TPM Vol. 32, No. S3, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

DIGITAL TOOLS FOR THE DEVELOPMENT OF CREATIVE THINKING

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ABSTRACT
This study aimed to demonstrate the impact of digital tools on the development of creative thinking in seventh-grade students of General Basic Education. The reserch fell into a quantitative approach, with an experimental longitudinal design and an explanatory scope. The study population consisted of 51 students. Among the main result, the relevance of using digital tools to foster creative thinking stands out. Statistical analyzes revealed significant differences between the pretest and posttest scores, with a p-value 0.05. Additionally, a negative correlation was found between grade level and originality, indicating a gradual decline as students progress through their education. In conclusion, the findings reinforce the importance of integrating digital tools into educational contexts to enhance crewtive thinking.
Keywords: Creative thinking, fluency, originality, flexibility, digital tools, teaching and learning.

1. INTRODUCTION

In today's knowledge-based society, it is essential to develop skills that enable optimal development among the population. One of these skills is the use of Information and Communication Technologies (ICT). This has become an important factor due to its growth in recent years in various fields. Therefore, it is important to consider the exponential progress that ICTs have experienced. In this regard, Peñaherrera-Acurio et al. (2021)they believe that ICTs serve as drivers in the construction of scenarios that foster interrelationships and allow for the establishment of new ways of interacting with reality.

Over time, education has undergone significant changes and has been forced to adapt in order to improve teaching and learning processes. One of the most significant developments has been the incorporation of Information and Communication Technologies (ICTs), which has provided a new approach and generated debates within the research community dedicated to the study of ICTs applied to education. In this regard, Livingstone et al. (2018), cited by [unclear Halpern et al. (2020)], mention that the implementation of ICTs in education has been a constant concern over the last decade for both academia and governments and governing bodies responsible for regulating the education system through public policies. Furthermore, Aparicio-Gómez (2018)they emphasize that the incorporation of ICT-mediated teaching strategies has become one of the main challenges of contemporary education.

In the educational field, for example, they have provided various tools that promote the development and evolution of fundamental skills, abilities, and competencies for life. Therefore, it is important to know and understand how these tools contribute to improving the quality of education. It is important to highlight the impact of ICTs in the educational.

Field because they allow for the renewal and strengthening of the teaching-learning process of students (Serrano et al., 2016). In this same sense,Alcalá (2016)He mentions that ICTs are an important element that contributes to improving education due to their easy adaptability in educational centers. In addition, Gargallo (2018) she indicates that the integration of ICTs in the educational field has generated a change and a qualitative leap from a traditional methodology to one that allows access to information.

An important aspect to note is that Al-Rahmi et al. (2020)the support and guidance teachers provide their students will influence their motivation to use ICTs, since these tools enable them to seek help in solving abstract and complex concepts and share and obtain information that contributes to improving their educational experiences. Therefore, the use of ICTs in the educational environment contributes

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positively as long as it is given a pedagogical and didactic approach that responds to students' needs. This facilitates greater student integration into the teaching-learning process.

Nowadays, it's possible to access tools developed virtually from anywhere. These technologies have generated a significant change in communication and understanding of the world, so the use of these resources should be encouraged. They can help develop creative thinking in students. In this sense, the importance of creative thinking in student development should be considered an important factor, since it allows for the generation of new and original ideas (Muñoz Silva et al., 2021). Furthermore, it provides an alternative perspective when it comes to problem-solving and decision-making. In this sense, Chaverra-Fernández y Gil-Restrepo (2017)they propose a comprehensive definition of creative thinking, indicating that it is receiving increasing attention as a factor in the development of society and, above all, in addressing the challenges currently posed in a globalized and ever-changing world.

Likewise, Galleguillos-Cortés et al. (2022)they define creative thinking as the process that shapes the creation of ideas and problem-solving. According to de Carvalho et al. (2021)this approach, creative thinking provides tools that empower individuals to face the challenges that arise in everyday life, both at school, at home, and in their communities. In other words, creativity is the ability to generate new ideas or objects. In this sense, Dogan et al. (2020)they propose several categories that respond to the generation of creative proposals, among which they explain that they must be new (original, unexpected), valuable (useful, high-quality), and appropriate (meet standards).

Discussing creativity involves understanding and identifying fields of knowledge and how it influences each of them (Palencia, 2023). The development of creative thinking is essential for students because it allows them to visualize, pose, and efficiently and creatively solve any problems they may encounter. In this context, Lopes et al. (2019)they argue that creative thinking has a functional nature, since it incorporates skills associated with cognitive functioning linked to problem-solving.

In parallel Salamanca y Badilla (2021), they mention that creative thinking is a cognitive aspect of human creativity, therefore, it is important to enhance it since it is essential for solving a variety of problems. Similarly, Sánchez-Macías et al. (2021)they consider that creativity requires constant interaction with advanced cognitive skills, such as working memory, continuous attention, mental adaptability and the ability to adjust actions in real time. Linked to this Prado-Arenas et al. (2022), they indicate the following regarding creative thinking: they support the progress of education by contextualizing and modeling knowledge, enriching student learning, since it allows them to formulate solutions to problems that may arise in their context.

When working on how to develop creative thinking in schoolchildren, several aspects must be considered due to their constant intellectual, emotional, social, and motor changes that are linked to the development of creativity (Krumm et al., 2018). Consequently, developing creative thinking in schoolchildren must be an elaborate and theoretically supported endeavor, not an improvised one. This is how we effectively develop students with a keen sense of problem-solving. Therefore, it is necessary to raise awareness within the educational community about the need to adapt new methodologies and pedagogical strategies to improve creative processes in students (Cárdenas, 2019).

In addition to the above, it is important to specify that the development of creative thinking has a crucial moment during the primary school stage. (Smare y Elfatihi, 2023).In this sense, Robinson 2014, cited by, Monteza, (2021)indicates that the school limits the creativity of students, which is why it is essential to reform the school, seen as a uniform educational system, into a novel educational system based on creativity. The responsibility of generating dynamic, curious, and creative students falls on educational institutions; therefore, it is their responsibility to train themselves to apply innovative methods that contribute to the training of students.

2. MATERIALS AND METHOD

This study responds to a type of applied research, since it seeks to modify an observed problem: the development of creative thinking in seventh-year students of Basic General Education. Applied research is based on the scientific method itself, which prioritizes the validation of theories (Bisquerra, 2009). Considering these aspects, the quantitative approach itself is characterized by being sequential and rigorous. The design that encompasses the development of this study is quasi-experimental with a longitudinal explanatory scope.

The participants were seventh-year students of basic general education. The groups were already established, so probability sampling was not used. With these considerations in mind, the groups were established, resulting in a total of 59 students. Twenty-nine students formed the experimental group and 30 the control group (see Table 1).

Table 1
Population and sample

Population	Experimental Group Seventh A	Control group Seventh B	Total
59	29	30	59

Note: Own elaboration

It is important to note that during the application of the pre and post test, there were students who for personal reasons did not attend the educational unit, so the exclusion criteria were applied, so in the experimental group there was a total of 27 students and in the control group 24. Therefore, the final sample was 51 students between the control and experimental groups.

The technique used was interrogative (questionnaire) with the purpose of identifying through questions unobservable aspects and at the same time giving them a numerical value (Hernández y Mendoza, 2018)and as an instrument the test called test to evaluate basic indicators of creativity EIBC-R validated by Hugo Sánchez Carlessi, this test allows to measure the dimensions of creative thinking such as fluency, originality and flexibility, through the comparison of objects, creation of stories and modification of drawings. Prior to the application of the test, it was submitted to a validation by experts with a doctorate in education from Ecuador and Peru, who confirmed that the applied instrument allows to measure the dimensions of creative thinking and contributes to the fulfillment of the stated objective.

was used for data analysis, which supported both descriptive and inferential analyses. In the descriptive section, measures of central tendency were calculated to summarize the characteristics of the study population. The inferential analysis required verification of compliance with the assumption of normality using the Kolmogorov-Smirnov statistic. This step is important because it allows for the use of the statistic that best fits the specific characteristics of the sample.

3. RESULTS AND DISCUSSION

In table 2 it can be identified prior to the intervention that the experimental group shows a distribution of creative thinking with 13 students (48.1%) at the minimum level, 8 (29.6%) at the medium level and 6 (22.2%) at the high level. On the other hand, in the control group, 13 students (54.2%) are located at the minimum level, 3 (12.5%) in the medium and 8 (33.3%) at the high level. In summary, of the total sample (51), 26 (51%) present minimal creative thinking, 11 (21.6%) medium and 14 (27.5%) high. These data provide a baseline to contrast after the intervention.

Table 2
Descriptive results of the pretest

	Creative thinking/pretest				
		Minimum	Half	High	Total
Cluster	Experimental group	13 48.1%	8 29.6%	6 22.2%	27 100%
	Control group	13 54.2%	3 12.5%	8 33.3%	24 100%
Total		26 51%	11 21.6%	14 27.5%	51 100%

Note. Prepared by the author

After the implementation of the program, the following results were obtained: in the experimental group, no students were found at the minimum level, while 5 (18.5%) were at the intermediate level and 22 (81.5%) reached a high level. This is unlike the control group, which had 3 students (12.5%) at the minimum level, 10 (41.7%) at the intermediate level, and 11 (45.8%) at the high level. In the total sample, 5.9% of students were at a minimum level of creative thinking, 29.4% at the intermediate level, and 64.7% at the high level. This suggests an increase in the levels of creative thinking, especially in the experimental group (see Table 3).

Table 3
Descriptive results of the post-test

		Creative thinking/posttest			
		Minimum	Half	High	Total
Cluster	Experimental group	0	5	22	27
			18.5%	81.5%	100%
	Control group	3	10	11	24
		12.5%	41.7%	45.8%	100%
Total		3	11	37	51
		5.9%	29.4%	64.7.5%	100%

Note. Prepared by the authors.

The comparison between the pre- and post-tests reveals a significant change in terms of creative thinking and its dimensions of fluency, originality, and flexibility. Before the intervention, the groups had a considerable number of students at the minimum level. However, the post-test data reveal a notable change. No students were observed at the intermediate level, and the majority reached the high level. It is worth noting that the control group also showed improvement in some aspects, although in this case, students still remained at the minimum level and a smaller percentage at the high level compared to the experimental group.

Table 4
Descriptive statistics

Statistical								
		95% confidence interval for the mean		Median	Variance	Standard deviation	Minimum	Maximum
	Average	Inner boundary	Upper limit					
GC Pretest	16	12.41	19.59	13	72.34	8.50	5	30
GE Pretest	15.13	12.52	17.98	15	41.93	6.476	6	27
GC post test	21.42	18.03	24.81	23	64.42	8.07	2	35
GE post test	27.04	24.79	29.30	28	28.47	5.33	14	36

Note. Prepared by the authors.

Table 4 details the characteristics of the creative thinking scores for both groups in the pretest and posttest. The control group (CG) had a mean of 16 with a 95% confidence interval ranging from 12.41 to 19.59, a median of 13, and a standard deviation of 8.50. The experimental group (EG) showed a mean of 15.13 in the pretest with a confidence interval ranging from 12.52 to 17.98, a mean of 15, and a standard deviation of 6.476. These data suggest that the groups were similar in their initial levels of creative thinking.

The posttest scores show a change after the program was implemented. The CG reached a mean of 21.42, with a confidence interval of 18.03 to 24.81, a median of 23, and a standard deviation of 8.07. On the other hand, the EG showed improvement with a mean of 27.04, a confidence interval of 24.79 to 29.30, a median of 28, and a standard deviation of 5.33. The results obtained demonstrate an increase in creative thinking in the EG.

Table 5
Levels of fluency

Fluency			Experimental group	Control group	Experimental Group	Control Group
Fluency	Low	Fi	16	13	4	6
		%	59.3%	54.2%	14.8%	25%
	Half	Fi	7	4	13	9
		%	25.9%	16.7%	48.1%	37.5%
	High	Fi	4	7	10	9
		%	14.8%	29.2%	37%	37.5%
Total		Fi	27	24	27	24
		%	100%	100%	100%	100%

Note. Prepared by the author

Table 5 details the fluency levels of the control and experimental groups before and after the program was implemented. In relation to the pretest, the experimental group had 16 students (59.3%) with low fluency, 7 (25.9%) with medium fluency, and 4 (14.8%) with high fluency. The CG, on the other hand, had 13 students (54.2%) with low fluency, 4 (16.7%) with medium fluency, and 7 (29.2%) with high fluency. Therefore, both groups show a greater accumulation of students at the low level.

Following the program's implementation, post-test results indicated changes. In the EG, the number of students with low fluency decreased to 4 (14.8%), while those with medium fluency increased to 13 (48.1%), and those with high fluency to 10 (37%). In the control group, the number of students with low fluency decreased to 6 (25%), those with medium fluency increased to 9 (37.5%), and those with high fluency reached a total of 9 students (37.5%). This suggests an improvement in fluency in both groups, but with greater significance in the experimental group.

Table 6
Levels of originality

Originality			Experimental group	Control group	Experimental Group	Control Group
Originality	Low	Fi	11	12	0	5
		%	40.7%	50%	0%	20.8%
	Half	Fi	9	3	9	10
		%	33.3%	12.5%	33.3%	41.7%
	High	Fi	7	9	18	9
		%	25.9%	37.5%	66.7%	37.5%
Total		Fi	27	24	27	24
		%	100%	100%	100%	100%

Note. Prepared by the authors.

The data shown in Table 6 according to the dimension of creative thinking (originality) for the two groups in the pre- and post-tests. It is evident that in the experimental group there is a group of 11 students (40.7%) with a low level of originality, 9 (33.3%) with a medium level, and 7 (25.9%) with a high level. On the other hand, the CG had 12 (50%) students with a low level of originality, 3 (12.5%) with a medium level, and 9 (37.5%) with a high level.

After implementing the program, the post-test results reflect significant changes. Nine (33.3%) students from the GE reached the intermediate level, and 18 (66.7%) reached the high level. This is in contrast to the CG, which has five (20.8%) students at the low level, 10 (41.7%) at the intermediate level, and nine (37.5%) at the high level. From the evidence, it can be inferred that there was a considerable improvement in the originality dimension.

Table 7
Levels of originality

Confidence intervals				
			95% confidence intervals (two-sided) [to]	
	Pearson correlation	Sig. (bilateral)	Lower	Superior
Degree - Originality	-0.468	0.001	-0.659	-0.222
a. The estimate is based on the Fisher root transformation				

Note. Prepared by the authors.

An important finding was obtained when correlating the variables grade or course with the total obtained from the originality dimension. A correlation of -0.468 was identified between these variables, with a bilateral significance of 0.001. This indicates an inverse and statistically significant relationship between grade and originality. This can be interpreted as indicating that students' originality decreases with higher grade levels.

Table 8
Levels of flexibility

Flexibility						
			Experimental group	Control group	Experimental Group	Control Group
Flexibility	Low	Fi	8	4	0	2
		%	29.6%	16.7%	0%	8.3%
	Half	Fi	8	11	7	11
		%	29.6%	45.8%	25.9%	45.8%
	High	Fi	11	9	20	11
		%	40.7%	37.5%	74.1%	45.8%
Total		Fi	27	24	27	24
		%	100%	100%	100%	100%

Note. Prepared by the authors.

Based on flexibility, Table 8 shows that in the experimental group prior to the application of the program, 8 (29.6%) of the students were at the low level, 8 (29.6%) at the medium level, and 11 (40.7%) at the high level. In relation to the control group, where 4 (16.7%) of the students were at the low level, 11 (45.8%) medium, and 9 (37.5%) at the high level. After the intervention in the experimental group, some improvements in flexibility were evident. Since there were no students at the low level, 7 (25.9%) were at the medium level, and 20 (74.1%) reached the high level. For its part, the control group maintained 2 students (8.3%) at the low level, 11 (45.8%) medium, and 11 (45.8%) at the high level. Therefore, the integration of digital tools in the classroom contributes to flexibility.

Table 9
General hypothesis test pretest and posttest experimental group

Paired sample test							
	Average	Standard deviation	95% confidence interval for the mean		t	gl	Sig. (bilateral)
			Inner boundary	Upper limit			
Experimental group pre-test Experimental group post test	-11.81	4.252	-13.49	-10.133	-14.43	26	<0.001

Note. Prepared by the authors.

Table 9 shows the results of the hypothesis contrast of the pretest and posttest measures of the experimental group. Where a mean of -11.81 is evident, with a standard deviation of 4.52. The 95% confidence interval, with a lower level of -13.49 and upper of -10.13. The calculated T value is -14.43. In addition, a p value = <0.001 is evident. This indicates a statistically significant difference between the pretest and posttest of the experimental group. Therefore, the alternative hypothesis H1 is accepted. The

use of digital tools significantly influences the development of creative thinking in seventh-year students of Basic General Education.

This research was developed with the purpose of demonstrating the impact of digital tools on the development of creative thinking in seventh-year students of Basic General Education in an institution in Ecuador 2024. For this reason, the focus of interest gravitates on creative thinking and its dimensions: fluency, originality and flexibility.

In this sense, and in light of the results obtained and declared, it is important to contrast them with different studies in order to understand the reality surrounding the study objective. In this regard, Parra-González et al. (2020)it is mentioned that the use of digital tools such as games generate spaces that strengthen creative thinking in students. This statement arises from analyzing the data obtained where students indicate that playing deserted their imagination (4.24 ± 0.814), they felt creative (4.21 ± 0.888). These results are contrasted with those obtained which show an improvement in creative thinking after the intervention. With a mean of 27.04 (95% CI: 24.79-29.30), a median of 28 and a standard deviation of 5.33.

Likewise, the results obtained from Trujillo y Cerón (2023)implementing teaching sequences based on the STEAM approach identified a positive impact, suggesting that this type of strategy is a valuable tool in education. However, they highlight the importance of delving deeper into the dimensions of creative thinking: fluency, originality, and flexibility. Consequently, the importance of using resources that integrate technology to enhance creative thinking is emphasized. Related to this, Rey y Vergara (2025)they agree that the use of various technological tools helps students become more innovative and creative.

Another point to highlight is Silva-Fuentealba (2024)that fluency did not present a significant difference ($p = 0.517$), which could also be evidenced in the results obtained despite having an improvement in relation to fluency. The experimental group with 13 students (54.2%) presented low fluency, 4 (16.7%) medium and 7 (29.2%) with high fluency. In contrast to the pretest in the experimental group, 16 students (59.3%) were evident with low fluency, 7 (25.9%) with medium fluency and 4 (14.8%) with high fluency. Despite observing changes, a significant change was not evident since the p value is greater than 0.05.Unlike originality and flexibility, dimensions that present a significant difference. One aspect to consider is that with higher school grade, originality decreases. The correlation between these variables is -0.468, with a significance of 0.001. This indicates an inverse and significant relationship. These results can serve as a basis for reviewing and optimizing intervention strategies in areas where significant changes are not evident and for strengthening those areas that showed clear improvements.

Padilla et al. (2022)they mention that digital tools contribute to a more dynamic teaching-learning process. Tools such as Google, WhatsApp, Kahoot, Jamboard, and Padlet adapt to students' needs. Along these lines, it is important to mention the use of digital tools significantly contributes to the development of creative thinking. This is supported by the results obtained, where a p-value of <0.001 is observed, which is interpreted as statistically significant.

For this reason, it is important to emphasize that for the correct use of digital tools, pedagogical and didactic aspects must be taken into account. This way, errors such as thinking that the use of these resources alone contributes to the development of entertaining and, above all, dynamic classes can be avoided. In this same context, Almazova et al. (2021)andNurlita, (2022)mention the importance of applying digital tools, and for this, they must be guided by pedagogical and didactic principles that respond to what is mentioned in the curriculum. Therefore, the objectives, skills, and assessment indicators must be considered.

4. CONCLUSIONS

The results obtained in this study demonstrate that the use of digital tools in the teaching and learning process has a positive impact on the development of creative thinking. These resources not only increase the possibilities for expression and knowledge construction, but also encourage the exploration of ideas, the creative and original resolution of challenges, and a shift in approach that allows students to explore new alternatives.

Likewise, it is important to highlight the importance of designing educational interventions that integrate digitally mediated activities to foster creative thinking. In this sense, they should no longer be seen as mere complementary resources for developing a lesson. It has been shown that they can contribute to developing complex thinking processes such as fluency, originality, and flexibility—important aspects of creative thinking.

The integration of digital tools into teaching and learning processes not only fosters the development of students' creative thinking, but also invites us to rethink how these resources are being used and their contributions to education, given the ever-changing world. Therefore, these types of interventions

contribute to developing competencies, skills, and abilities that enable students to confront challenges with critical and creative thinking.

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