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Percepciones del profesorado sobre la implementación de metodologías centradas en el alumnado a partir de la formación en Entornos Innovadores de Aprendizaje

Teachers' perceptions on the effect of in-service training in Innovative Learning Environments on the implementation of student-centred approaches

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RESUMEN

Este artículo tiene como objetivo conocer la percepción del profesorado con relación al uso de metodologías centradas en el alumnado tras haber realizado una formación en la temática de los Entornos Innovadores de Aprendizaje. Para ello, se creó un cuestionario que se envió al profesorado participante en formaciones de esta temática en la Comunidad Valenciana, al menos tres meses después de la finalización de la misma. Se analizaron 152 respuestas obtenidas, extrayendo el porcentaje de docentes que indican que en efecto aplicaron en mayor medida, después de la formación recibida, metodologías centradas en el alumnado donde el alumnado debe ser responsable de su aprendizaje (55,3%, f=84). Se constata un efecto significativo de las características de la formación recibida en la posterior aplicabilidad, concretamente el efecto de recibir formaciones variadas (p=.003), de más de 20 horas (p=.008) y que incluyen una visita a un espacio de aprendizaje innovador (p=.002). En segundo lugar, se recopiló información sobre las metodologías o estrategias que se empleaban, obteniendo los resultados más altos para las metodologías de Aprendizaje Basado en Proyectos y la Gamificación y los más bajos para el Design Thinking o los Paisajes de Aprendizaje. Estos datos varían

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ligeramente al analizarlos en función de la etapa educativa donde imparten clase. Se realiza también un estudio de las correlaciones entre metodologías, detectando que Flipped Classroom es la que tiene una correlación débil pero consistente con varias de las metodologías analizadas. Se concluye que es fundamental diseñar programas de desarrollo profesional del profesorado que incluyan formaciones variadas, con una duración de mínimo 20 horas y proporcionando la oportunidad de visitar y experimentar un entorno innovador de aprendizaje.

PALABRAS CLAVE

Percepciones del profesorado; entornos Innovadores de Aprendizaje; aprendizaje basado en el alumnado; ABP; ludificación; aula invertida; pensamiento de diseño; paisajes de aprendizaje.

ABSTRACT

The objective of the study presented in this article was to gather the teachers' perceptions in relation to the use of student-centred approaches after having received an in-service teacher training under the Innovative Learning Environment umbrella. The instrument used was a questionnaire which was sent, at least three months after finishing the training on the topic, to teachers from the Valencian Community. 152 answers were analysed, obtaining the percentage of teachers who indicated that, after the training, they applied methodologies or strategies which aimed to give more responsibility to students (55,3%, f=84). Evidence on the effect of the characteristics of the training was proved to be significant. More concretely, teachers answered the question positively, in a higher proportion, when they expressed having received various trainings (p=.003), lasting more than 20 hours (p=.008) and including a visit to an innovative learning space (p=.002). Secondly, information about the used methodologies or strategies used was collected. The higher percentages of use were obtained in relation to Project Based Learning (80.3%) and Gamification (45.4%) while the lowest were found in Learning landscapes (7.2%) and Design Thinking (11.2%). Some variations were detected when analysing this according to the stage in which they teach. A correlation study was also developed, in which Flipped Classroom was identified with a weak but consistent correlation with an important number of the other methodologies analysed. As a conclusion, it is highlighted the importance of designing in-service teacher training programs that include a variety of typologies of training (inside the school, outside the school and guided visits), lasting at least 20 hours and offering the opportunity of visiting and experimenting in an innovative learning environment.

KEYWORDS

Teacher perceptions; Innovative Learning Environments; student;centred approach; PBL; gamification; flipped classroom; design thinking; learning landscapes.

1. INTRODUCTION

Teachers' pedagogical knowledge and skills become obsolete in a short time due to the rapid changes of the contemporary world. Despite the rise of social media platforms as sources of new ideas and actualization (Martín-Gutiérrez, Said-Hung and Conde-Jiménez, 2024), the in-service teacher training is considered a fundamental tool to provide with the needed actualization, promote continuous improvement and enable the implementation of innovations (European Union, 2013; Osamwonyi, 2016; Sheth, 2004). Teacher training must, therefore, address the latest evidence and trends to assimilate them with the solid pedagogical foundations that have proved to be effective.

The design of teacher training programs is usually influenced by legal requirements, by trends identified by international reports in educational matters namely Horizon report 2023 (Pelletier et al., 2023) or by interests and needs freely shared by the teachers themselves (Granda-Pinan, Lozano y Alameda Villarrubia, 2024).

The European Union, through its institution called European Schoolnet (a consortium of ministries of education), has been promoting, since 2012, the creation of Innovative Learning Environments (ILE) based on the iTEC study (European Commission, 2024). This study resulted in the creation of a teacher training lab named Future Classroom Lab (European Schoolnet, 2024) and a toolkit to be used by teachers. The Spanish Government supports and expands this initiative through the National Institute of Educational Technologies and Teacher Training (INTEF because of its name in Spanish, Instituto Nacional de Tecnologías Educativas y Formación del Profesorado), with the creation of the Aula del Futuro project (AdF) (INTEF, 2024) and its network of ambassadors. Lately, several regional governments have adapted it, as it can be seen in the Valencian Community and its Aules Transformadores training program (Generalitat Valenciana, 2024).

ILEs, currently considered as important promoters of pedagogical innovation, can be defined as highly flexible spaces, with intentioned furniture and ubiquitous technology, used in an innovative way, facilitating a student-centred learning experience (Blannin *et al.*, 2020). Scientific evidence has shown that these environments indeed foster student-centred pedagogies (Byers *et al.*, 2018b; Cleveland, 2016; Granda-Pinan and Rojo-Bofill, 2024; Jorion *et al.*, 2016), in which various types of grouping are used depending on purpose and students are engaged in more active, collaborative and creative learning activities (Byers *et al.*, 2018a), where the digital space is an extension of the physical space (Gonzalez-Mohino *et al.*, 2023; Granda-Pinan, Roda-Segarra, and Mengual-Andrés, 2024; Rivera-Vargas *et al.*, 2024). engaged in more active, collaborative and creative learning activities (Byers *et al.*, 2018a), where the digital space is an extension of the physical space (Gonzalez-Mohino *et al.*, 2023; Granda-Pinan, Roda-Segarra, and Mengual-Andrés, 2024; Rivera-Vargas *et al.*, 2024).

Several examples of public policies fostering or even imposing the creation of innovative spaces can be found worldwide. However, the evidence contradicts itself in relation to the impact of these spaces on teachers, when it is not supported by training. On the one hand, there is evidence that supports that these spaces make teachers feel an urge to change their teaching approach (Byers *et al.*, 2014). On the other hand, some studies have described those teachers, when approaching these spaces which are significatively different to the traditional ones, don't easily identify the pedagogic strategies that they can use to create effective innovative learning environments (Cleveland, 2016). Therefore, literature emphasises the importance of training teachers in spatial manipulation (French et al., 2022), as evidence indicates that, despite being in innovative environments, teachers who lack training on how to utilise these spaces do not transition to more active pedagogical approaches (Beery et al., 2013).

In-service teacher training, being designed as workshops in which daily aspects are addressed and didactic materials are designed and planned to be implemented, has shown its effectiveness in its posterior implementation and has been recognized as essential in teachers' career (Alkuş y Olgan, 2014; Osamwonyi, 2016). In such events teachers can accede to updated pedagogy that enriches their practice.

The verification of the transferability to classroom practice is a complex issue that requires follow-up over time after the completion of the training. Different conditioners such as the available time or staff, the objectives to achieve or the population characteristics determine how the tracing is implemented. For this study, it was decided to monitor the impact through a questionnaire created ad hoc, which queries teachers trained in ILE about various classroom application issues linked to the use of student-centred approaches. With this study we aim to answer to Imms *et al.* (2023) detection of lack of evidence of ILE's impact.

Student-centred approaches place pupils at the centre, providing them with the opportunity of having an active role in their own learning through decision-making and problem-solving (Altay, 2014;

Wilson, 2004). The teaching practice focus migrates from an approach aimed at knowledge learning to a different one based on the acquisition of skills and competences through experience and practice (Hoskins and Deakin, 2010). In this context, students are given more opportunities to participate, to be autonomous and responsible for their own learning (Hong, 2012). Since these approaches are included in the recommendations of the European Council (2006) and subsequent regulations, their characteristics, application and effectiveness are current research topics (Bezanilla *et al.*, 2019; Jiménez-Hernández *et al.*, 2021). Student-centred approaches effectivity is supported by an increasing body of empirical findings (Biggs and Tang, 2011; Cornelius-White, 2007; da Silva Santos *et al.*, 2022; Freeman *et al.*, 2014; Michael, 2006; Prince, 2004; Ruiz-Primo *et al.*, 2011; Stes *et al.*, 2010; Taveras-Pichardo, 2022). Consequently, different training institutions offer professional development programs aiming to qualify teachers to use these methodologies and strategies, institutions such as the Centers of training, innovation and educative resources (CEFIRE because of their name in Spanish, Centros de Formación, Innovación y Recursos Educativos) dependent of the Valencian government or the Ministry of Education in Spain.

This study is precisely within the scope of the first of these institutions. CEFIRE are the institutions through which the Valencian government provides in-service teacher training. In them, ILEs are approached through different training modalities. Faculty are invited to attend training with different characteristics (online, face-to-face or blended), different length (from 8 to 35 hours) and different aims (guided visits to innovative learning spaces, introductory events or planning workshops, to name some). All these proposals have the goal of giving teachers some basic knowledge about the main characteristics of ILE, provide them with experiences replicable in their classrooms and enable them to plan student-centred learning situations, often enriched with other aspects such as Universal Learning Design, eTwinning and Scientix.

Driven by the interest for knowing the impact of these trainings in the classroom, in the approach implemented by teachers while designing the teaching-learning processes, a questionnaire was designed as an starting point, to survey teachers trained in ILEs about their perceptions in the increase use of student-centred approaches as as result of them. Attention is focused on a specific characteristic of them: pupils' responsibility in decision-making regarding their own learning.

Therefore, this study has a dual objective: (1) to analyse teachers' perceptions regarding whether there is an increased demand for student responsibility in their learning after participating in training related to ILE, and (2) to investigate which approaches or strategies are used in this regard.

2. MATERIAL AND METHOD

The present study was conducted through a quantitative, non-experimental, descriptive, comparative, and correlational research design through a questionnaire (McMillan & Schumacher, 2005). This method was considered the most appropriate given that the research scenario unfolded in a real-world context (Losada López & López-Feal- Ramil, 2003).

2.1. Data gathering instrument

As it has already been mentioned, a specific questionnaire was created and sent to the participants electronically to simplify completion and subsequent data analysis. The content validation process was conducted under the specifications of Lawshe (1975) with the modifications of Tristán-López (2008): understanding and importance were analysed for every item by seven experts in the field: two members of the national network of Future Classroom Lab ambassadors, four university professors and one statistical. Based on this review, 31 items were eliminated or modified as they were considered irrelevant or confusing. The questionnaire was structured in three dimensions, including multiple-choice items or Likert-scale items (1 - strongly disagree, 5 - strongly agree). These dimensions include: A) Demographic variables, to gather, through 17 items, the personal profile of the sample and the characteristics of the training received; B) Impact on the methodology used, identifying pedagogical strategies implemented and space modifications undergone, through 10 items, and C) Impact in the Center organisation, assessing the transformative changes fostered.

This questionnaire was sent to selected faculty three months after ending the training in ILE, considering that three months was enough time to implement some changes in their teaching practices.

2.2. Sample

The sample consisted of 152 teachers from different educational stages (see table 1). The non-probabilistic sampling was intentionally -or conveniently- selected, including participants from various training activities (workshops, seminars, guided visits and online courses, among others) related to ILE, such as Aula del Futuro or Aules Transformadores. All training activities have been developed by the CEFIRE network under the jurisdiction of the Generalitat Valenciana during the 2022-2023 academic year.

Table 1. Distribution of background characteristics of respondents (N=152).

Characteristic	Frequency (n)	Percent (%)
Gender		
Female	102	67.10
Male	46	30.26
Lost	4	2.63
Stage		
Infant and Primary **Education**	83	54.60
Secondary Education	60	39.47
Lost	9	5.92
Age		
40 years or less	32	21.1
More than 40 years	119	78.3
Lost	1	0.7
Years of teaching experience		
0-10	36	23.7
11-20	65	42.8
More than 20	50	32.9
Lost	1	0.7
Type of training		
Training (in or out school)	36	23.7
Guided visit	33	21.7
Various	82	53.9
Lost	1	0.7
Format		
Online or semi	30	19.7
In-place	79	52.0
Various	43	28.3
Length		
20h or less	76	50.0
More than 20h	71	46.7
Lost	5	3.3
Visit to an ILE		
Yes	115	75.7
No	37	24.3

2.3. Data analysis

Obtained data was analysed using the statistical package IBM SPSS 28. Measures of central tendency and dispersion were employed to analyse the sample's responses to different items on the scale. Subsequently, after checking for normal distribution and homogeneity of variances, various non-parametric tests were selected for independent variables: the Mann-Whitney U test and the Kruskal-Wallis H test, as well as Pearson's bivariate correlations. These tests allowed us to observe the relationship between various general variables in dimension A (educational stage, performance of leadership roles such as school management or ICT coordination, training modality, etc.) and the research questions of dimensions B and C.

3. RESULTS

In order to determine if the participating teachers design their sessions with a higher degree of student responsibility for learning, a descriptive exploration of the sample results was conducted. As it is shown in table 2, 55.3 % of the sample (f=84) indicates that the training received has stimulated the incorporation of activities with a higher degree of student responsibility. Conversely, only 9.2 % (f=14) have disagreed that the training has fostered this habit in the design of their class sessions.

Table 2. Descriptive statistics on the influence of training on designing sessions with greater student responsibility.

	Frequency	Percentage
Totally disagree/Disagree	14	9.2
Indifferent	54	35.5
Agree/Totally agree	84	55.3

After refusing the assumption of normality of the obtained punctuations through Komogorov Smirnov test, non-parametric test statistics were applied to comprehend the existing relationships between the sociodemographic data and the answers gathered.

In general terms, statistically significative differences were not found when relating a higher use of pupils' responsibility to teachers' genre (U = 2200.00, p =.409), age (U = 1814.50, p =.668), years of teaching experience [H *(2, n = 151) =.158, p =.924*] or educational stage (U = 1761.00, p =.576).

Similarly, no significant differences were found based on the training modality (online, in-person, or blended) (H (2, n = 152) = 5.411, p =.067). However, significant differences were identified when analysing the responses based on the type of training received (see Table 3).

Table 3. Kruskal-Wallis H test for the type of training received.

	Frequency	Percentage	Range
Training in or out the school	36	23.8	69.67
Guided visit	33	21.9	55.62
Various types	82	54.3	86.98

Kruskal-Wallis test results reveal an effect of the type of training received (training within or outside the school, guided visit, or a combination of different types of training) on the design of situations where students' responsibility is promoted: there are significant differences between the three categories of the independent variable regarding the dependent variable [H (2, n = 151) = 11.739, p =.003)]. Post-hoc contrast tests confirmed that significant differences exist between the group of teachers who have undergone guided visits and those who have participated in various types of training (p=.000), being the latter group the one that has most frequently indicated having designed their classes granting greater responsibility to the students.

In parallel, statistically significant differences were found in relation to the duration of the training (U = 2049.500, p =.008), (see Table 4).

Table 4. Mann-Whitney U according to the duration of the training.

	Frequency	Percentage	Range
20 h or less	76	51.7	66.50
More than 20	71	48.3	82.03

From these results, it can be inferred that teachers who have participated in training programs lasting more than 20 hours have responded more positively to the question about whether they have included aspects to grant greater responsibility in student learning.

On the other hand, when analysing the responses of teachers based on whether they have visited an innovative learning space, such as an Aula del Futuro or Aula Transformadora, a significance of p=.002 was obtained. Thus, it can be affirmed that those who have visited such spaces have experienced a greater impact, as they have responded more positively to this question (see table 5).

Table 5. Mann-Whitney U according to whether an innovative learning space has been visited.

	Frequency	Percentage	Range
Yes	115	75.7	82.03
No	37	24.3	59.31

A second level of analysis aimed to analyse the strategies that teachers used to promote greater student participation and responsibility in sessions. To that end, the sample responded to a dichotomous response scale containing different didactic strategies (Cooperative Learning, Project-Based Learning, Learning Landscapes, Flipped Classroom, Design Thinking, Visual Thinking, Service Learning, Gamification, Other (specify)). Table 6 summarises the main descriptive statistics of the study sample for this question.

Table 6. Frequencies and percentages of responses regarding the use of different methodologies or strategies.

		No		Yes	
	N	Frequency	Percentage	Frequency	Percentage
Project-based learning	152	30	19.7	122	80.3
Learning landscapes	152	141	92.8	11	7.2
Flipped Classroom	152	112	73.7	40	26.3
Design Thinking	152	135	88.8	17	11.2
Visual Thinking	152	116	76.3	36	23.7
APS	152	108	71.1	44	28.9
Gamification	152	83	54.6	69	45.4

These data show that surveyed teachers most commonly used Project-Based Learning (80.3%, f=122), followed by Gamification (45.4%, f=69). The least used strategies are Learning Landscapes (7.2%, f=11) and Design Thinking (11.2%, f=17).

Through the Pearson correlation coefficient R, methodologies that tended to be used simultaneously to promote greater student engagement were identified (see Table 7).

Table 7. Pearson correlation between the consulted methodologies or strategies (n=152).

Variables	1	2	3	4	5	6	7
1. Project-based learning	–						
2. Learning landscapes	,139	–					
3. Flipped Classroom	,184*	,237**	–				
4. Design Thinking	–,086	,062	,167*	–			
5. Visual Thinking	,043	,083	,124	,195*	–		
6. APS	,025	–,010	,080	–,042	,020	–	
7. Gamification	,087	,051	,295**	–,072	,083	,176*	–

*p<0.05; **p<0.01

Results describe a weak but consistent correlation between Flipped Classroom and four other methodologies: Project-Based Learning (c=.184), Learning Landscapes (c=.237), Design Thinking (c=.167), and Gamification (c=.295). In parallel with these interactions, there is also a similarly weak correlation between Design Thinking and Visual Thinking (c=.195), and between Service Learning and Gamification (c=.176).

A third level of analysis was developed conditioning the sample to a positive answer to the first question (if they have included greater student responsibility in their own learning after receiving the training), and observing the frequency and percentages obtained concerning the use of these strategies or methodologies (table 8).

Table 8. Frequencies and percentages of responses regarding the use of different methodologies or strategies conditioned on the group of teachers who responded affirmatively to the first question (N=84).

		No		Yes	
	N	Frequency	Percentage	Frequency	Percentage
Project-based learning	84	12	14.3	72	85.7
Learning landscapes	84	77	91.7	7	8.3
Flipped Classroom	84	57	67.9	27	32.1
Design Thinking	84	69	82.1	15	17.9
Visual Thinking	84	60	71.4	24	28.6
APS	84	54	64.3	30	35.7
Gamification	84	42	50	40	50

The trend observed is similar to that described earlier: the most used methodologies are Project-based Learning (85.7%, f=72) and Gamification (50%, f=40), while the least used are Learning Landscapes (8.3%, f=7) and Design Thinking (17.9%, f=15).

Finally, frequencies in the use of the surveyed methodologies were analysed based on the educational stage where teaching is imparted (see Table 9).

Table 9: Frequencies and percentages of responses regarding the use of different methodologies or strategies conditioned on the group of teachers who responded affirmatively to the first question, according to the educational stage where teaching is imparted.

	Pre- and Primary Education					Secondary Education				
		No		Yes			No		Yes	
	N	F	%	F	%	N	F	%	F	%
Project-based learning	46	6	13.0	40	87.0	25	4	16.0	21	84.0
Learning landscapes	46	41	89.1	5	10.9	25	23	92.0	2	8.0
Flipped Classroom	46	37	80.4	9	19.6	25	11	44.0	14	56.0
Design Thinking	46	41	89.1	5	10.9	25	19	76.0	6	24.0
Visual Thinking	46	32	69.6	14	30.4	25	17	68.0	8	32.0
APS	46	28	60.9	18	39.1	25	16	64.0	9	36.0
Gamification	46	25	54.3	21	45.7	25	8	32.0	17	68.0

The table above reveals differences compared to the previous data. In both cases, the most used methodologies are Project-Based Learning and Gamification, while the least used are Learning Landscapes and Design Thinking. However, there is a variation in the use of certain methodologies, such as Flipped Classroom, which is used in Early Childhood and Primary Education at 19.6% (f=9), but at 56% (f=14) in Secondary Education. Similarly, Design Thinking increases from 10.9% (f=5) in Early Childhood and Primary Education to 24% (f=6) in Secondary Education, and Gamification is used by 45.7% in the first stage and by 68% (f=17) in the second.

4. DISCUSSION

In this study, the possible impact of training sessions related to innovative learning environments on the design of teaching and learning situations using student centred approaches is analysed. Conclusions are deduced from 152 answers to a survey sent to teachers who finished a training on this topic three months ago or more.

Results show that 55.3% of the respondents reported designing their sessions to enhance student responsibility post-training. This percentage must be compared with the 9.2% obtained from surveyors that expressed disagreement with the statement. Having a percentage of 35.5% indifferent teachers in relation to the application of student-centred approaches after the training, is an aspect to reflect on. Further investigation could search for the reasons for such a high percentage, which may be related to a lack of motivation, to a misunderstood purpose or to an unclear message, among others.

No statistically significant differences were found when relating the responses to demographic data related to gender, age, years of teaching experience or the educational stage in which classes are taught. However, differences were found when related to the characteristics of the training. The Kruskal-Wallis test and post-hoc contrast test showed statistically significant differences between teachers who only participated in a guided visit to an innovative learning space and those who received training of various types on this topic, with the latter expressing more frequently that they had designed their classes giving more responsibility to the students. This suggests that diversity in training can enrich pedagogical practices, favouring more student-centred approaches.

Training programs' length has also been highlighted as a relevant factor, having received more positive responses from teachers who have participated in training sessions of more than 20 hours. This finding underscores the importance of offering extensive and comprehensive training programs that allow teachers to delve into these topics and methodologies.

The data behaves similarly when comparing the answers of teachers who have visited an innovative learning space to those of the teachers who have not. This suggests that direct exposure to innovative learning environments can inspire and motivate teachers to implement significant changes in their pedagogical practices.

Considering all this, we can conclude that training related to innovative learning environments must be varied, last at least 20 hours and include a visit to one innovative learning space, as teachers attending it are more likely to apply student-centred approaches. Therefore, institutions responsible for teacher training and policymakers should consider the incorporation of these elements to training programs to maximise their effectiveness. Schools, when designing their personalised training, should also consider them, especially the adequacy of including a visit to an innovative learning space.

Answering the second question, the most commonly used methodologies and strategies were compiled. Project based learning was the one used by more teachers, both in pre and primary education and secondary education, followed by Gamification. The least used methodologies were Learning Landscapes and Design thinking, results that could be due to a possible lack of familiarity or specific training in these methodological strategies among the surveyed educators, as they are quite concrete or for an occasional use. Some differences were found between the use of some methodologies between secondary and primary students, perceiving an increase of use of Flipped Classroom, Design Thinking or Gamification, maybe due to the greater maturity and capacity of secondary students to adapt to these forms of learning.

Pearson's correlation showed a weak but consistent interaction between Flipped Classroom and other methodologies, indicating a tendency to combine it with Project-Based learning, Landscape learning, Design thinking and Gamification. Therefore, when looking for information or designing training related to Flipped Classroom it would be efficient to enrich it with some of these methodologies, as they may tend to use some of them simultaneously. The complementary nature of these methodologies can be highlighted in training, which can be designed covering some of these approaches simultaneously, fostering an understanding on how to combine them effectively.

In conclusion, this study provides valuable insights into the impact of teacher training in the topic of innovative learning environments. The results suggest that the characteristics of the training program affect the subsequent implementation, highlighting that both the diversity and duration of training are crucial for enhancing the desired transferability. Furthermore, exposure to innovative learning environments seems to have a positive impact on teachers' willingness to implement pedagogical changes in this regard. It also identifies the most and less used approaches to foster students' responsibility in their own learning.

Future studies should consider the longitudinal monitoring of the effects of these training programs on teaching practices and student performance. Additionally, educational institutions should consider these findings when designing professional development programs, ensuring they are comprehensive, diverse and include direct exposure to innovative learning environments. This could lead to more student-centred teaching practices.

AUTHORS' CONTRIBUTION

Granda-Pinan, Amelia R. Conceptualization. Data curation. Formal Analysis. Investigation. Methodology. Project administration. Resources. Visualisation. Writing - original draft.

Alameda Villarrubia, Alberto. Conceptualization. Investigation. Methodology. Project administration. Writing - original draft.

Mengual Andrés, Santiago. Formal Analysis. Validation. Supervision. Writing - review & editing.

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