RESEARCH PAPER

Autonomous Learning Mediated by Virtual Environments: A Quasi-Experimental Analysis of the Impact of an Educational Intervention at the Basic Secondary Level

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ABSTRACT
This article presents the results of a quasi-experimental research that aimed to determine the effect of a virtual learning environment (EVA) on autonomous learning in students of the middle school sublevel. A total of 93 students from a private educational institution in Azogues, Ecuador, participated in the study, divided into an experimental group (n = 54) and a control group (n = 39). The intervention was with the application of an EVA designed with criteria focused on autonomy, with a duration of twelve sessions in the area of Social Studies. The dependent variable was measured with a 19-item questionnaire organized into four dimensions: self-regulation, teaching strategies, intrinsic motivation and collaborative work. The results of the study showed significant differences in the experimental group both at the construct level and in each dimension with visibly improved intrinsic motivation and teaching strategies. The Wilcoxon-test confirmed the positive impact of EVA with the value ($p < 0.001$), validating the research hypothesis. It is concluded that the intentional use of virtual environments, didactically designed with the student at the forefront, significantly strengthens student autonomy and supports the integration of digital tools in basic education to promote key competencies of the 21st century.

Keywords: autonomous learning; virtual learning environment; motivation; self-regulation; collaborative work.
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Introduction

Today, the expansion of digital technologies has generated structural and systematic transformations in the way people access information and knowledge, interact with content, and learn from it. From this perspective, virtual learning environments (VLEs) are emerging as a relevant methodological alternative that, far from being limited to an instrumental function, offers new pedagogical and didactic possibilities focused on interactivity, self-regulation, the active construction of knowledge, and, above all, autonomy. Studies such as those by Arauco (2022) and Calvazos (2025) show that VLEs can become privileged spaces for teaching and educational transformation, even more so if they are articulated with clear pedagogical principles, achievable objectives, and the development of 21st-century competencies.

In Latin America, and particularly in Ecuador, the education system has faced latent challenges linked to curricular rigidity, transmissive pedagogical methods, limited learning personalization, and an overreliance on the role of the teacher as the sole manager of the teaching and learning process. Even in the 21st century, the teacher's prominence in the classroom and resistance to didactics adapted to the current era continue to be observed. These challenges became visible and aggravated by the COVID-19 pandemic, which, in most countries, forced the system to adopt and adapt remote emergency educational and didactic strategies, highlighting deep technological and pedagogical gaps (Castro et al., 2021). However, according to Abella and Otondo (2023), although policies have been implemented that seek to incorporate digital resources in the classroom, the transition toward pedagogical models that develop students' autonomous learning remains a gap, an outstanding debt for the education system, especially in basic education.

In the context of basic general education, with an emphasis on the secondary education sublevel (children aged approximately 9 to 11), there is a strategic opportunity to develop autonomy

from an early age. According to Piaget's theory of cognitive development, it is at these ages that students begin to transition toward greater levels of cognitive and organizational independence. However, studies such as those by Rivera (2024) and Villaprado et al. (2025) show that at this educational level, teaching is predominantly focused on the fulfillment of content, generally with practices that promote dependence on the teacher, reducing student initiative, proactivity, and protagonism. Hence, there is an urgent need to innovate the teaching-learning process through the incorporation of didactic proposals that strengthen autonomous learning based on student empowerment.

Now, autonomous learning, understood from the perspectives of Knowles, Candy, and Zimmerman, refers to the student's ability to self-regulate their learning process, set goals or objectives, observe and monitor their progress, use appropriate strategies, and remain intrinsically motivated (Chávez, 2025; Barca-Lozano, 2012; Nieto-Márquez, 2021). In this context, VLEs act as catalysts for autonomous learning as long as they are conceived and designed with relevant teaching resources, challenging activities, and a structure that guides student independence without ignoring pedagogical mediation. From the socioconstructivist perspective of Vygotsky and Bruner, autonomy does not separate itself from collaboration; on the contrary, it is built in interaction with the environment, resources, and collectively with other educational stakeholders.

Although current school education is well aware of the significant interest in ICTs in the classroom, the scientific literature reveals significant gaps regarding the effectiveness of VLEs in real-life educational contexts, particularly in empirical approaches with methodological rigor. In the case of Ecuador, research dedicated to analyzing the relationship between VLEs and independent learning in middle school students is scarce, fragmented, or focused primarily on anecdotal experiences; that is, there is little systematic evidence to establish the concrete effects of these technologies. Furthermore, there is still a lack of quasi-experimental studies that facilitate measuring, with reasonable internal validity, the differential effects of a technological pedagogical intervention compared to teaching with traditional methods.

Therefore, this article seeks to analyze the effect of a virtual learning environment specifically designed to promote student autonomy on levels of independent learning in the secondary education sublevel. It is structured under a quasi-experimental design, with an identified control and experimental group. Furthermore, the study addresses the key dimensions of independent learning, which include self-regulation, learning strategies, intrinsic motivation, and collaborative learning. This intervention is contextualized in the area of Social Studies through digital resources, asynchronous activities, and student learning monitoring.

Therefore, the general objective of this research was to determine the effect of a virtual environment on strengthening autonomous learning in middle school students. The hypothesis was that students participating in the EVA would experience a significant increase in their levels of autonomy in each of the dimensions.

Autonomous learning is an important competency in contemporary educational processes that allows students to assume an active and conscious role in their overall development and growth (Gómez et al., 2024). Autonomous learning responds to a transformation in the new learning ecology, which shifts from traditional models focused on the reproduction and transmission of information to constructivist, enactivist, and sociocognitivist models. In these models, according to Arán-Filippettie et al. (2023), the learner becomes the protagonist of their own learning, with the ability to make decisions, self-regulate their responsibilities, and allocate resources to achieve the objectives set.Desde la perspectiva de Knowles (1975) citado por Gutiérrez (2021), un estudiante autónomo es aquel que diagnostica las necesidades propias, se plantea metas, selecciona recursos, identifica y ejecuta estrategias de aprendizaje y, evalúa los resultados obtenidos. Por lo que, se entiende que la autonomía no es una habilidad innata del ser humano, sino, una competencia sujeta a desarrollarse de forma progresiva desde la experiencia educativa y bajo condiciones didácticas adecuadas. Mientras que, Candy (1991) citado por Crispín et al. (2011), manifiesta que el aprendizaje autónomo tiene su base sobre cuatro dimensiones: motivación, autorregulación, interacción o trabajo colaborativo y estrategias de aprendizaje. Es aquello que refuerza el carácter multifactorial de esta importante competencia.

In the educational context, Zimmerman (2002) cited by Quishpe (2025), introduces the concept of self-regulation of learning to define autonomy in a student who plans, monitors and evaluates their

own affective, cognitive and behavioral processes. Here, metacognitive, motivational and attitudinal strategies intervene that make a student direct their learning intentionally. For Quishpe (2025), the autonomous student is characterized by being conscious, active and strategic.

In the case of basic education, with an emphasis on children ages 9 to 11, autonomy should not be viewed as complete independence from the teacher, but rather, should be characterized by the capacity for construction, mediated by the environment, teaching resources, and teaching strategies (Rivera, 2024). Therefore, according to Sáez-Delgado et al. (2023), autonomy at these ages requires adequate scaffolding with gradual guidance, constant feedback, and opportunities to make decisions within rules structured by the teacher or another adult.

For the Ecuadorian national curriculum, autonomy is a cross-cutting principle that becomes a competency. Students are expected to actively and meaningfully learn how to learn. However, transmissive models limit student autonomy through rigid structures, rote practices, and limited opportunities for active participation (Zevallos et al., 2024). Hence the need to foster independent learning at early ages as an ethical and social responsibility, in response to a changing, uncertain, and highly interconnected world, providing critical, resilient individuals capable of continuous lifelong learning. It is in this context that, following Cumpa and Gálvez (2021), Virtual Learning Environments (VLE) constitute an opportunity to strengthen autonomy in elementary school students.

A VLE is a digital space that is didactically structured to facilitate teaching and learning mediated by technological tools and resources (Cuello and Delgado, 2011). Its intention is not to digitize content, but rather to generate learning experiences based on flexibility, interaction, and a focus on the learner. For Martínez (2022), a VLE is an ecosystem that articulates materials, activities, communication tools, and assessment methods, innovating learning beyond the classroom. Thus, one of the theories that supports the use of VLE in the school context is that of connectivism proposed by Siemens (2005), cited by Tapia (2022), who highlights the capacity of technology to expand learning opportunities by interconnecting the subject with diverse sources of information and learning communities. Therefore, a VLE can be conceptually defined from four dimensions in order to understand its functional structure and didactic potential, taking as reference the studies proposed by Diogo de Oliveira et al. (2022), Casa et al. (2024) and Cruz-Carballosa et al. (2024).

The technical capacity of an EVA refers to its accessibility, navigability, and ease of use by students. It also involves technological compatibility, a clear interface, available multimedia resources, and the absence of technical barriers that hinder exploration. This is crucial for children aged 9 to 11, as in some cases, their level of familiarity with ICTs is low, leading to a less meaningful experience.

Meanwhile, the organizational capacity of the EVA requires that the activities considered be designed in a logical, time-based, and functional manner. This includes session planning, clear objectives, a logical sequence of tasks, and the provision of resources consistent with the pedagogical progression. This capacity strengthens the development of skills such as time management and conscious planning, which also facilitates individual responsibility and independent learning.

Regarding communicative capacity, this refers to the possibility of interaction and feedback between teachers and students, or between students and students. To achieve this, VLE relies on tools such as chats, forums, personalized feedback, and synchronous or asynchronous collaboration spaces. This gives VLE a dialogic character for the co-construction of knowledge, a sense of belonging, and the expression of thoughts as factors in student intrinsic motivation.

Finally, reference is made to the didactic capacity of VLE, which integrates the pedagogical design of activities, their relationship with the curriculum, and the ability to generate motivation and meaningful learning. Teaching in a virtual environment requires adapting content to the students' cognitive level, diversifying resources, and including active methodologies. Therefore, the challenge of VLE is to generate challenging, contextualized, and interactive experiences. The impact it produces will depend on how it is didactically structured, how it generates active participation, and how it facilitates the appropriation of knowledge.

Thus, studies such as those by Leite et al. (2022) and Guillén et al. (2023) have highlighted the potential of a VLE to strengthen autonomous learning and develop self-regulation, intrinsic motivation, teaching-learning strategies, and collaborative work. VLEs foster autonomy by allowing students to play an active role, choosing

when and how to interact with the structured design based on their interests, styles, and learning needs. This is affirmed by Trueba and Remuzgo (2025), who state that autonomy does not arise spontaneously, but rather develops in environments where students must self-regulate and have constant feedback. However, it also requires good access conditions and digital literacy.

In basic secondary education, VLEs must be carefully designed to guide, motivate, and challenge students. Since autonomy is influenced by the perception of self-efficacy, it is necessary to consider the affective dimension of learning to foster a sense of belonging (Maliza et al., 2020). This is why the central hypothesis of this study is based on the assumption that a pedagogically structured EVA based on criteria of accessibility, organization, interactivity, and pedagogical relevance has a significant impact on student autonomy at early ages.

Materials and Methods

This study used a quantitative approach, explanatory scope, and a quasi-experimental design with a control group and an experimental group under a pretest and posttest framework. This methodological process evaluated the effect of the intervention, implemented using a virtual learning environment designed in Moodle Mil Aulas (Mil Aulas), on students' autonomous learning levels by comparing the groups before and after the application of the VLE (treatment).

The study sample consisted of a total of 93 students from the secondary education sublevel of a private educational institution located in the city of Azogues, Ecuador, which operates in person. The sample was selected using a non-probabilistic convenience method, meaning that courses or grades already available were considered. The experimental group consisted of 54 students who participated in the VLE intervention; while the control group consisted of a total of 39 students from the same sublevel; this group continued their learning process without access to the virtual environment.

The independent variable was the implementation of the virtual learning environment, which was designed based on four dimensions: technical ability, organizational ability, communication ability, and didactic ability. The dependent variable was autonomous learning, focusing on autonomy: self-regulation, teaching strategies, intrinsic motivation, and collaborative work.

To measure autonomous learning, a 19-item questionnaire developed from current theoretical frameworks and validated through expert judgment was used. This instrument was administered as a pretest and posttest to both participant groups. Each item was related to one of the four dimensions mentioned, and its assessment was based on a Likert-type scale. The validity of the instrument was analyzed using Cronbach's alpha coefficient.

The intervention was carried out over 12 learning sessions, each lasting 40 minutes. Each session was planned according to the Social Studies subject, where skills from the prioritized national curriculum were progressively addressed. The EVA, designed at Mil Aulas, included digital resources such as blogs, books, and videos, as well as asynchronous activities, forums, and personalized assignments. During this same period, the control group worked with the same content in the classroom without access to the EVA.

Finally, data analysis was processed using SPSS statistical software. Descriptive statistics were used to characterize the sample and analyze data distribution. Inferential statistics were also used to compare levels of independent learning between both groups and at different time points. To this end, the Kolmogorov-Smirnov normality test and the nonparametric Wilcoxon test for paired samples were applied. To assess the effectiveness of the study, a significance level of $p \leq 0.05$ was considered.

Results

The results analysis comprised three stages, depending on the objectives and the nature of the research. First, the results obtained for each dimension of the dependent variable are presented. This facilitates observing the effect on self-regulation, learning strategies, intrinsic motivation, and collaborative work following the pedagogical intervention with the VLE. This comparison was conducted within the same experimental group; that is, variations were observed between the pretest and posttest for each dimension. Subsequently, the results for the variable itself (dependent variable) are reported, taking into account the mean and standard deviation scored in the experimental group before and after treatment. This provides a comprehensive view of the variable as a construct beyond its individual components. Finally, the inferential results are presented, comparing the level of autonomous learning in the experimental group before and after the VLE.

The descriptive results reveal an increase in levels of independent learning following the administration of the VLE. The pretest showed a mean of 74.43 points with a standard deviation of 9.26, while the posttest average rose to 81.33 points with a nearly identical standard deviation (9.27). This suggests an overall improvement in independent learning among the students who participated in the treatment. Regarding the ranges, the minimum score on the pretest was 50 and the maximum 91; while the posttest score increased to 62 and 95, respectively. The median score also increased from 76.0 to 83, reflecting a general improvement in the group (Figure 1).

Table 1

Descriptive Statistics of the Dependent Variable: Autonomous Learning

	Descriptives	
	Statistic	**Standard Error**
DV – Pretest		
Mean	74.43	1.260
Median	76.00	
Standard Deviation	9.263	
Minimum	50	
Maximum	91	
Range	41	
DV – Post		
Mean	81.33	1.263
Median	83.00	
Variance	86.075	
Standard Deviation	9.278	
Minimum	62	
Maximum	95	
Range	33	

Note: Obtained from SPSS.

Likewise, in order to have validity in the inferential analyses, as indicated in Figure 2, a value of d p = 0.200 was obtained in the Kolmorogov-Smirnov normality test in both the pretest and the posttest, which shows that the data meet the assumption of normality (p > 0.05).

Table 2

Normality Test for Data Distribution

	Kolmogorov-Smirnov	df	Sig.
DV – Autonomous Learning – Pretest	0.094	54	0.200*
DV – Autonomous Learning – Post	0.095	54	0.200*

Note: Obtained from SPSS.

Table 3

Inferential Analysis of the Dependent Variable

	DV pre and post
Z	-4.174[b]
Asymp. Sig. (2-tailed)	0.001
a. Wilcoxon signed-rank test	
b. Based on negative ranks.	

Note: Obtained from SPSS.

According to the table, a statistically significant change in the levels of independent learning is evident between the pretest and posttest of the experimental group. The Z-value was -4.174 with a bilateral significance level of p = 0.001, indicating that after the EVA, students showed significant improvements in independent learning. Therefore, it is determined that the virtual learning environment positively influences the independent learning of students in the basic secondary education sublevel of an educational institution.

Table 4

Inferential Analysis of the Dimensions of the Dependent Variable

	D1POST - D1PRE	D2POST - D2PRE	D3POST - D3PRE	D4POST - D4PRE
Z	-1.542[b]	-3.816[b]	-3.427[b]	-4.397[b]
Asymp. Sig. (2-tailed)	0.123	0.000	0.001	0.000
a. Wilcoxon signed-rank test				
b. Based on negative ranks.				

Note: Obtained from SPSS.

Finally, the result of the inferential analysis revealed statistically significant differences in three of the four dimensions of autonomous learning. First, the teaching strategies dimension presented a value of Z = -3.816 and a significance level of p < .001, indicating a significant improvement after the intervention. Similarly, the intrinsic motivation

dimension showed a significant difference between the pre- and post-test with a value of Z = -3.427, p < .001, as did the collaborative work dimension, which reflected a value of Z = -4.397, also with a significance level of p < .001, indicating the significant impact on these dimensions. However, there is a contrast with the self-regulation dimension because a value of Z = -1.542, p = .123 was obtained, which shows that there were no significant differences between the measurements before and after the application of the EVA, in other words, it is understood that a statistically broad and significant improvement in self-regulation has not been achieved under the conditions of this research.

Discussion

According to the results obtained, it can be stated that the implementation of a VLE has a positive and significant impact on the development of independent learning in middle school students. This is reflected in the comparison of the pre- and post-test results of the experimental group, which showed statistically significant improvements in both independent learning and teaching strategies, intrinsic motivation and collaborative work, and, in contrast, self-regulation. Therefore, the VLE has not only functioned as a content-integrating tool but also as a didactic mediator to activate key internal processes in student autonomy. For example, the intrinsic motivation dimension showed a marked difference, suggesting that the VLE sparked greater interest and commitment to learning in students, even without teacher intervention. According to Al-Duhani et al. (2024), this strengthens autonomy because students perceive a sense of control, competence, and value in the activities they complete.

Regarding learning strategies, a significant increase was also shown, which may be due to the good instructional design of the VLE. This incorporated a variety of information resources, differentiated activities, and opportunities for learning in diverse ways. For Leite et al. (2022) and Maliza et al. (2023), a well-structured VLE helps students diversify their cognitive pathways and apply effective metacognitive techniques. Collaborative work, although with less pronounced differences in the pre- and post-tests, also represented a significant result. However, in self-regulation, from a statistical point of view, a significant effect was not evidenced because the value obtained is higher than the conventional threshold of 0.05. Therefore, this should not be attributed to the VLE's ineffectiveness, but may be due to chance or natural variations in the group.

This strengthening in the three dimensions, from the perspective of Abella and Otondo (2023) and Fuentes-Riquero (2025), is related to the incorporation of planning tools, asynchronous feedback, and spaces for interaction and communication within the EVA. As Brunner would say, autonomy is then built in a socially mediated way. However, in self-regulation, the need for more prolonged and personalized support is observed to develop metacognitive skills, since, as Zimmerman would say, self-regulation demands guided practice, constant feedback, time, a previous level of maturity, and autonomy as aspects that may not have been fully consolidated during the intervention.

From the perspective of González-Rincón et al. (2024), the idea that autonomy is not a static condition but a competence to be developed through adequate training opportunities is reinforced. From this perspective, the use of the VLE constituted a digital scaffolding that progressively strengthened student independence without ignoring the pedagogical support of the teacher. Landing in the Ecuadorian educational system, the results take on special relevance, since basic education still faces significant challenges in teacher-centered teaching, the limited use of technological resources, and limited opportunities to strengthen autonomy (Cuesta and Chamorro, 2022; Coello et al., 2023). Hence, this study provides empirical evidence on the need to transform teaching practice with the use of technology (particularly VLE) at the sublevel of middle basic education, which, according to Piaget's cognitive theory, is where children begin to develop self-regulation skills.

Finally, it is important to recognize that the study's limitations lie primarily in the sample size and type. Being non-probabilistic and restricted to a single educational context may limit the generalizability of the results. Furthermore, although the instruments were validated, it is acknowledged that the data obtained were self-reported, which leads to a certain desirability bias. Therefore, future research should incorporate mixed methods or longitudinal designs to observe the evolution of children's autonomy at different times, contexts, or educational levels, depending on the researcher's interest.

Conclusions

The findings of this research conclude that a virtual learning environment designed and implemented in

the subject of Social Studies had a significant effect on strengthening the independent learning of students at the lower secondary level, as evidenced by the overall improvement in the dependent variable and its respective dimensions. Intrinsic motivation registered the most notable change, showing that the EVA fostered personal interest in learning and encouraged active engagement among each student. Improvements in the learning strategies and self-regulation dimensions showed that the EVA not only organized content but also encouraged students to plan, monitor, and adapt their cognitive learning processes based on their autonomy. Collaborative work also supports the idea that independence and interaction can also go hand in hand among students.

Overall, the study's hypothesis is confirmed, and the relevance of using a VLE as a teaching and pedagogical tool to strengthen student autonomy at the intermediate levels of schooling is supported. It reaffirms that autonomy is not innate but is built and developed through digital environments designed with clear purposes, active teaching strategies, and student-centered activities. Finally, the study contributes to filling a theoretical and empirical gap in Ecuadorian education by providing the scientific community with concrete evidence of the benefits of VLE in basic general education. All of this leads to a recommendation that other educational institutions consider implementing similar proposals, considering autonomy as a skill for lifelong learning.

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