[Cierre de edición el 30 de abril del 2026]

https://doi.org/10.15359/ree.30-1.20132
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High School Students' Perceptions of Flexible Classrooms: An Analysis of Attention, Motivation, Interaction, and Comprehension

Percepciones de estudiantes de preparatoria sobre las aulas flexibles: Un análisis de la atención, motivación, interacción y comprensión

Percepções de estudantes do ensino médio sobre salas de aula flexíveis: Uma análise da atenção, motivação, interação e compreensão

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Recibido • Received • Recebido: 13 / 06 / 2024
Corregido • Revised • Revisado: 29 / 01 / 2026
Aceptado • Accepted • Aprovado: 04 / 03 / 2026

Abstract

Introduction. Flexible classroom spaces, characterized by movable tables and chairs that can be easily rearranged into different layouts, facilitate the effective implementation of active learning. However, there is a scarcity of studies examining the impact of flexible classrooms, particularly within high school settings and the Latin American context. **Objective.** This study aimed to examine high school students' perceptions of the influence of flexible classrooms on their attention, interaction, motivation, and comprehension. **Method.** A survey was conducted with 98 students from a high school in the metropolitan area of Monterrey who attended courses in flexible classrooms. **Results.** The results indicate that students have more positive perceptions of interaction and motivation as learning components influenced by flexible classrooms, compared to their perceptions of attention

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and comprehension. Additionally, it was found that students in more advanced semesters expressed less positive perceptions of how flexible classrooms enhance their comprehension. **Conclusion.** High school students perceive flexible classrooms as fostering peer interaction, which in turn contributes to an increase in their learning motivation.

Keywords: Learning space; classroom furniture; high school; attention; motivation; interaction; comprehension.
SDG: SDG 4; quality education; learning environments.

Resumen
Introducción. Los espacios de las aulas flexibles, caracterizados por mesas y sillas móviles que se pueden reorganizar fácilmente en diferentes diseños, facilitan la implementación efectiva del aprendizaje activo. Sin embargo, hay escasez de estudios de impacto sobre las aulas flexibles, particularmente en entornos de secundaria y en el contexto latinoamericano. **Objetivo.** Este estudio tuvo como objetivo explorar las percepciones de la población de estudiantes de secundaria sobre la influencia de las aulas flexibles en su atención, interacción, motivación y comprensión. **Método.** Se aplicó una encuesta a 98 estudiantes de una escuela secundaria del área metropolitana de Monterrey que asistieron a cursos en aulas flexibles. **Resultados.** Los resultados indican que las personas estudiantes tienen una percepción más positiva de la interacción y la motivación como elementos de aprendizaje influenciados por las aulas flexibles, en comparación con su atención y comprensión. Además, se encontró que el grupo de estudiantes de semestres más avanzados tenían una percepción menos positiva de cómo las aulas flexibles promueven su comprensión. **Conclusión.** Las personas estudiantes de preparatoria perciben que las aulas flexibles fomentan la interacción entre sí, lo que a su vez les proporciona motivación en su aprendizaje.

Palabras claves: Espacio de aprendizaje; mobiliario del aula; preparatoria; atención; motivación; interacción; comprensión.
ODS: ODS 4; educación de calidad; entornos de aprendizaje.

Resumo
Introdução. Os espaços de salas de aula flexíveis, caracterizados por mesas e cadeiras móveis que podem ser facilmente reorganizadas em múltiplas disposições, facilitam a implementação eficaz da aprendizagem ativa. No entanto, há escassez de estudos de impacto sobre salas de aula flexíveis, especialmente no ensino médio e no contexto latino-americano. **Objetivo.** Este estudo teve como objetivo analisar as percepções de estudantes do ensino médio sobre a influência de salas de aula flexíveis em sua atenção, interação, motivação e compreensão. **Método.** Aplicou-se um questionário a 98 estudantes de uma escola de ensino médio da região metropolitana de Monterrey que frequentavam cursos em salas de aula flexíveis. **Resultados.** Os resultados indicam que os estudantes têm uma percepção mais positiva da interação e da motivação como elementos de aprendizagem influenciados pelas salas de aula flexíveis, em comparação com a sua atenção e compreensão. Além disso, descobriu-se que os estudantes dos semestres mais avançados têm uma percepção menos positiva de como as salas de aula flexíveis promovem a sua compreensão. **Conclusão.** Os estudantes do ensino médio percebem que salas de aula flexíveis estimulam a interação entre os alunos, o que por sua vez lhes proporciona motivação no aprendizado.

Palavras-chave: Espaço de aprendizagem; mobiliário de sala de aula; ensino médio; atenção; motivação; interação; compreensão.
ODS: ODS 4; educação de qualidade; ambientes de aprendizagem.

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Introduction

In the 21st century, learning spaces have become the most important infrastructure requirement for the teaching-learning of students (Uduku, 2015). A 21st century learning classroom is flexible to adapt to the needs and potentials of all students, and foster a personalized and inclusive environment (Joint Information Systems Committee [JISC], 2009). Space is a fundamental element in the teaching-learning process and, therefore, must be carefully planned according to the needs of the group and the methodological opportunities (Laorden Gutiérrez & Pérez López, 2002).

Although learning spaces are a relatively new topic of interest for the educational community, the number of researches that demonstrate that the furniture in a classroom is a factor that positively influences the learning process has been increasing. Studies show that a flexible classroom, furnished with chairs of different designs that can be arranged at the will of the students, increases student interaction and learning, compared to learning within a traditional classroom (Adedokun et al., 2017; Beichner et al., 2007). Furthermore, it has been identified that active learning spaces significantly increase the participation and even the interaction of teachers with the group (Talbert & Mor-Avi, 2019).

Flexible classrooms and their influence on learning

Researchers emphasize the importance of selecting and managing classroom materials to ensure they adequately reinforce the diverse activities students undertake (Ozkan Bekiroglu et al., 2022). The ways of arranging seating in the classroom have different effects on the learning process (Adedokun, et al., 2017). Sitting in rows can enhance behavior in carrying out activities when students sit individually, while asking questions and brainstorming promotes greater interaction and communication between students when they are seated in a semicircle (Adedokun et al., 2017).

The elements that make up an educational environment are the architectural facilities and the environment, which relate to each other since they reinforce and determine student learning. Likewise, the learning environment has a direct relationship with the colors, objects, shapes, smell, sounds and people in the room, in addition to the distribution of furniture, walls, materials, the way of organization and decoration (Castro Pérez & Morales Ramírez, 2015).

Furthermore, the elements that make up an educational environment are linked to: safe, ethical, clean, comfortable, bright spaces, adapted to the needs of each student, with a union of colors, are intercessors of thoughts and social relationships; free, open, respectful and diverse materials. Also, in the classroom there is respectful, horizontal and dialogic communication that respects the styles, intelligence and learning rhythms of each student (Castro Pérez & Morales Ramírez, 2015).

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Flexible classrooms, where tables and chairs can be easily moved and rearranged into different layouts, support both active and traditional classroom preferences. The adaptable configuration of these learning environments allows for transitions between traditional row seating and collaborative clusters, depending on the specific pedagogical requirements of the lesson (Bork et al., 2018).

Moreover, flexible classroom spaces, equipped with portable seating and desks, allow teachers to adopt active methodologies more efficiently than conventional classrooms. This spatial mobility grants instructors the freedom to interact closely with learners and promotes peer-to-peer discussion through modular group configurations. Furthermore, the adaptability of the furniture ensures that the room can still be oriented for lecture-based instruction when the lesson requires a more traditional approach (Johnson et al., 2019).

These learning spaces involve properties and designs specifically assigned to encourage active student learning. Generally, these classrooms involve furniture that can be easily modified and changed shape as many times as necessary, in addition to having seats that position students in small groups, blackboards, and technological instruments that allow students to easily access information (Talbert & Mor-Avi, 2019).

Modular educational settings are structured to promote cooperative work and encourages students to take ownership of their education through a collaborative partnership with their educators (McCullough, 2009; Trask et al., 2023). Furniture is capable of multiple reconfigurations to facilitate teaching and learning (Attai et al., 2021). Thus, students experience and describe learning in flexible classrooms as less structured (Trask et al., 2023). It is striking that, according to the study by Chan et al. (2023), students value higher the advantages of flexible classrooms as "save time (group discussion can waste time)" and "allow more time for questions and answers" in comparison with teachers.

Although Demir-Yildiz & Tatik (2019) did not find significant differences in learning between a flexible classroom and a traditional one, when using experimental and control groups, they found that the performance evaluations of both groups were high. Moreover, observations from both student cohorts suggested that the spatial setting impacts educational outcomes by enhancing students' motivation and enthusiasm.

In their observational study, Johnson et al. (2018) pointed out that two courses out of seven observed stood out in the number of active learning activities applied in the flexible classrooms: a first-year course focused on computer science and a mechanical engineering dynamics course. They also identified that instructors used the front screen and front whiteboard in 60% of the class meetings observed, being the furniture they used the most. Additionally, classroom observations show that teachers who participated in flexible classroom training and who were not yet using active learning employed a new strategy once or twice, but needed more training to feel comfortable using it consistently in their teaching.

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Influence of learning spaces on attention

The physical environment significantly impacts students' attention, behavior, and engagement (Fehlandt, 2017). According to Hernandez (2023), elements such as movement, speech, and the classroom's physical environment influence student learning. Ozkan Bekiroglu et al. (2022) emphasize that the ease of movement in flexible classrooms facilitates more agile transitions between learning activities. Building on these insights, Absi et al. (2018) implemented strategies to enhance teaching by incorporating active tutoring with modular classroom furniture and promoting learning through game-based pedagogy.

Llorens-Gámez et al. (2022), in a systematic literature review, highlight that the design of learning spaces significantly impacts memory and attention. Key factors include the shape and geometry of the space, its distribution and context, color and texture, dimensions such as height and width, the sense of enclosure, transitions and circulation, as well as environmental aspects like light, sound, and temperature.

Classrooms have traditionally maintained a uniform square shape with rigid, forward-facing furniture, often neglecting the needs and engagement of students. This immobility has positioned teachers as the primary focal point, dictating the attention of the room. Such an educational configuration has permeated public school systems throughout history, remaining relatively unchanged (Cornell, 2002). These spaces have been designed under the educational approach of passive learning (Baker, 2012), characterized by the transmission of knowledge through methods such as recitation and repetition (Basye et al., 2015).

Influence of learning spaces on motivation

Motivation is a predominant factor in students as it depends on how much success they are going to achieve in acquiring knowledge in any learning space (Tarón Dunoyer et al., 2020; Törmänen et al., 2025). An adequate classroom environment facilitates greater motivation in students, and makes the learning process fluid and satisfactory (Tarón Dunoyer et al., 2020). Additionally, student engagement increases in flexible and active classrooms (Hernandez 2023).

When using flexible classrooms, students describe experiencing greater motivation, a more constructive disposition toward their learning, and a more favorable mindset regarding the instructional process. Such engagement manifests as both self-directed motivation and the positive influence within peer groups (Kariippanon et al., 2018). Also, students who experience the use of flexible classrooms report greater satisfaction with the learning environment than their peers in traditional classrooms (Attai et al., 2021).

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Influence of learning spaces on interaction

Interaction within the classroom encompasses the exchange of communications, actions, attitudes between the students themselves, as well as between the students and the teacher (Arias Sandoval, 2009). The flexible classroom encourages better and more frequent interaction between student-teachers and student-peers (Johnson et al., 2018; Picciano, 2002). The exchange of ideas that arises from interactions such as asking a partner, discussing different opinions or even complementing an idea together are basic activities that promote the acquisition of knowledge (Arias Sandoval, 2009).

Flexible classrooms enable teachers to allocate more time to active learning and reduce the time spent on instructor-directed examples. In a study by Adedokun et al. (2017), students reported that flexible classrooms were significantly more effective compared to traditional classrooms. Specifically, students noted that flexible classrooms were better for facilitating interactions with teachers, more comfortable, better for peer interactions, more effective for knowledge acquisition, and increased their motivation to learn.

Influence of learning spaces on understanding

According to Absi et al. (2018), flexible classrooms enhance understanding through a problem-based approach, where students work in groups, discuss problems, and seek solutions within set time constraints or with available assistance. However, studies on the impact of flexible classrooms on learning outcomes are not entirely conclusive. Talbert and Mor-Avi (2019) found that active learning spaces significantly enhance learning. In contrast, Demir-Yildiz and Tatik (2019) did not observe significant differences in learning outcomes between experimental groups using flexible classrooms and control groups using traditional classrooms.

Research objective

Although there are few impact studies of flexible classrooms (Attai et al., 2021), even fewer studies have focused on high school and the Latin American context. By investigating how students perceive their own learning through the dimensions of attention, motivation, interaction and understanding, a broader vision of the benefits of these innovative learning spaces can be obtained regarding the educational needs they address.

The purpose of this research is to describe the perceptions of high school students about their attention, motivation, interaction and understanding, based on the use of the furniture that exists within the classroom. Thus, the following research question was posed: What is the perceived influence of flexible classrooms on the attention, motivation, interaction and understanding of high school students?

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Furthermore, to analyze the differences in perception based on the students' academic semester, the following hypotheses were formulated:

Research Hypothesis (H_i): There is a significant relationship between the academic semester and students' perception of how flexible classrooms influence their attention, motivation, interaction, and understanding.

Null Hypothesis (H_0): There is no statistically significant relationship between the students' academic semester and their perception of how flexible classrooms impact their attention, motivation, interaction, or understanding.

Method

This study employs a quantitative, non-experimental, and cross-sectional design, which is highly effective for identifying patterns and establishing statistical relationships within educational environments. This consisted of a survey applied to a previously selected sample of a group of 98 students from a private high school in the metropolitan area of Monterrey, Mexico. The sample comprised 41 male and 57 female students, aged 15 to 18, who have completed one or more courses in a classroom with mobile furniture. Students in all high school grades take at least one class in a flexible classroom during the school year.

The flexible classrooms were adequate with mobile chairs and work tables, as well as technological resources such as screens and projectors (see Figure 1). It is recognized that there are many ways to design a flexible classroom, depending on the resources and/or needs of the educational institution, so this is a factor to take into account when analyzing the research results.

Figure 1: Flexible classroom of the high school in which the study was conducted

Note: Own elaboration.

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The instrument used was developed by Ramos Coronado et al. (In press), consisted of 14 items focused on students' perception of the influence of flexible classrooms on their attention, motivation, interaction and understanding, as elements that describe their learning process in these learning spaces (see Table 1).

Table 1: Instrument to measure the perception of learning in flexible classrooms

Subscale	Items	Description
Attention	1-4	It refers to the disposition of the senses towards the activities of the class.
Motivation	5-7	It refers to the positive attitude that is favored in an attractive environment for learning.
Interaction	8-12	It refers to communication with peers and the teacher.
Understanding	13-14	It refers to a level of learning higher than memorization.

Note: Own elaboration.

This survey was sent to the participating students via a Google Forms link and they were asked for their informed consent for the use of the data collected. These data were downloaded to be analyzed with the SPSS statistical software, to perform the descriptive and inferential analyzes presented below in this study. Normality was not identified in the learning subscales, so it was decided to use non-parametric tests. Spearman's Rho test was applied to relate the subscales of the learning process with the semester that the students are studying. In addition, the Mann-Whitney U test was performed to relate the aforementioned learning variables with the gender of the students.

Results

Descriptive analysis

Figure 2 illustrates that students perceive attention as the element of the learning process least benefited by the use of flexible classrooms. This finding prompts questions regarding the teaching-learning strategies employed. Flexible classrooms are not designed for one-way communication typical of traditional lectures; instead, they are intended to promote collaborative learning. Additionally, while not statistically significant, understanding was also rated lower by students when considering the benefits of flexible classrooms, with higher ratings given to motivation and interaction.

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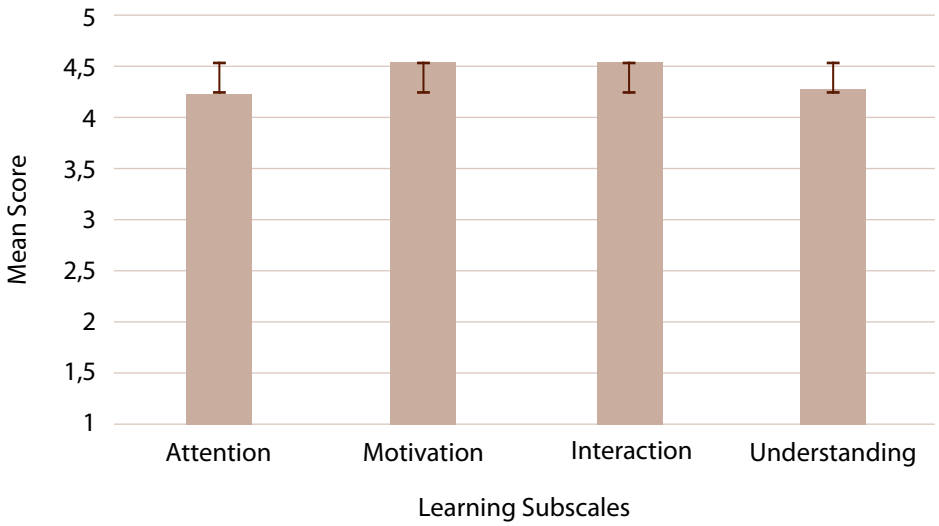
Figure 2: Comparison of learning perception subscales



Note: Own elaboration.

Table 2 presents the mean and standard deviation of students' perceptions regarding attention, motivation, and interaction in flexible classrooms. Notably, the statement "the flexible classroom facilitates the exchange of ideas and team projects" received the highest score (M=4,70, SD=0,724) among all evaluated items. Following this, the statement "the flexible classroom favors a change in attitude" scored highly as well (M=4,59, SD=0,848). The third highest average score was for the statement "the flexible classroom favors my interest in the class" (M=4,56, SD=0,838). It is important to note that each of these top-rated items assesses a different aspect of the influence of flexible classrooms: interaction, attention, and motivation, respectively.

The three items that received the lowest scores pertain to the influence of flexible classrooms on attention. The lowest-scoring item was "the flexible classroom prevents me from being distracted in the classroom" (M=3,99, SD=1,231). This was followed by "the flexible classroom allows you to organize, relate, and remember the contents of the class in a more meaningful way" (M=4,14, SD=1,045), and "the flexible classroom helps me keep my attention in class" (M=4,18, SD=1,097). Despite being the lowest scores among all items, these ratings are still above the midpoint of the scale (2,5), indicating that while these aspects are not perceived as the greatest positive influences, they are not viewed negatively either.

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Table 2: Perception of high school students on the influence of the flexible classroom on their learning

Item	Mean	Std. Dev.
1. The flexible classroom keeps me from getting distracted in the classroom.	3,99**	1,231
2. Flexible classroom furniture positively influences focusing my attention.	4,27	1,108
3. The flexible classroom helps me keep my attention in class.	4,18**	1,097
4. The flexible classroom allows you to explore the contents of the class in a more active and practical way.	4,43	0,876
Attention	**4,22**	**1,078**
5. The flexible classroom favors my interest in the class.	4,56*	0,838
6. The flexible classroom influences presenting a favorable attitude towards learning.	4,43	0,956
7. The flexible classroom favors a change in attitude.	4,59*	0,848
Motivation	**4,53**	**0,880**
8. The flexible classroom facilitates the exchange of ideas and team projects.	4,70*	0,724
9. The flexible classroom has a positive impact on communication with my teacher.	4,30	0,838
10. The flexible classroom encourages participation during class.	4,54	0,827
11. The flexible classroom improves my involvement in class.	4,55	0,814
12. The flexible classroom provides the possibility of choosing the best seat to promote my academic performance.	4,5	0,944
Interaction	**4,52**	**0,829**
13. The flexible classroom allows you to organize, relate and remember the contents of the class in a more meaningful way.	4,14**	1,045
14. The flexible classroom makes it easy to create associations between class topics.	4,34	1,030
Understanding	**4,28**	**0,960**
Learning in Flexible Classrooms	**4,40**	**0,796**

*Higher means, **Lower means.
Note: Own elaboration.

Inferential analysis

A correlational study was conducted to examine the relationship between the items on the instrument and the semester high school students were in. Significant negative correlations were found in the items of the Comprehension subscale (see Table 3). Specifically, "The flexible

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classroom allows you to organize, relate, and remember the contents of the class in a more meaningful way" (r=-0,225, p=0,026) and "The flexible classroom facilitates the creation of associations between class topics" (r=-0,332, p=0,001). These findings indicate that students in the earlier semesters of high school are more likely to perceive that the flexible classroom enhances their understanding, compared to students in the later semesters, who have a lesser perception of this benefit.

Additionally, students in the later semesters assigned lower values to the perception that the flexible classroom promotes a favorable attitude towards learning (r=-0,227, p=0,026) and that it prevents them from being distracted in class (r=-0,267, p=0,008).

Table 3: Correlation between the semester taken and learning with the use of flexible classrooms

Item	Spearman's Rho	P value
1. The flexible classroom keeps me from getting distracted in the classroom.	-0,267	0,008**
2. Flexible classroom furniture positively influences focusing my attention.	-0,148	0,147
3. The flexible classroom helps me keep my attention in class.	-0,166	0,103
4. The flexible classroom allows you to explore the contents of the class in a more active and practical way.	-0,178	0,080
5. The flexible classroom favors my interest in the class.	-0,081	0,427
6. The flexible classroom influences presenting a favorable attitude towards learning.	-0,227	0,026*
7. The flexible classroom favors a change in attitude.	-0,020	0,847
8. The flexible classroom facilitates the exchange of ideas and team projects.	-0,045	0,659
9. The flexible classroom has a positive impact on communication with my teacher.	-0,134	0,187
10. The flexible classroom encourages participation during class.	-0,124	0,225
11. The flexible classroom improves my involvement in class.	-0,105	0,305
12. The flexible classroom provides the possibility of choosing the best seat to promote my academic performance.	-0,181	0,075
13. The flexible classroom allows you to organize, relate and remember the contents of the class in a more meaningful way.	-0,225	0,026*
14. The flexible classroom makes it easy to create associations between class topics.	-0,332	< 0,001***

***p value lower than 0.001. ** p value lower than 0.01. * p value lower than 0.05.
Note: Own elaboration.

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Finally, it should be noted that a comparison was made between perceived influence and the gender of the respondents. No significant mean differences were identified between these two variables.

Discussion

Based on the results obtained with this research, we can affirm that high school students identify that flexible classrooms have a positive influence on their motivation and interaction, while to a lesser extent they perceive that their attention and understanding benefit. On the other hand, the findings highlight a significant negative correlation between the semester taken and students' perception of understanding when using a flexible classroom. That is, the positive perception of the influence of flexible classrooms on their understanding decreases in students in the last semesters of high school.

This phenomenon may be attributed to the increased cognitive load and abstraction inherent in senior-level curricula, where students might perceive the open and active nature of flexible classrooms as a hindrance to deep concentration (Llorens-Gámez et al. (2022) unless pedagogical strategies are explicitly adapted to high-stakes academic tasks (Trask et al., 2023). Consequently, these results reinforce the idea that furniture alone does not enhance understanding; rather, it requires a deliberate alignment between spatial design and the more rigorous methodological needs of advanced courses (Ozkan Bekiroglu et al., 2022).

It is relevant that motivation and interaction have been the learning elements best perceived by students when evaluating the use of flexible classrooms. Since previous studies have found a very significant positive relationship between connection and motivation to share knowledge (Kim et al., 2015). Furthermore, motivated students can foster motivation in their classmates through collaboration (Saab et al., 2009).

Among the results of this study, it also stands out that attention has been less perceived by students as an enhancing element for learning through the use of flexible classrooms. It should be noted that studies on flexible classrooms point out the benefits of these spaces to generate active learning (Absi et al., 2018; Adedokun et al., 2017; Johnson et al., 2019; Talbert & Mor-Avi, 2019). However, the aforementioned result may be due to the fact that teachers have not taken advantage of the potential of classrooms to promote active learning.

On the other hand, some authors relate movement and play to the benefits of flexible classrooms that influence students' attention (Absi et al., 2018; Fehlandt, 2017; Hernandez, 2023). These types of activities could have been less present in the implementations carried out in high school. However, another explanation for the lower perception that students give to attention through the use of flexible classrooms may be due to the conceptions of the students themselves, that attention is only exercised by being attentive in unidirectional communication with the teacher (Baker, 2012).

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Conclusions

The findings presented here allow greater clarity about the influence of flexible classrooms on the learning process. It is highlighted that flexible classrooms encourage interaction between students, which in turn provides them with motivation in their learning. This motivation is favored through the use of collaborative strategies. On the other hand, it is understood that students attribute learning achievement to flexible classrooms to a lesser extent, since learning is a complex process that is not explained solely by environmental factors.

Furthermore, these findings support, in addition to a vast literature, that the incorporation of innovative resources and materials does not produce better learning results by themselves, but rather that learning must be understood from a holistic perspective that integrates the educational needs of the students. students and the understanding of the pedagogical strategies and methodologies that give meaning to educational practices.

Finally, it should be noted that students in more advanced semesters find less benefit from flexible classrooms for their understanding for learning. Flexible classroom studies that measure the learning strategies implemented and their relationship with the learning process are relevant. Studies that address teacher training in the use of flexible classrooms are also recommended, since this is found to be a determining factor so that the use of resources is optimized according to the benefits mentioned here.

Contribuciones

The authors declare they have contributed in the following roles: **F. M.** contributed to the writing of the article and the development of the research. **B. H.** contributed to the writing of the article and the development of the research. **J.E.G.** contributed to the writing of the article; the management of the research process and the development of the research.

Datos y material complementario

Este artículo tiene disponible material complementario:
Preprint: http://dx.doi.org/10.13140/RG.2.2.22483.39203

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