exists, teacher vary in technological skills, and curricula focus on content rather than processes. These circumstances generate significant concerns regarding the possibility and effectiveness of the implementation of flipped learning. This study clearly carves a new path within literature because it

focuses specifically on the implementation of the flipped classroom concept through "*Darsak*," the national, officially supported, and commonly used platform in Jordanian schools. This educational platform provides an enabling environment for a positive and effective learning process through its interactive and automated educational materials.

The research aimed at examining the effect of employing the flipped classroom approach through the "*Darsak platform*" on the capacity of creative thinking skills (in terms of fluency, flexibility, and originality) among primary-level students in computer science education in the Hashemite Kingdom of Jordan. The research makes three contributions: (a) focusing on computer education among primary-level students, which is relatively less researched in terms of Flipped Classroom; (b) considering creative thinking as a multidimensional concept rather than limiting research on academic outcomes; and (c) conducting the research in a developing country utilizing a national platform.

Through these dimensions, the research contributes to the global discussion regarding the educational potential of flipped classrooms and provides the possibility of informing educational systems challenged by technological restrictions and high content-dense curricula. The expected results may help in designing curricula and training programs, and the development of educational policy regarding the improvement of interactive and self-directed learning activities in primary-school education. Thus, the problem of the study is formulated as follows: What is the effect of the flipped classroom model, implemented through the "*Darsak platform*," on developing creative thinking skills (fluency, flexibility, and originality) among primary students in computer lessons in Jordan?

II. Literature Review

In 21st century, flipped classroom model is one of the most adaptable and appropriate models in terms of providing opportunities for promoting autonomous learning and changing classroom environment to be more dialogic and active [25, 26]. Within this educational framework, the traditional educational process is reversed; and students are assigned various digital resources (instructional videos, interactive presentations, digital readings, and online texts) prior to attending the course, the course is then spent on active learning, discussions, problem solving, and project work designed to develop the students' higher order thinking skills [27–30].

This reorder of learning steps indicates a change of an entire educational philosophy. Classroom is no longer an arena where learners passively receive content, rather, it is an environment where learners actively construct their knowledge and engage in application, discussion, and re-interpretation of content in varied contexts [31, 32]. Within this framework, the student moves from being a passive, knowledge-receiving, teacher-dependent individual to an active constructor and applicator of knowledge [7, 13, 33]. Simultaneously, the teacher's role changes from being a knowledge-dispensing lecturer to a guide, learning designer, and critical and creative thinking facilitator. Instead of a dominant lecturing role, the teacher's primary task is to structure classroom discussions, while guiding the learners' activities, stimulating their thoughtful engagement, and addressing the conceptual difficulties they meet when applying the content [31, 33, 34].

Constructivism sees learning as the reconstruction of knowledge with personal experiences and interaction, along with Vygotsky's social constructivist theory on the importance of social interaction in understanding something deeply to explain the purpose of the flipped classroom [35–38]. By socializing, collaborating, and dialoguing with each other, learners are able to exchange different viewpoints, and deepen their understanding on the subject. In that sense, the educational flipped classroom is more than just rearranging the order of activities to be completed, as there are other dynamics involved with learners becoming the center of education and the teacher being a thinking and cognitive partner [39, 40].

The flipped classroom model is characterized by the combination of self-paced learning with active learning. During the pre-class phase, students self-direct their learning by interacting with instructional materials through digital media they can control through pause, review, and re-research, which promotes deeper understanding and self-regulated learning [41–43]. During classroom time, students apply interactive learning activities that require them to transfer concepts to novel situations through discussions, cooperative work, and design of problems and projects. Such activities develop the capabilities to think critically, evaluate and create which are high order skills. Thus, learning in the flipped model is cumulative and provides an opportunity for students to integrate and build upon digitally acquired knowledge and classroom interactive activities in a sequential, organized manner [10, 17, 18].

In flipped classrooms, students learn theoretical material via instructional videos and interactive online resources. Then, during the scheduled instructional time, students participate in hands-on activities and utilize critical and creative thinking skills [23, 29, 33]. This is a reorganization in the stages of learning, resulting in changing the students' and the teacher's roles. Increasingly, students become inquirers, thinkers, and producers of knowledge, whereas the teacher steps away from being a simple transmitter of information to a facilitator of thinking and creative activities. In other words, the flipped classroom model is based on a modern educational philosophy that changes the elements in education (content, teacher, student, and technology); it moves the educational process from rote learning to inquiry-based learning and creative application [44–46].

The construction of the model illustrates the connection of the flipped classroom and creative thinking skills. The learner who engages in the content at his or her own pace before class achieves fluency the capacity to develop a wide array of ideas and various outcomes to a problem or question about learning [45–47]. This fluency is a central dimension of creative thinking since it permits students to articulate more viable alternatives without the fear of making mistakes or having their ideas dismissed. This enhances cognitive engagement and enriches learning outcomes [26, 29, 38].

Another dimension of creative thinking is flexibility. It is defined as the capacity to view a situation from other points, reframe it, and employ different techniques to solve it [47, 48]. In the flipped classroom, flexibility is cultivated by group work the class discussions, which encourage

students to articulate their ideas, consider the other's position, and use different alternatives prior to making the final decision. This interactive context provides learners with the opportunity to gain mental agility, challenge the current status, and develop creative solutions to complex problems [34, 39, 48].

The multiplication of new concepts that are original, unusual, and independent, as well as the exercising of creativity and intellectual independence, is what Originality, the third aspect of creative thought, is all about [49–51]. Instead of just providing instruction, the teacher's role as a facilitator allows for even more student independence, promotes a greater sense of learning ownership, and raises the probability of the development of original and creative thoughts [51–54]. The Flipped Classroom model provides an excellent context for originality, as students are able to suggest their own problem-solving strategies; design applied projects and integrate abstract knowledge into practice.

The flipped classroom transforms the traditional classroom into an inquiry and application model [19, 28, 29]. It is suitable for developing creative thinking and generating new ideas (fluency), adopting different viewpoints and strategies (flexibility) and formulating an independent and innovative solution (originality). It is not only an approach that optimizes instructional time, rather, it transforms the learning environment from being mainly teacher-centered to a learner-centered one. It allows for exploration and experiential learning where learners are active and the classroom becomes a hub for creative intellectual activity [13, 17, 25, 44, 46].

Research [50–53] revealed significant improvements in student interaction, engagement, motivation, and interest in learning. The students were more participative in class discourse, more proactive in learning mastery, and demonstrated improvements in their learning achievement [27, 28, 44, 47, 49]. Lu and He [38] revealed improvements in engagement at the cognitive and behavioral level, suggesting increased engagement in critical and creative thinking processes. The activities conducted in class prior to learning, for example, learning through introduction videos or other computer-based learning resources, help students in detecting knowledge gaps and in higher-order thinking processes; these include brainstorming, flexible problem-solving, and creation of innovative solutions [28, 55, 56].

Anan *et al.* [33] argue that students with prior knowledge of the content are more effective in class discussions and cooperative activities since they are more active in the learning process and gain an understanding of the subject matter. Studies [16, 23, 25, 57], also emphasize the importance of flipped classrooms in providing an environment that is ideal for experimenting and implementation of creative approaches, emphasizing the principles of creative thinking: fluency, flexibility, and originality. Within the context of computer education at primary stage, the flipped classroom approach helps students gain basic principles outside the classrooms and utilize varied views within them to creatively solve problems and work together [20, 21].

Though research have underpinned the effectiveness of flipped classrooms in terms of engagement, motivation, and problem-solving skills, only a few of them have analyzed the development of creative thinking at primary stage [9, 18, 25, 29], as they often focused on the cognitive aspects, problem-solving, and critical thinking skills with a minor attention to dimensions of creativity (fluency, flexibility, and originality). Again, the possible benefits of the incorporation of flipped classrooms and the usage of digital tools to support creativity remain largely underexplored [34, 37, 41, 42, 46, 58–60]. This gap underlines the need for research about how flipped learning strategies, especially in technologically enriched environments, could enhance creative thinking in children.

With its strong focus on primary-level computer education, this research helps to fill this gap in research by investigating how a technology-integrated flipped classroom approach can help develop skills in fluency, flexibility, and originality in students in an elementary setting, thus further developing the evidence base for educational practices in promoting creative skills in early technology-based learning environments.

III. Methods and Procedures

A. Research Design

This research adopted a quasi-experimental approach to explore the impact of implementing the flipped classroom strategy on developing creative thinking skills among basic stage students in the computer curriculum. A unit called "I Design, Play, and Innovate with My Computer" was created to achieve this goal. The unit contained interactive tasks and open-ended assignments that focused on exploration and problem-solving activities which matched creative thinking standards. The unit was implemented in two different learning environments where the experimental group received the content through flipped classroom model. With the help of an online platform, and outside class hours, the students were provided with the content and preparatory tasks to be done independently which allowed them to concentrate on practical work and the development of higher order thinking skills during the class. The control group was directly instructed on the same content during the class in their second environment. Both groups received pre-test and post-test assessments to determine the effect of flipped classroom implementation on creative thinking development.

This design of the research can be described as follows:

- Experimental group: Pre-test (O_1), Intervention (X), Post-test (O_2)
- Control group: Pre-test (O_1), Post-test (O_2)

where: O_1 = Pre-test, X = Instruction using flipped classroom, and O_2 = Post-test

More specifically, the flow of this research design is presented in Fig. 1.

B. Sample of the Research

The sample of the research included 120 eighth-grade students from primary schools in the Irbid Governorate in Jordan**,** all of whom were enrolled in computer science as a core subject within the official school curriculum. The researchers engaged in purposeful sampling when selecting schools, where the schools selected have the appropriate resources for the research in the form of technological laboratories, classrooms, and adequate school facilities.

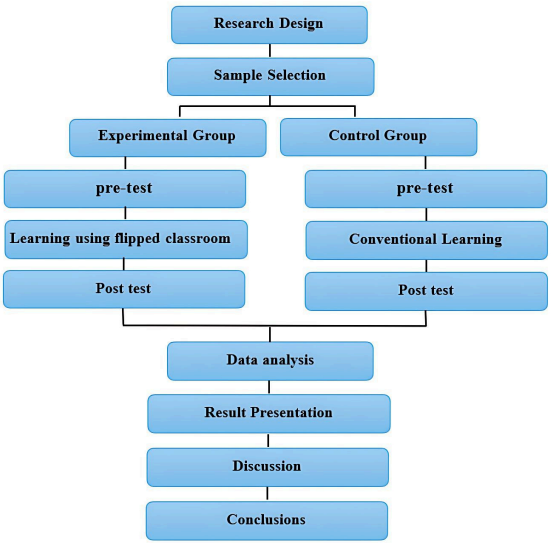

Fig. 1. Research design.

To maintain the impartiality of the results, 120 learners were randomized and equally split into two groups, namely, the experimental and control groups, with 60 learners in each. The pretest scores of the components of creative thinking (fluency, flexibility, and originality) and other pertinent academic achievement variables were analyzed for the two groups to authenticate their equivalence and to guarantee that no statistically significant differences existed between the groups prior to the intervention. These pertinent variables included achievement in computers and general performance.

C. Instructional Unit Design

An educational unit titled "*Design, Play, and Innovate with Computers*" was created based on the ADDIE model of educational design [41, 42, 61, 62], and delivered through Jordan's educational platform, "*Darsak*". The purpose of this educational unit is to develop fluency, flexibility, and originality of primary education students through a flipped-classroom approach. The design of the unit was guided by an analysis of educational needs using students' pre-existing knowledge, digital competencies, and motivation for learning, as well as context factors that include the structure of the school and the availability of digital technologies and the Internet. This process helped determining the most effective technological intervention strategies for encouraging creative thinking processes aligned with the educational environment.

Learning objectives and teaching approaches were aligned to support technology-enhanced active and collaborative learning. The learning resources made use of interactive videos, guided learning activities, and teacher guides, which aimed at promoting higher-level thinking and problem-solving skills. The emphasis was on using technology not only as a delivery channel but also a tool to promote creativity, engagement, and critical thinking, so as to empower students to apply and construct learning within a controlled learning environment.

To evaluate the unit, professionals in computer education, curriculum and instruction, educational psychology, and instructional design analyzed the unit. Based on the evaluation carried out, recommendations aimed at improving the quality of the content, the teaching methods, and the learning environments were implemented. In addition, training for the teaching staff took place regarding the effective application of the flipped classroom strategy and teaching methods that incorporate the adoption of technologies for interactive learning.

The unit was later tested among primary-level learners, and its effectiveness in improving creative thinking skills was determined. The evaluation mainly focused on the effectiveness of pedagogical and technological interventions carried out among the learners in relation to their skills in creative thinking.

D. Creative Thinking Skills Test

The Creative Thinking Skills Test was conceived as a holistic instrument to assess the extent to which the creative thinking skills of eighth graders have been developed and enhanced, during the implementation of the instructional unit, "Design, Play, and Create Using Computers". The test was designed to meet the specific objectives of the unit, which aimed to develop the participants' creative thinking and computer technology utilization as a tool for creation.

The test contained 9 opened-ended questions, divided among 3 factors to assess creative thinking: fluency, originality, and flexibility. Taking into consideration academic literature regarding creative thinking, these sections were selected to measure different levels of student's creativity, both cognitive and practical.

- **Fluency:** Measuring the student's ability to produce a large number of answers was done through 3 questions. These questions were designed to assess broad and unrestricted thinking while considering quality and quantity.
- **Originality:** Measuring the student's ability to produce ideas that are different and out of the box was done through 3 questions that encourage the student to think differently and innovatively.
- **Flexibility:** To measure the student's ability to pursue different paths of thinking in order to formulate various answers to the same problem, 3 questions were included. These questions were aimed at measuring cognitive diversity and the ability to think in an agile manner.

As a student, you would be able to express your thoughts freely, and with the help of a computer, come up with something new and creative regarding the questions. Each of the responses was rated on a five-point scale. Therefore, a student could potentially score a maximum of 45 points on the test, which would allow the instructor to distinguish the different levels of creative thinking of each student. The test was created from a synthesis of the different literature on assessment of creative thinking and was also tested to make sure that it was relevant to the students and to the learning context [23, 27, 43, 44, 51].

E. Validity and Reliability

The construct validity and the reliability of the assessment were achieved through different procedures. First, a group of seven experts from the fields of computer science education, curriculum and instruction, educational psychology, and instructional design were asked to review the virtual validity of the test. They reviewed all the items to determine if and how the different dimensions of creative thinking were being addressed. Once they provided their feedback, it was used to improve the final version of the test.

External validity was further improved by administering the exam to a sample of 23 students who were also excluded from the main research population. Respondents' scores were statistically analyzed, and it was found that there were strong item correlations with coefficient values ranging from 0.71 to 0.91 which indicates a grade level of internal coherence. This suggests the strong accuracy and reliability of the test in measuring the constructions it was intended to measure.

To assess the test reliability, a Cronbach's alpha coefficient of 0.95 was obtained. This suggests the results to be stable and consistent irrespective of the number of test attempts which means test results having strong internal consistency. In this case, a high level of reliability means higher confidence and lower random error in the scoring provided by the examination on the students' creative thinking skills.

Moreover, for constructing validity indicators and coefficients, reliability assessments for questionnaires and tests entail the use of McDonald Omega and Composite Reliability (CR) coefficients. In comparison to those traditional metrics, the reliability of Cronbach's alpha, internal consistency, McDonald Omega and composite reliability metrics, which are far more sophisticated and insightful, enabling us to estimate how well the items of one dimension in a test are correlated, and, in fact, how well they measure the construct itself. The metrics are in fact Omega McDonald and composite reliability equal to 0.956 and 0.959. Accordingly, they fall outside the margin of acceptable limits (<0.7), which in comparison implies the metric is of considerable high level of internal consistency.

F. Data Collection and Analysis

Considering the objective of the research, which was to assess the effects of the flipped classroom method on the development of creative thinking skills in computer science for eighth grade students, data collection was done. The research had a quasi-experimental design with two groups. One was an experimental group that was taught using the flipped classroom approach on the "*Darsak*" digital platform, and a control group that was taught through baseline traditional teaching methods in accordance with the national curriculum.

Both groups were pre-tested in creative thinking prior to the intervention to measure their baseline level of the three skills: fluency, originality, and flexibility. This was done to establish baseline comparability and control for pre-existing differences between the two groups.

The intervention ran from October 1st to December 3rd, 2024, comprising 18 daily instructional sessions of 45 minutes each. They were taught by 4 computer science instructors Streamed Lecture, who completed a CPD course on flipped learning and "*Darsak*' *platform*" usage. They taught the experimental groups with pre-recorded videos, interactive materials, and guided peers. Direct instruction was used for the control group.

In order to eliminate the impact of external factors, the same qualified teachers taught the same intervention and control groups. The schools attended by the students were also matched in terms of socioeconomic status. Contextual similarities strengthen the findings credibility, reducing the chances for contextual bias.

Post-testing both groups involved measuring the creative thinking capabilities change as well as assessing the effectiveness of the flipped classroom strategy in the control group, students in classically taught classrooms. Some statistical analysis was obviously required for the information collected; means and standard deviations were computed for a better grasp of the students' performance before and after the intervention. Noted differences were assessed using an Analysis of Covariance (ANCOVA) model using pre-test scores as covariates. Subsequently, a One-Way Multivariate Analysis of Covariance (MANCOVA) was performed to examine the impact of the teaching model on each specific creative thinking skill. The last analysis was focused on the flipped classroom strategy effect size calculated with the partial eta squared measure (η^2) to assess the classroom teaching impact in the shifting phases of students' creative development.

IV. Results of the Research

The first research question aimed to investigate the effectiveness of the flipped classroom strategy in enhancing creative thinking skills among students in the experimental group compared to their peers in the control group, which was taught using the traditional method. To achieve this, means and standard deviations were calculated for the creative thinking skills test scores of eighth-grade students in both the experimental and control groups for the pre- and post-tests, based on the teaching method (flipped classroom vs. traditional method). Table 1 and Fig. 2 illustrate these results.

Table 1. Means and standard deviations for creative thinking skills by group and time

Skills	Group	*N*	Pre-Test Mean*	Pre-Test SD*	Post-Test Mean*	Post-Test SD*
Fluency	Experimental	60	2.93	0.98	13.98	0.83
	Control	60	2.99	1.02	9.73	1.05
Originality	Experimental	60	1.64	0.76	12.73	0.97
	Control	60	1.75	0.81	8.98	0.99
Flexibility	Experimental	60	1.30	0.91	11.78	0.83
	Control	60	1.76	0.76	7.99	1.12
Total score	Experimental	60	12.46	1.49	43.91	0.95
	Control	60	12.70	1.53	23.52	1.68

**Mmaximum scores: Total = 45; Fluency = 15; Originality = 15; Flexibility = 15.*

Table 1 and Fig. 2 show an existence of differences in the mean scores of participants on the Creative Thinking Skills Test between the pre- and post-measurements, with a clear advantage for the experimental group in the post-test across all creative thinking skills and the overall score. These findings indicate a significant improvement in the performance of the experimental group after the implementation of the flipped classroom strategy. To verify the significance of these differences, a One-Way Multivariate Analysis of Covariance (One-Way MANCOVA) was conducted, as shown in Table 2.

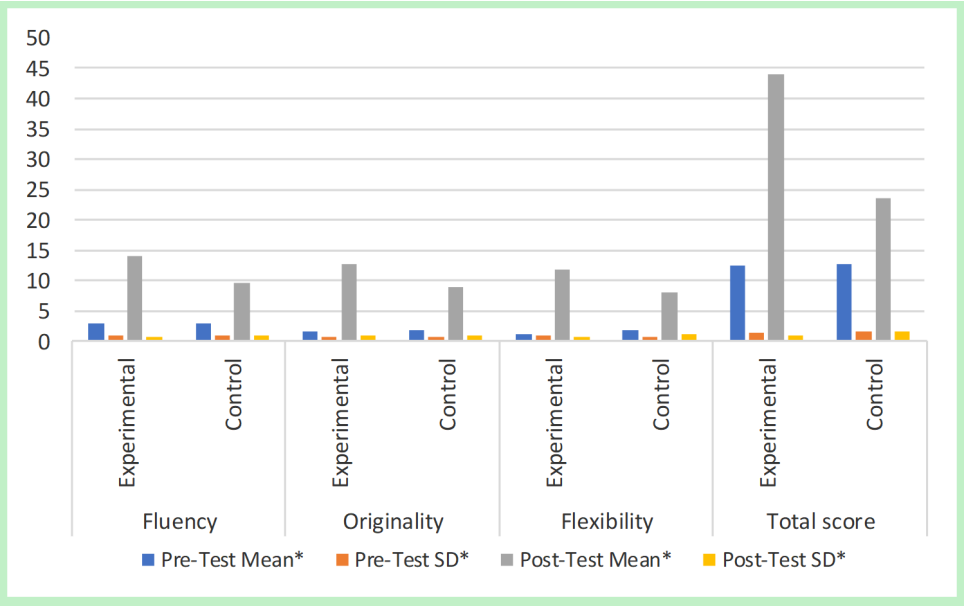

Fig. 2. Means and standard deviations for creative thinking skills.

Table 2. One-way MANCOVA for the effect of teaching method on creative thinking skills

Effect	Multivariate Test Type	Value	*F*	Hypothesis *df*	Error *df*	**p**	Partial η^2
Teaching Method	Hotelling's Trace	0.717	17.097	3	117	0.001	0.435

Table 2 shows that there are statistically significant differences between the two groups in the post-test scores across all creative thinking skills combined, indicating that the teaching method had a substantial impact on students' creative thinking development. To determine which specific skills were most affected by the group variable, a separate Analysis of Covariance (ANCOVA) was conducted for each skill, after adjusting for the pre-test scores, as shown in Table 3.

Table 3. Analysis of covariance for the effect of teaching method on creative thinking skills

Source of Variation	Skill	Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial η^2
Pre-Test	Fluency	129.84	1	129.84	11.35	0.001	0.069
	Originality	10.94	1	10.94	0.99	0.006	0.128
	Flexibility	9.84	1	9.84	5.64	0.002	0.002
Teaching Method	Fluency	268.07	1	268.07	27.55	0.001	0.459
	Originality	258.53	1	258.53	11.33	0.001	0.417
	Flexibility	45.73	1	45.73	31.50	0.001	0.390
Error	Fluency	476.06	117	8.72			
	Originality	1016.06	117	19.12			
	Flexibility	67.38	117	1.28			

Table 3 shows statistically significant differences between the groups regarding the teaching methodology for the three skills: fluency, originality, and flexibility, after adjusting for pre-test effects. The results indicate that the flipped classroom method had a clear positive impact on the development of participants' creative thinking skills. To find out which group was more affected by these differences, the adjusted means and standard errors were computed by group for each skill which can be seen in Table 4.

Table 4. Adjusted means and standard errors for creative thinking skills by group

Skill	Group	Adjusted Mean	Standard Error
Fluency	Experimental	13.98	0.21
	Control	9.73	0.15
Originality	Experimental	12.73	0.37
	Control	8.98	0.29
Flexibility	Experimental	11.78	0.43
	Control	7.99	0.32
Total Score	Experimental	43.91	0.34
	Control	23.52	0.28

Table 4 above shows the superior performance of the experimental group in all aspects of creative thinking, highlighting the effectiveness of the flipped classroom model. It is evident that certain aspects of creative thinking are more sensitive to the characteristics and modalities of digital learning resources than others, since the largest effect size is observed in fluency, indicating a constant availability of opportunities for generating ideas within interactive digital activities. Besides, even though originality and flexibility also became significantly enhanced, the effect size is marginally lower, which could be attributed to the greater cognitive load involved in arriving at novel and flexible responses.

The presentation of digital materials has, likely, played a significant role in these findings, as aspects such as guided exploration, use of multimedia stimuli, and increasingly

scaffolded exercises presented an environment encouraging experimentation, heuristic thinking, and self-directed learning, all of which are crucial to developing creativity. Furthermore, various contextual factors, such as prior experience, class use of interactive materials, and the class environment, may have exerted their own enhancing effects.

The outcomes, in general, show that the flipped classroom approach, combined with the incorporation of innovative digital resources, not only promotes engagement among participants but also enables the development of creative thinking skills among primary school-level students to a great extent.

V. Discussion of the Results

The positive impact of the flipped classroom model on the development of creativity skills for eighth students was obvious. In the overall creative thinking test and in the subdomains of fluency, originality, and flexibility, students learning through this model on the "*Darsak platform*" scored better on the test against the students in the control group. Shifting from a traditional teacher-centered model to a student-centered model with the incorporation of technology creates a better environment for learning and encourages the students to think creatively, inquire, and think at a higher level.

The benefits of the flipped classroom approach include the active learning approach used and the optimal learning outcomes achieved from the improvement of the diverse learning resources and the effective use of technology for instructional support. Besides, this improvement demonstrates that the flipped classroom's effectiveness in re-structuring the use of instructional time by emphasizing the integration of interaction and practice within the instructional time for the respective class. Importantly, students had access to pre-lesson videos and digital activities to work on at their own pace prior to class, preparing for the lessons and participation in class debate, collaboration in group work, and computer activities at the creative levels. As a result, the class converted to a rich learning environment in which various ideas could be generated, analyzed, and used in various innovative ways.

From the comparison of these results to some of previous studies such as [11–13], the contribution of active participation and interaction in the learning environment to the development of higher-order, creative thinking, and other results have been demonstrated. Similar to this, the research also correlates with the findings of Lyman *et al.* [12] where they demonstrated the contribution of pre-class digital learning, coupled with active classroom participation, towards the improvement of flexible and original thinking.

Also, further studies [7, 8, 13, 14] mentioned benefits of flipped classroom other than previously mentioned, and among those, the ability to focus learning on more significant themes and addressing the uniqueness of students as individuals. It further allows students to clarify and discuss topics in class, and students have the ability to access and review instructional materials which allow them to master the material as needed at their own pace.

When comparing the results of this research to those of [15, 16], regarding the improvement of creative thinking skills, they confirm the global view on the significance of an intensive students' engagement within the flipped classroom approach. The results have shown that the implementation of the flipped classroom approach enables the promotion of self-enquiry and the development of creative thinking skills. In this case, it provides an opportunity for teachers, as well as students, to develop an interactive learning environment by means of the national "*Darsak platform*" that connects students, teachers, educational resources, as well as other elements of the e-learning environment, helping to diversify the feedback process and identifying the individual differences between students through a variety of tasks and evaluations.

As far as the authors' knowledge, this research is the first attempt to test the flipped classroom approach in primary education, thus reaching a level of significance by enriching the body of knowledge on implementing this approach at this level of education. Results revealed that the constructivist approach to learning, postulating the construction of knowledge through self-autonomous activities, interaction, and critical thinking, was successfully implemented in the classroom. This provided the learners with the opportunity to participate in knowledge combination, interaction, and collective construction, hence enabling the learners to develop their creative and innovative potential. Besides, the results were in line with the "social constructivist" approach, as it emphasized the significance of interaction as a means to achieve a common goal that results from creativity.

Additionally, the results reveal the added value of technology integration in the entire process of learning. "*Darsak platform*" offered easy communication tools as well as electronic resources that positively influenced the activity of learning. The platform also provided a mechanism that supports a teaching approach embracing student variation, where the learners are able to control the rate of their learning as well as revisit study materials several times, thereby creating significant value in the whole learning process.

However, it must be pointed out that the investigation does not include the effects of self-directed learning and intrinsic motivation of learners in the flipped classroom. Therefore, the positive outcome in the development of creative thinking skills is mainly to be ascribed to the learning design, namely the unification of pre-class computer-based materials and in-class activities.

From a critical perspective, the research highlights the great potential that "*Darsak platform*" offer for the design of flipped learning modules, stipulating the shortcomings of the platform within certain aspects. These aspects include the dependency on the predefined structure of the activity, the lack of tools to evaluate the impact of the training level on the effectiveness of the implementation, as well as the lack of tools to evaluate the long-term impact of the platform on the innovative thinking of the students. This, in turn, highlights the need for further research to consider these aspects and evaluate their impact.

In conclusion, it has been made clear through this research that the flipped-classroom approach leads to an improvement in divergent and creative thinking as higher-order thinking skills in primary education by restructuring class time and leveraging technology. This has been a major scientific and technological input towards integrating education and modern technology in the twenty-first century, highlighting the importance of "*Darsak platform*" in facilitating

educational innovation and building an interactive educational environment that enhances the development of higher-order thinking skills of learners.

VI. Conclusions

Findings from this research have practical contributions in primary education through conducting flipped classes, promoting students ability to develop their creative, higher-order thinking skills. Theoretical foundations of the study have contributions in affirming that the flipped classroom approach does not only function as a delivery channel for information. On the other hand, it affirms that students' construction of knowledge can take place through active participation, whether individually or in groups, especially in line with constructivism or social learning theories.

From a practical point of view, the importance of building learning activities that can be interactive and focused on clear objectives is highlighted. In addition, the development of teamwork and discourse skills and the development of constructive feedback are also pointed out. Further, the results acknowledge the need for professional development courses for educators that will help them develop effective digital learning experiences. Moreover, the integration of self-directed learning and intrinsic motivation on the part of the students within the educational procedure has also been emphasized.

On a technological level, the research highlights the crucial role of the "*Darsak platform*" in bringing together asynchronous electronic content with synchronous classes. This is particularly important, as it encourages a shift towards innovation in education, enhances formative assessment, and allows students to control the pace at which they learn, accessing instructional materials as needed. The convergence of technology and education design has created a sustainable model of a flipped classroom in a digital learning space.

Based on the findings, this study recommends the integration of the flipped classroom approach in the digital curriculum in a way that promotes the design of interactive learning activities to ensure active learning and creativity, alongside the formulation of programs for professional development opportunities to upgrade the skills of teachers in the design of effective digital learning experiences. In addition, creating awareness among the student and parent communities about the benefits of the flipped classroom approach could greatly promote student engagement and motivation towards self-directed learning.

Limitations of the research stress the importance of future research relating to exploring the flipped classroom's influence on other key skills, like critical thinking, teamwork, and self-learning, along with exploring its long-term influence on cognitive and social development of students. Future research studies would further relate to designing a sustainable digital learning space and exploring ways for merging project-based and game-based learning approaches to improve the efficiency of a flipped classroom and further work towards promoting key advantages for 21st-century digital learning.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

A.A.A. and R.M.A -B. conceptualized the manuscript's focus, proposed the aims, prepared the draft manuscript, and wrote all the sections. B.A.A., S.M.Q., M.M.H. and Y.Z.A. collected, analyzed, and interpreted the data. A.A.A. and R.M.A -B. were major contributors to writing the manuscript. All authors read and approved the final version of the manuscript.

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