



ORIGINAL ARTICLE


## Implementation of a virtual classroom in Moodle for learning mathematics within the framework of relational education

*Implementación de un aula virtual en Moodle para el aprendizaje de las matemáticas en el marco de la educación relacional*

Implementação de uma sala de aula virtual no Moodle para aprender matemática no âmbito da educação relacional

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### KEYWORDS

learning, autonomy,  
skills, metacognition,  
Moodle.

**ABSTRACT.** The departmental school Pio XII, located in Colombia, is one of the educational centers that implemented the relational education system. Thanks to this process, shortcomings were evidenced in the personalized attention offered by teachers. In this sense, the present research aims to establish the incidence of implementing a virtual classroom designed in Moodle for the learning of mathematics under the considerations of the relational system with the seventh-grade students of this institution. It was carried out with a quantitative approach, based on a correlational cross-sectional design, where seven previously designed instruments were applied. The information of the three scenarios was collected: before, during, and after the implementation of the virtual classroom, which led to making comparisons of 46 different processes. The results reveal that the virtual classroom makes the analyst's attention time more efficient since it allows the student to develop metacognitive skills that strengthen her autonomy process. In addition, as a consequence, it was shown that the virtual classroom generates a progressive increase in the students' academic results.

### PALABRAS CLAVE

aprendizaje, autonomía,  
habilidades,  
metacognición, Moodle.

**RESUMEN.** El colegio departamental Pio XII, ubicado en Colombia, es uno de los centros educativos que implementó el sistema de educación relacional. Gracias a este proceso se evidenció falencias en la atención personalizada que ofrecen los docentes. En este sentido, la presente investigación tiene como objetivo establecer la incidencia de la implementación de un aula virtual diseñada en Moodle para el aprendizaje de las matemáticas bajo las consideraciones del sistema relacional con los estudiantes de grado séptimo de esta institución. Se realizó con un enfoque cuantitativo, basada en un diseño transversal correlacional, donde se aplicaron siete instrumentos, previamente

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diseñados. Se recogió la información de los tres escenarios: antes, durante y después de la implementación del aula virtual, lo que llevó a realizar comparativos de 46 procesos diferentes. Los resultados revelan que el aula virtual hace más eficiente el tiempo de atención del analista, puesto que permite en el estudiante desarrollar habilidades metacognitivas que fortalecen su proceso de autonomía. Además, como consecuencia se demostró que el aula virtual genera un incremento progresivo en los resultados académicos de los estudiantes.

**PALAVRAS-CHAVE**

aprendizagem, autonomia, habilidades, metacognição, Moodle.

**RESUMO.** A escola departamental Pio XII, localizada na Colômbia, é um dos centros educacionais que implementaram o sistema de educação relacional. Graças a esse processo, evidenciaram-se deficiências no atendimento personalizado oferecido pelos professores. Nesse sentido, a presente pesquisa visa estabelecer a incidência da implementação de uma sala de aula virtual projetada no Moodle para o aprendizado da matemática sob as considerações do sistema relacional com os alunos do sétimo ano desta instituição. Foi realizado com abordagem quantitativa, baseado em delineamento transversal correlacional, onde foram aplicados sete instrumentos previamente elaborados. Foram coletadas as informações dos três cenários: antes, durante e após a implantação da sala de aula virtual, o que levou a fazer comparações de 46 processos diferentes. Os resultados revelam que a sala de aula virtual torna o tempo de atenção do analista mais eficiente, pois permite ao aluno desenvolver habilidades metacognitivas que fortalecem seu processo de autonomia. Além disso, como consequência, foi demonstrado que a sala de aula virtual gera um aumento progressivo nos resultados acadêmicos dos alunos.

**1. INTRODUCTION**

The Departmental Educational Institution (IED) Pio XII, located in the municipality of Pacho (Cund.), in 2017, adopted the Cundinamarca Relational Education System (SERC). Their principles are based on the Fontan Relational Education model (FRE). These models are based on a constructivist perspective, in which each student is assumed to be unique (Mayer, 2000). Therefore, the educational system must respect the learning rhythms of each of them from a personalization process. In addition, it must strengthen each student's autonomy for the advancement of their understanding (Colen & Medina, 2019).

This project has been developed specifically with seventh-grade students in mathematics since the incorporation of the SERC. This produced changes at the macro, meso, and micro curricular levels, in which at least the following stand out:

At the macro-curricular level, it was possible to establish the change in managing the study plans by rethinking the contents and the evaluation. This facilitated the promotion of students at any time of the school year, as long as they met the requirements regarding the development of skills corresponding to each school grade.

At the meso-curricular level, changes were established in teaching practices by moving from a massive discourse to a particular dialogue exercise between analyst (the name given to the teacher in the SERC) and student. In addition, the mediation of knowledge is carried out on the development of six preconfigured guides for mathematics. These are designed in the form of a workshop so that each student can learn to self-regulate their time (Colen & Medina, 2019).

In each guide, four stages are developed according to the SERC. The first is called the starting point and consists of the student setting learning goals and recognizing their pre-knowledge for the subject to be developed. The second, called research, corresponds to the consultation work done on the new knowledge that will be acquired.



The third is called skills development, whose purpose is to display specific skills in the incorporation of new knowledge with pre-knowledge. And the fourth stage is the so-called relationship, whose goal is to use the knowledge acquired in the solution of real-type situations (Calderón et al., 2018).

In this sense, in a face-to-face session of one hour, the analyst can have up to 40 students. Simultaneously, each of them can be in one of the six guides proposed and specifically in one of the four stages of that guide, according to their evolutionary process. Therefore, in each of the working hours, the analyst must attend to a maximum of 960 different methods according to the personalization principle of the model.

And at the micro-curricular level, the change in the relationships between the analyst, the student, and knowledge can be observed. This transformation occurs by proposing a reflective environment where the construction of knowledge and metacognitive development are stimulated. To generate this environment, the analyst "has the task of carrying out the instructional design, which implies the ability to plan, direct (monitor) and evaluates the learning processes" (Colen & Medina, 2019, p. 104). These three abilities are taken up in IED Pius XII as learning skills and must be developed by the analyst in each class. In this way, respect for the learning rhythm of each of the students is encouraged according to the unique process that each one carries out (Iedpioxii, 2021).

The changes mentioned above translate into unmanageable and ineffective situations. This highlights the difficulty of the analyst to guide all seventh-grade students in the area of mathematics adequately. Consequently, students cannot meet the learning goals that were set. In addition, it influences the disinterest and demotivation of students, teachers, and parents.

Due to this diversity in the learning goals presented in a class versus the class time that the analyst has to attend to each student, shortcomings were detected in the personalized attention of the SERC. Therefore, it was intended to enhance the autonomous process of the students, through the design and implementation of a virtual classroom, for the seventh-grade mathematics area.

In addition, it is essential to highlight that the National Planning Department (2020) in the CONPES 3988 document directs several lines of action to implement Information and Communication Technologies (ICT) in academic improvement in all educational institutions:

The Ministry of ICT, through the project computers to educate, will develop from April 2020 to December 2024, regional and national spaces for the exchange of significant and innovative experiences in the classroom based on the use of digital technologies that allow: (i) the reflection of the educational community on the ethical, communicative and cognitive dimensions of the use of digital technologies, (ii) encourage the use of digital technologies in the classroom and (iii) make visible the experiences of the educational community of all the regions of the country against the use of digital technologies (National Planning Department, 2020).

Therefore, the virtual classroom that was designed and responding as a significant experience from the national guidelines allows mediating in problematic situations such as the one observed in this institution.

To achieve the purposes of this research, the following research question was posed. What is the impact of implementing a virtual classroom designed within the framework of the SERC in the learning of mathematics with seventh-grade students at the IED Pio XII?

Other institutions have carried out various studies on relational education and its high impact on student autonomy. Among them are Angulo and Torres (2016), who conclude that personalized education guides their actions, strategies, and projects towards developing and strengthening the principles that identify the human person. The authors define these principles as uniqueness, openness, and autonomy. In this same sense, the Ministry of National Education (2016) has the challenge of strengthening the person's development in their learning and innovation by promoting new and diverse technologies.

The difficulty of evaluating educational systems based on the relational model is appreciated by Ojeda (2017) when he deduces that in his research, it was not possible to determine what the understandings reached by the students were since they are the ones who make the decisions regarding their learning process. In other words, given that the student decides autonomously when to carry out the experimental activity and at what time to contact the teacher, the data collected did not correspond to the entire sample observed.

Therefore, this research aims to establish the incidence of implementing the virtual classroom designed in the learning of mathematics with seventh-grade students at the IED Pio XII. In this line, it is essential to highlight that the resources added to the educational processes must be based on the principle of coordination and articulation with the institution's pedagogical model (Rincón, 2020).

## 2. METHOD

The research was carried out at the IED Pio XII in the municipality of Pacho (Cundinamarca) in Colombia. The work was carried out with a quantitative approach since it is intended to collect numerical information or responses transformed into numerical scales (Cárdenas, 2018). In addition, the research had a correlational scope. Faced with this, Hernández et al. (2014) state that "this type of study aims to know the degree of association that exists between two or more concepts, categories or variables in a particular context" (p. 93).

For this research, the entire seventh-grade population of the IED Pio XII was used, which corresponds to approximately 140 students. It is essential to clarify that the population is variable due to the SERC model since students are promoted according to their learning rates.

Two variables were determined for the investigation. The first was called the learning process, which was defined as the set of three fundamental metacognitive skills that make a person capable of learning to think better (Moreno & Daza, 2014). These metacognitive skills are planning, monitoring, and evaluation, corresponding to the categories established for this variable. The second was called personalized attention and compared to the follow-up processes in the existing relationship between the analyst and each of the students. Again, the established categories are the academic results, the strengthening of autonomy, and the vision regarding the analyst's attention time.

The research was carried out in three phases. The first phase was called diagnosis, and in it, the state of the students' learning process was recognized, based on the established variables, before implementing the virtual classroom. The second phase was called design and implementation, in which the virtual classroom was carried out and introduced to school work for 45 days. During this time, information was collected on the proposed variables. Finally, the third phase was called analysis and corresponded to data collection after implementation. In addition, the corresponding comparison was made to establish the degree of incidence of the virtual classroom in the learning of mathematics with the study population.

For the collection of information, three instruments were available that collected the academic reports of the analyst and the information provided by the virtual classroom. Also, four surveys applied through Google forms were carried out. The first two sought to know the views of both students and parents about the seventh-grade math class. The third survey was aimed at analysts of the institution, whose objective was to understand the appreciations of the courses they directed according to the determining variables. These first three were validated by external peers, and an internal consistency test was also carried out, where Cronbach's Alpha values greater than 0.7 were obtained. The last survey was aimed at students. Its objective was to inquire specifically about the learning process. The instrument called inventory of metacognitive skills validated for the Colombian population was partially used (Huertas et al., 2014).

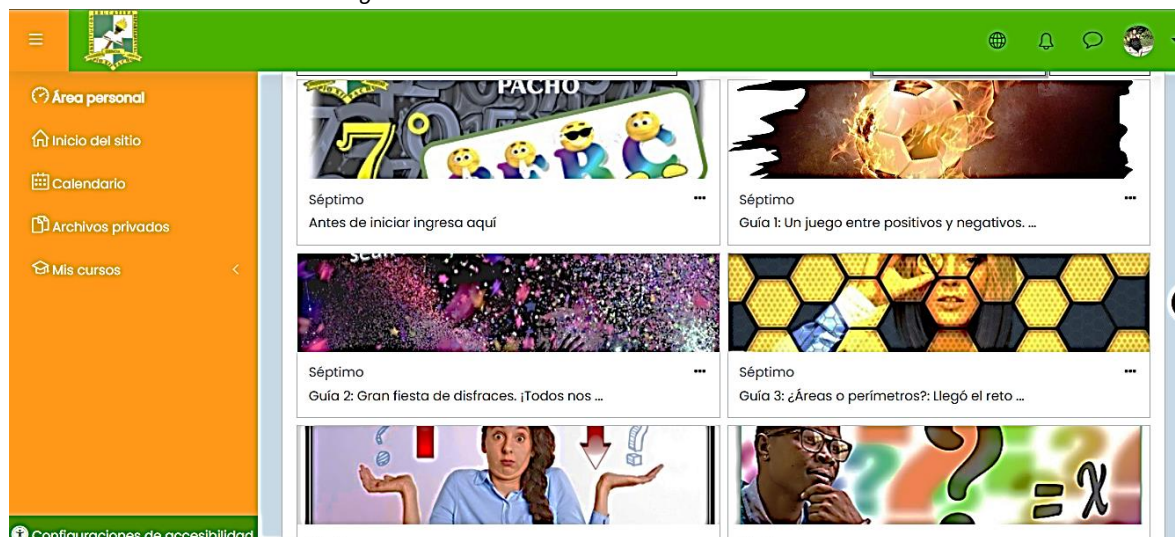
The Open-Source Moodle version 3.11 was chosen for the virtual classroom design. One of the reasons this platform was chosen is that it allows creating roles by adjusting them to the parts of the model (Albelda, 2013). Other capabilities that Moodle presents are that it is designed in a modular way, is very easily upgradeable from one version to another and has solid security (Domínguez, 2010).

For this, the hosting was acquired, and to access the resource, the address [www.elmatematicoenlinea.com](http://www.elmatematicoenlinea.com) was determined where the link of the virtual classroom was hosted. The virtual classroom can also be accessed directly through the address [www.elmatematicoenlinea.com/aulavirtual](http://www.elmatematicoenlinea.com/aulavirtual).

In this virtual classroom, seven courses were created, one course for learning how to manage the virtual classroom and another six that correspond to each learning guide. In this way, all students had access to the material of each direction independently. Figure 1 shows the appearance of the created virtual classroom.

**Figure 1**

*Virtual classroom interface designed in Moodle 3.11*



**Note:** Image is taken from the virtual classroom designed for research.

Source: self-made.

Each course was assigned an eye-catching label related to the corresponding tutorial's name. In addition, each one contains six sections where the various resources or tools for developing skills were placed. These sections were: What is your goal? Forum, guide, and annexes in pdf, book in pdf, explanatory videos, activities in mini-exams, and support material.

Thanks to the fact that the IED Pio XII is based on a face-to-face learning environment, the ICT immersion was carried out from the virtual learning environment called Blended-Learning. These environments are a hybrid between face-to-face education (face-to-face modality) and non-face-to-face education (virtual) (Bermúdez, 2016).

### 3. RESULTS

To analyze the information, three theoretical references were taken into account. The first concerns constructivism, personalized education, and the SERC. The second focused on autonomous learning and metacognitive skills. The third is alluding to ICT and the virtual classroom designed in Moodle.

#### **Constructivism, personalized education, and the SERC**

According to Tünnermann (2011) constructivism is defined as "the self-construction that is produced day by day as the result of the interactions of the product of the environment and the internal dispositions in cognitive, social and affective aspects" (p. 26). Therefore, not only should a look at the student's cognitive process be made, but also consider social constructions when interacting with their peers and teachers.

From the perspective of García (1993) personalized education "is the commitment to an educational process based on the person whose objective is to seek the perfection of the person through educational work" (p. 31). That is to say. It is to focus the educational process on the student to develop her full potential, where all her previous knowledge is considered. As mentioned, the FRE model is based on personalized education, aware of the respect that must be had for the learning rhythms of the students.

The previous idea makes the concept of autonomy emerge naturally within the model. This is understood as the ability of an individual to set standards for himself and, with them, manage his life from a vision of the person himself as well as the context in which he finds himself (Fontán, 2020).

As described, the analysis of the teaching-learning process from a personalized education falls on the meeting between teacher and student and the characteristics that this meeting must-have. In this sense, Pérez and Ahedo (2020) affirm that "personalized education takes place in an environment of a personal encounter between teacher and student" (p. 157). Therefore, this meeting implicitly must be measured in contrast to the quality of the time that the teacher gives in that meeting and the results obtained. The first study variable was derived from all this, which was called *personalized attention*.

#### **Autonomous learning and metacognitive skills**

According to Amaya (2017) autonomous learning is "a strategic learning in which the person makes key decisions about their learning" (p. 5). That is, the student responsibly assumes decisions in their educational process. The FRE model encourages autonomous learning through personal study plans in the IED Pio XII called learning guides. These guides are made up of the national curriculum and a metacognitive process-oriented to the progress of specific skills in each area.

The term metacognition is attributed to Flavell, and he defines it as "knowledge about knowledge, referring to three primary fields, the person, the task and the strategies" (Ugartetxea, 2014, p. 51). To make this concept more understandable, it can be considered as the existence of people capable of learning to think better through

the development of three metacognitive skills. Therefore, it is necessary from the perspectives of Moreno and Daza (2014) to define these skills, which together were called the learning process.

Planning is the first of the metacognitive skills, which seeks to predict and anticipate the consequences of one's actions. This includes understanding, knowledge of the situation to be resolved, the definition of objectives, strategies, and the development of an action plan. The second of the metacognitive skills is monitoring, understood as a control in the internal process of the student. It seeks to check the plan's progress, verify the process and identify errors. The last of the metacognitive skills is evaluation, in which results are contrasted according to the applied strategies (Moreno & Daza, 2014).

This learning process requires continuous support from the teacher, whose objective is to generate a habit of implementing the three metacognitive skills. This is why this learning process was the other variable of analysis of the research.

### **ICT: a virtual classroom designed in Moodle.**

Today's society shows generations in which electronic devices and the internet facilitate communication and the exchange of information between people. In addition to the above, it also eliminates the barriers of spatial and temporal type. The field of education is no stranger to the immersion of ICT. On the contrary, the different secretaries of education in the country generate new educational strategies by considering the characteristics of these technologies. The accessible, constant, and even continuous interaction with technological resources directly impacts the student's way of processing information and, therefore, on their learning processes (Guerrero & Flores, 2009).

In this sense, the FRE model and the institutions where it is implemented must also benefit from the technological tools that make it more efficient. Two key aspects are referred to in the model's relationship with virtuality. The first is the use of the Internet as an enhancer of learning processes, giving relevance to autonomous and personalized functions. The second is digital platforms that make it possible to monitor student learning processes individually. For example, the preceding allows personalized planning and monitoring of the achievement of goals (Colen & Medina, 2019).

### **Analysis of the information**

Figure 2 shows the information analysis in which three scenarios were determined. These correspond to the study of the information collected in the instruments about the moments of implementation of the virtual classroom. That is, a first scenario was carried out that was highlighted in red, where the analysis was presented for the information obtained before the implementation of the virtual classroom. The second scenario, highlighted in yellow, corresponds to the study of the information obtained during the performance and its comparison with the data from the first scenario. And the third scenario is shown in green, where the analysis of the information collected after implementing the virtual classroom was presented, additionally comparing it with the first scenario. This figure also shows the 46 different analysis processes carried out in the investigation. These are obtained by crossing the variables and their categories with the instruments used and the moment they were applied.

**Figure 2**

*The sequence of processes and relationship with the three scenarios*

Instrumentos		Variable: Proceso de Aprendizaje			Variable: Atención Personalizada			Convenciones						
		Planeación	Monitoreo	Evaluación	Resultados académicos	Fort. de la autonomía	Tiempo de atención							
Objetivos	Avance estudiantil				13	27			Procesos rojos Primer escenario					
	Estado actual				14	28								
	Cuantificación del aula virtual	24	25	26	29	30	31		Procesos amarillos Segundo escenario					
Subjetivos	Clase de matemáticas (estudiantes)	1	32	5	35	9	38	15	41	18	43	21	45	Procesos verdes Tercer escenario
	Clase de matemáticas (padres)	2	33	6	36	10	39	16	42	19	44	22	46	
	Clases IED Pio XII (analistas)	3		7		11		17		20		23		
	Habilidades metacognitivas	4	34	8	37	12	40							

Source: self made.

The results of these 46 processes were carried out by groups whose analysis is explained below, according to the moments of implementation.

Before implementation (highlighted in red color).

The results obtained from 1 to 12 reflect that the learning process is not a job entrenched in the institution. Parents, students, and analysts agree that students recognize the procedures necessary to do adequate planning, but they do not do it correctly. In addition, they do not carry out an appropriate follow-up of the proposed goals. Also, it can be affirmed that more than 60% of the analysts consider that the material they deliver is sufficient, but the students do not use it. The opinion of parents and analysts regarding the integrity of the progress that students communicate to their parents is contradictory. On the one hand, parents state in more than 70% that they are aware of the progress, the current state, and the fulfillment of their children's goals. But, on the other hand, more than 50% of analysts say that this is not true.

Also, there is evidence of fear regarding the security that a student should have about her knowledge before and after presenting a defense. This is ratified by the analysts' answers since more than 50% of the teachers assure that the students do not prepare adequately for their support.

Faced with the personalized attention variable, processes 13 to 23 showed that the percentage of support students is between 5% and 35% depending on the course. These values are considered very low by the institution. In addition, the results show that the institution and the analysts provide tools to strengthen autonomy. In agreement, parents with a percentage higher than 50% also consider their children autonomous. But, more than 80% of the students think that their autonomy is regular or low.

Although the school is located in a municipality and several of its students do not live in the urban area, it can be said that more than 70% have internet. But this resource is adequately used for their schooling for less than



60%. This technology is used more to watch videos on platforms such as YouTube and communicate with the analyst via WhatsApp, but it is rarely used in other educational resources.

The information shows that, for the analysts, the lack of time is a factor that prevents excellent work performance, and therefore the follow-up processes of the students are complex. This confirms the problematic situation that was raised in the investigation. Therefore, Álvarez and López (2015) assert that personalized education is the right option for teaching-learning, as long as it allows a close relationship between the process members.

*During deployment (highlighted in yellow).*

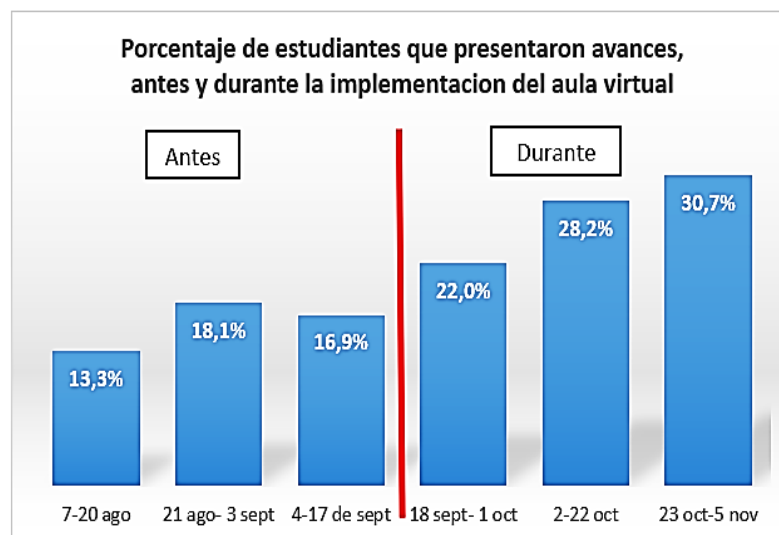
According to procedures 24 to 26, the learning process exposes a gradual increase in the management of the tools proposed in the virtual classroom. This increase was reflected mainly in the visits to the explanation videos and the mini-exam activities. Compared to the other metacognitive skills, a low percentage of work related to planning activities was evidenced. The evaluation process showed the highest rate among the three skills analyzed.

The results obtained in processes 27 to 31 show that the personalized attention variable gradually presents improvements in each category. One of them is highlighted in figure 3, where the students' progress before the implementation is compared with the results obtained during the use of the virtual classroom. Two aspects stand out when investigating the factors that intervene in this improvement. On the one hand, the students state that the virtual classroom allowed them to have the analyst's explanations when they needed it. On the other hand, the test evaluations carried out in the technological resource contributed to the strengthening of security at the time of support.

On the other hand, the activities during the class naturally diversified since, in addition to the six tablets arranged in the room, the students began to carry and use their cell phones and tablets. This generated teamwork with those students who did not have these materials. Furthermore, the situation led to the analyst dedicating more time to carry out the support and feedback. As a consequence, the attention time to each student became more profitable.

**Figure 3**

*Comparison of the academic results category.*

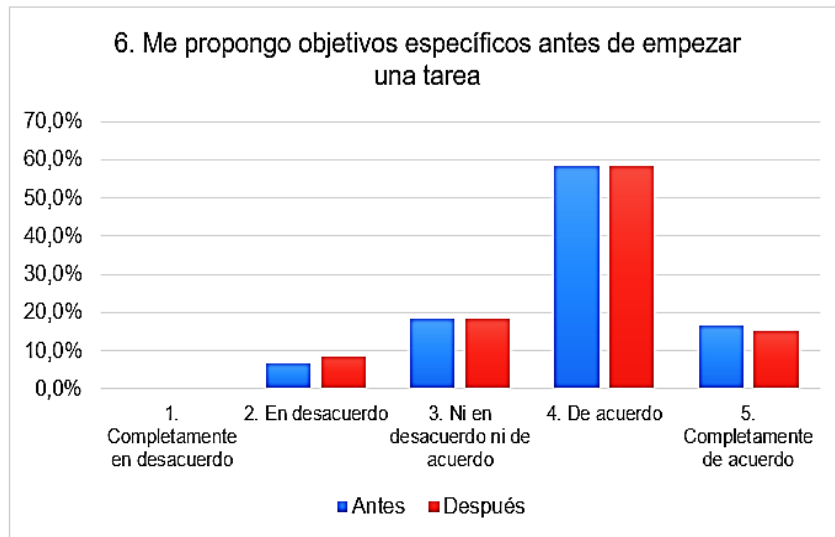


After deployment (highlighted in green color).

From the results of processes 32 to 40, the learning process declared two relevant situations. The first one showed a null variation compared to the planning ability, which is reflected in figure 4. This confirms the little relevance when planning activities with the virtual classroom and without it.

**Figure 4**

Comparison of the planning category.

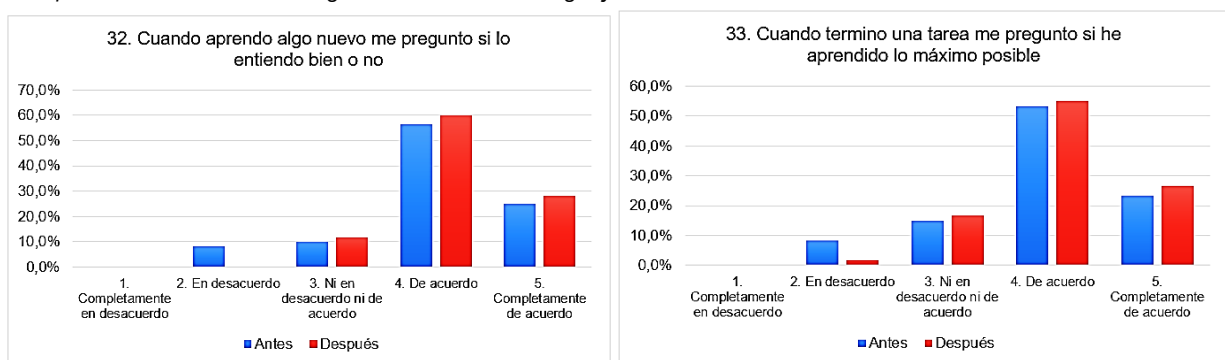


Source: self-made.

Unlike previous results, monitoring and evaluation showed consequences for progress for both students and parents. Figure 5 compares these two categories according to the students' responses. It shows improvement in the appropriation of these two skills.

**Figure 5**

Comparison of the monitoring and evaluation category.



Note: Monitoring category on the left. Evaluation category on the right.

Source: self-made.

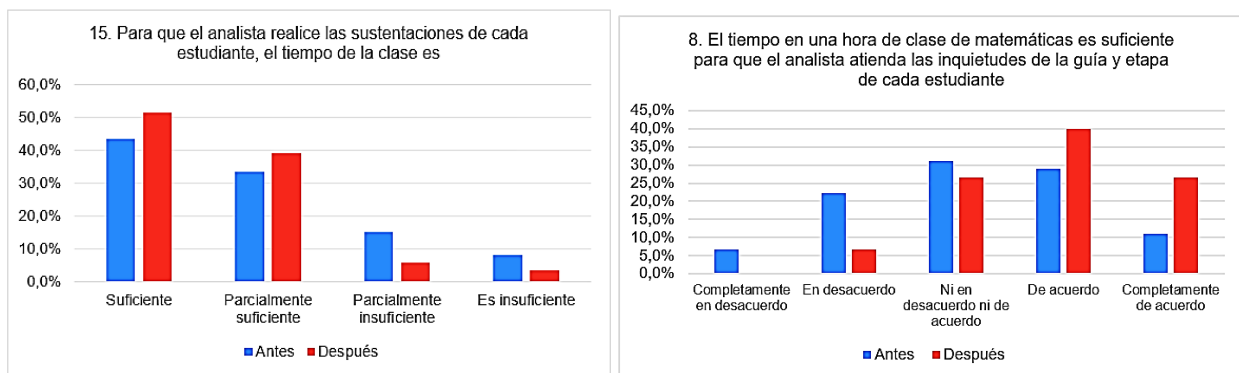
The results of processes 41 to 46, which deal with personalized attention, reveal the improvement in the appreciation of parents and students. They perceive progress against autonomy since they see the virtual

classroom as a reliable resource. Therefore, parents could supervise extracurricular work from each of the homes.

Graph 6 presents the analysis of two questions about attention time, where the answers' favorability is evident. This category was considered the most significant increase compared to the others. From the above, it can be inferred that the virtual classroom promoted better use of the time resource.

**Figure 6**

*Comparative attention time category*



Source: self-made.

Finally, the results obtained in the two variables were compared to observe their relationship. Against this contrast, the following statements are made:

At the end of the second scenario, it was possible to affirm that, of the 140 students, 83 students accessed the virtual classroom. Of these, only 28 students carried out all the activities corresponding to the guide they were found. In addition, 11 students carried out monitoring and evaluation activities. Still, they did not carry out the planning activities, and the remaining 44 students only accessed the virtual classroom to work on the evaluation activities. In this way, we can deduce that 57 students did not enter the virtual classroom.

The approval rates of the students according to work done in the virtual classroom were as follows. Of the 28 students who completed the process in the virtual classroom, 24 students achieved full approval of the educational process, corresponding to 85.7%. Of the 11 students who dedicated their time to monitoring and evaluation activities, seven obtained satisfactory permission, corresponding to 63.6%. Of the 44 students who used the virtual classroom exclusively for evaluation activities, 11 students passed, corresponding to 25%. Finally, of the 57 students who did not enter the virtual classroom, only five students satisfactorily passed the stages of the guide in which they were, corresponding to 8.8%. From the above, it can be inferred that developing the learning process and its three metacognitive skills through the virtual classroom was directly related to the academic results obtained.

#### 4. DISCUSSION

Yamila (2016) maintains that the academic tasks that are offered in the context and that involve the subject in planning, control, and evaluation processes must respond strategically on what needs to be done, how it is going to be done, with what goals and resources. These strategies were reflected in the virtual classroom through the sections of each course and showed positive results in two of the three metacognitive skills. In addition, the virtual classroom allowed academic work, resources, and strategies to converge in a single resource. This permitted an alignment between the different members of the academic community.

The findings found by Soler and Rojas (2014) indicate that virtual learning environments encourage an approach to learn mathematics since ICTs facilitate representation and simulation. These mathematical skills strengthened the learning process in the virtual classroom since the students reinforced their self-confidence and thus strengthened their autonomy. In addition, the results favor both face-to-face and virtual work through the implemented classroom since it allows home education to be balanced between digital and non-digital resources. Additionally, it lightens teachers' workload and supports parents to make students more independent. Characteristics that Forbes magazine (2020) highlights when working under the mixed educational modality in which this research was carried out. The preceding reinforces what was concluded by Ángel and Patiño (2019), who affirm that teachers and managers significantly accept ICT practices in educational settings, as long as they are done for specific purposes.

The results obtained that show a positive impact on the learning of mathematics by the SERC guidelines are mainly due to the characteristics of Moodle. For example, Reyes (2010) deduces that thanks to this platform, students can enjoy greater autonomy in learning and studying rhythms since it adapts to the concept of doing things when they feel like it. These results are parallel to those evidenced by Perochena and Coria (2017), where they show the relationship between the person's uniqueness, within a personalized education, with digital processes.

It is necessary to recognize that the students in whom the study was carried out need more time to adapt to educational platforms such as Moodle. Therefore, it is unavoidable to reinforce ICT management and propose strategies to strengthen the autonomy process in a virtual environment.

This research presented two relevant biases against the results presented. The first bias is related to the time intervals in which the academic results were quantified. The data on the virtual classroom implementation was collected in 3 periods of 15 days each, but the second period was fragmented due to the week of school break. During this week, the virtual classroom continued operation and allowed students to carry out autonomous work in it. Consequently, this period showed the most significant increase in the presentation of progress. Therefore, it can be inferred that the greater the time of interaction of the students with the virtual classroom, the more significant the improvement they show.

The second bias is due to the Covid-19 pandemic since the study is carried out. The institutional directives implemented from the first week of August 2021 the gradual and progressive return of students. The recovery began with a small number of students. At the end of the implementation period of the virtual classroom, only 40% attendance was reached. The instructional design of the virtual classroom was supported for a mixed modality, but more than 50% of the student body did it virtually. This difficulty is viewed by Rey (2020) as an

opportunity for teachers and students to see the importance of ICT in education since it should not only serve in times of quarantine but for the rest of life.

The most significant limitation was presented with several students who did not have the internet resource at home or mobile phones and who had to wait to be scheduled in the progressive return that the institution established. This led to them seeing little benefit from the resources and activities available in the classroom since they could only access them from school with limited time. In this way, inequity was generated in the conditions for the entire study population.

It is recommended to carry out other similar studies within official educational institutions that implement the SERC, but with a longer implementation time than in this research. This will allow corroborating the results more frequently. In addition, it is invited to strengthen the metacognitive planning ability through other activities within the classroom, different from an open forum as was carried out in this research.

## 5. CONCLUSIONS

The results obtained in this research, referring to the development of metacognitive skills through the virtual classroom, show a progressive increase in monitoring and evaluation. The preceding illustrates a degree of the positive impact of the virtual classroom on the learning process of the students surveyed. On the contrary, the planning ability did not show any variation.

Thanks to the diagnosis made with students, parents, and analysts, a holistic view of the problem situation presented was obtained. Furthermore, the analysis confirmed the institutional difficulties that affect the educational process in other subjects and, therefore, other school analysts.

The implemented virtual classroom makes the SERC more efficient. It was constituted in the powerful means to access and manage the relevant information for the learning of seventh-grade mathematics in the IED Pio XII. In addition, it was the apparent instrument in the individualized follow-up of the academic results of each student.

The progressive increase in the academic results of seventh-grade students in mathematics demonstrates the growth of the learning process. These results, contrasted with the visualization of the parents against their children's autonomy, confirm the virtual classroom's usefulness as an incident factor in the strengthening of the institutional pedagogical model.

The design of the virtual classroom in mathematics that adjusts to the requirements of the SERC allowed balancing personalized education between digital resources and the development of a face-to-face reflective environment. In this way, the analyst's multitasking was relieved, and the degree of independence of the students was strengthened.

As a suggestion, the possibility of linking the results obtained in this research with other related studies is proposed to compare and deepen the axes on which this work is based.

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**Rol de los autores / Authors Roles:**

No aplica.

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**Aspectos éticos / legales; Ethics / legals:**

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