

PIXEL BIT

Nº 71 SEPTIEMBRE 2024
MONOGRÁFICO

e-ISSN:2171-7966

ISSN:1133-8482

Revista de Medios y Educación

la inclusión educativa - Tecnologías emergentes y recursos didáctico-tecnológicos para

PB



PIXEL-BIT

REVISTA DE MEDIOS Y EDUCACIÓN

Nº 71 - SEPTIEMBRE - 2024

<https://revistapixelbit.com>

Pixel-Bit: Revista de Medios y Educación. 2024 - ISSN: 1133-8482. e-ISSN: 2171-7966.

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SCOPUS Q1 Education: Posición 236 de 1406 (83% Percentil). CiteScore Tracker 2022: 5,6 - Journal Citation Indicator (JCI). Emerging Sources Citation Index (ESCI). Categoría: Education & Educational Research. Posición 257 de 739. Cuartil Q2 (Percentil: 65.29) - FECYT: Ciencias de la Educación. Cuartil 1. Posición 16. Puntuación: 35,68- DIALNET MÉTRICAS (Factor impacto 2021: 1.72. Q1 Educación. Posición 12 de 228) - REDIB Calificación Glogal: 29,102 (71/1.119) Percentil del Factor de Impacto Normalizado: 95,455- ERIH PLUS - Clasificación CIRC: B- Categoría ANEP: B - CARHUS (+2018): B - MIAR (ICDS 2020): 9,9 - Google Scholar (global): h5: 42; Mediana: 42 - Journal Scholar Metric Q2 Educación. Actualización 2016 Posición: 405a de 1,115- Criterios ANECA: 20 de 21 - INDEX COPERNICUS Puntuación ICV 2019: 95.10

Pixel-Bit, Revista de Medios y Educación está indexada entre otras bases en: SCOPUS, Fecyt, DOAJ, Iresie, ISOC (CSIC/CINDOC), DICE, MIAR, IN-RECS, RESH, Ulrich's Periodicals, Catálogo Latindex, Biné-EDUSOL, Dialnet, Redinet, OEI, DOCE, Scribd, Redalyc, Red Iberoamericana de Revistas de Comunicación y Cultura, Gage Cengage Learning, Centro de Documentación del Observatorio de la Infancia en Andalucía. Además de estar presente en portales especializados, Buscadores Científicos y Catálogos de Bibliotecas de reconocido prestigio, y pendiente de evaluación en otras bases de datos.

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Dirección de correo electrónico: revistapixelbit@us.es . URL: <https://revistapixelbit.com/>
ISSN: 1133-8482; e-ISSN: 2171-7966; Depósito Legal: SE-1725-02
Formato de la revista: 16,5 x 23,0 cm

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Self-efficacy beliefs in Spanish pre-service teachers: a microteaching case study using immersive virtual reality

Percepciones de autoeficacia en docentes en formación en España: un estudio de caso de microenseñanza utilizando realidad virtual inmersiva

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Recibido:2024/05/07; **Revisado:**2024/05/18; **Aceptado:**2024/06/24; **Online First:**2024/07/03; **Publicado:**2024/09/01

ABSTRACT

The sense of self-efficacy among pre-service teachers (PSTs) has garnered increasing attention in research due to its impact on professional development. Effective training methods like microteaching have proven to serve as a catalyst to enhance PSTs' self-efficacy. This study examines the impact of microteaching on PSTs' self-efficacy in teaching, using immersive virtual reality (iVR) cameras for video recording. The research explores PSTs' self-efficacy levels before and after microteaching and their insights post-experience. Using a mixed methods approach, we conducted a quasi-experimental pre-test-post-test setup with the Teacher Self-efficacy Scale (TSES) and qualitative focus groups. The study involved 27 English language PSTs from a Master's program at the University of Las Palmas de Gran Canaria. Quantitative analysis showed high reliability in the three dimensions of the TSES: instructional strategies, classroom management, and student engagement, with significant improvements post-test regarding instructional strategies. Qualitative analysis revealed the importance of these dimensions alongside the innovative use of iVR. Our findings suggest that understanding the interactions affecting self-efficacy can inform the design of effective teacher training programs, enhancing the professional growth and confidence of future educators.

RESUMEN

El sentido de autoeficacia del profesorado en formación (PeF) se estudia cada vez más por su impacto en el desarrollo profesional. Métodos como la microenseñanza han demostrado mejorar la autoeficacia del PeF. Este estudio examina el impacto de la microenseñanza, grabada con cámaras de realidad virtual inmersiva (RVI), en la autoeficacia del PeF. Se exploran los niveles de autoeficacia de los PeF antes y después de la microenseñanza y sus percepciones posteriores. Utilizando un enfoque de método mixto, realizamos un diseño cuasi-experimental de pretest-postest con la Escala de Autoeficacia del Profesor (TSES) y grupos focales. El estudio involucró a 27 PeF de inglés de un programa de máster en la Universidad de Las Palmas de Gran Canaria. El análisis cuantitativo mostró alta fiabilidad en las tres dimensiones del TSES: estrategias de enseñanza, gestión del aula e implicación del estudiante, con mejoras significativas postest con respecto a las estrategias de enseñanza. El análisis cualitativo destacó la importancia de estas dimensiones junto con el uso innovador de RVI. Nuestros hallazgos sugieren que comprender las interacciones que afectan la autoeficacia puede mejorar el diseño de programas de formación docente, promover el crecimiento profesional y la confianza de los futuros educadores.

KEYWORDS · PALABRAS CLAVES

Teachers' self-efficacy, teacher training, microteaching, 360-degree video, education
Autoeficacia del docente, formación de docentes, microenseñanza, videos de 360°, educación

1. Introduction

While some pre-service teachers (PSTs) have optimistic conceptions about the teaching task, most of them are aware that their education is a never-ending process, and that teaching involves not only transfer of subject matter knowledge, but also many other challenges such as knowing how to organize time effectively, managing the classroom, and developing methodological and teaching skills, among others (Carcamo, 2023; Yasemin, 2016).

Ideally, those pedagogical skills should be acquired through structured faculty training techniques, rather than in school classrooms (Remesh, 2013). To that end, universities have implemented professional development programs for the purposes of enhancing the teaching quality and educators' overall efficacy in classrooms when designing and delivering their lessons (Cerruto et al., 2023).

One way to attain those goals is to ensure that PSTs achieve a strong sense of self-efficacy during their training (Colson et al., 2017). The use of microteaching, a practice-based training method implemented in many university teacher training programs to improve the quality of teacher education, has proven to enable teachers to develop pedagogical skills in simulated classroom real situations (León & Santiago, 2014), identify the complexity of teaching, and establish a connection between theory and practice. Accordingly, the reflective nature of microteaching can help PSTs develop their sense of self-efficacy in teaching (Arsal, 2014).

1.1. Teacher self-efficacy

Following Bandura's (1977) construct of self-efficacy, teacher self-efficacy (TSE) has been defined as the beliefs that teachers hold regarding their own capabilities to perform the tasks of teaching (Tschannen-Moran & Hoy, 2001). TSE has been operationalized on three dimensions of teaching, i.e., student engagement, class management and instructional strategies (González et al., 2018). Research on TSE indicates that teachers who exhibit high levels of self-efficacy in their teaching abilities tend to experience greater job satisfaction, lower levels of burnout, and demonstrate increased effectiveness in using diverse instructional methods (Bueno-Álvarez et al., 2022; Yerdelen et al., 2019). Conversely, teachers with low self-efficacy may shy away from challenging tasks, readily give up in the face of obstacles, and encounter feelings of anxiety and self-doubt (Borrachero et al., 2013; Cerruto et al., 2023).

Teachers' sense of self-efficacy derives from four distinct sources of information, namely, mastery experience, verbal persuasion, vicarious experience, and physiological and emotional state (Bandura, 1997). Mastery experience suggests that past performances in a specific task enable teachers to draw comparisons between the former and the later experiences. This way, they develop beliefs about their ability to undertake future tasks

based on judgements of their past performance on a specific task. Therefore, successful experiences achieved through this process leads to a strong sense of self-efficacy.

Experiences gained through personal practice are described as the most impactful source of self-efficacy (Bandura, 1986; Yerdelen et al., 2019). Verbal persuasion shapes TSE by the positive feedback they receive from competent and trusted models. This source of self-efficacy provides insights into the complexity of teaching tasks, enhances the teacher's abilities to overcome situational challenges, and furnishes particular feedback on performance (González et al., 2018; Tschannen-Moran & Hoy, 2007). Vicarious modelling refers to teachers' developing self-efficacy beliefs by comparing their own performance to that of other models. If a model is perceived as more capable or talented, teachers tend to reduce the relevance of the model's performance outcomes for themselves (Arsal, 2014; Bandura, 1986). Finally, physiological and emotional state, including stress, anxiety, fear, fatigue and physical incapability, can influence teachers' sense of self-efficacy regarding their teaching practice (Carcamo, 2023).

Since it may be difficult for in-service teachers to change their self-assessment of efficacy once it is established, the pre-service training period becomes crucial for fostering the development of a strong sense of efficacy of prospective teachers (Borrachero et al., 2013). It has been shown that integrating opportunities to enhance teacher development in teacher training programs can have a significant impact on their self-efficacy beliefs. One of the most used techniques is microteaching. Research studies (Arsal, 2014; Cerruto et al., 2023; Mergler & Tangen, 2010; Takkaç Tulgar, 2019) indicate that microteaching significantly enhances PSTs' self-efficacy through mastery experiences, verbal persuasion, vicarious modelling, and improvements in physiological and emotional state.

1.2. Microteaching

Initially developed by Allen and Ryan (1969) at Stanford University to enhance teaching skills by providing PSTs with a controlled training environment, today microteaching is defined as "the implementation of the knowledge and skills related to teaching in a controlled class and a limited time, identification and overcoming the deficiencies through the use of feedback" (Yasemin, 2016, p. 1475). The objectives of this approach are to offer future teachers the opportunity to design lesson plans, apply teaching strategies, manage classroom, self-assess their performance, and receive feedback through practical application of educational theories during their initial teacher training (Bell, 2007; Fernández, 2010; Yerdelen et al., 2019).

Microteaching aims to reduce teaching complexities by limiting the number of students, content, and teaching time, while providing immediate feedback after each session. It can be conducted as a single micro-lesson or in a six-stage cyclical process: planning, teaching, observation/feedback, re-planning, re-teaching, and re-observation/feedback. Before starting, PSTs receive training on teaching skills and methodologies through lectures and demonstrations. During the planning stage, trainees set the skills and objectives to be

practiced. In the teaching stage, they deliver their micro-lesson to peers. Following this, feedback is provided by the instructor and peers. This cycle can be repeated with the same or different lesson plans to enhance teaching efficacy based on the received feedback (Allen, 1967).

Of all the mentioned stages, evaluation has been found the most useful in improving general teaching skills (Arsal, 2014; Yasemin, 2016). However, the subjective feedback from instructors, combined with potential lapses in recalling session details, can lead to inaccurate evaluations. PSTs may also struggle to analyze and evaluate their own performance (Bryan & Recesso, 2006). To address this, some teacher education programs incorporate video into microteaching for more objective feedback. Video recordings allow prospective teachers to watch, analyze, and reflect on their teaching, leading to behavior modification (Kpanja, 2001; Shadiev et al., 2022). Thus, using video in microteaching enhances self-efficacy (Fernandez & Robinson, 2006; Yerdelen et al., 2019) and better prepares PSTs for the teaching profession (Mayo, 2004).

The initial use of standard video cameras in microteaching provided limited spatial and temporal context, hindering prospective teachers' ability to analyze and evaluate their own performance and their peers' attitudes in real time (Cross et al., 2022). To address these limitations, the use of 360-degree cameras in microteaching has increased in recent years. This immersive video technology records spatial audio and views in every direction, enhancing the analysis of teaching sessions. Studies have shown positive effects of 360-degree, or immersive virtual reality video (iVR), in teacher education, including improved empathy, reflection skills, mastery of content, attitudes, feelings of immersion and presence, and perceptions of the technology (Evens et al., 2023). Likewise, the implementation of iVR facilitates participants' exposure to novel experiences, thereby equipping them for the educational environments of the future (García-Tudela et al., 2023). Notably, Walshe and Driver (2019) found that 360-degree video recordings of PSTs' microteaching sessions positively impacted their self-efficacy towards teaching.

While some studies focusing on teacher self-efficacy in several countries have proved that microteaching practice is a beneficial contribution (Arsal, 2014; Cerruto et al., 2023; Yerdelen et al., 2019), its effects on Spanish PSTs' self-efficacy development within higher education teacher training programs have not been investigated to date. Similarly, while literature suggests that 360-degree video has significant potential to support Spanish PSTs' self-efficacy and, consequently, their professional development, empirical research supporting this claim remains unexplored.

In the light of the above stated gaps in research, this study examines the effects of a microteaching experience on Spanish PSTs' sense of self-efficacy in teaching before and after a microteaching experience. Specifically, the study explores the following research questions:

1. What are PSTs' levels of self-efficacy for teaching before and after participating in a microteaching practice, recorded with a 360-degree camera?
2. What are the PSTs' insights concerning self-efficacy after the iVR microteaching experience?

2. Methodology

This research employs a mixed methods design, with a view to facilitating a more comprehensive exploration of self-efficacy (Bryman, 2006). Combining quantitative and qualitative research approaches is recognized for producing research results that are informative, complete, balanced, and useful (Johnson & Onwuegbuzie, 2007). Initially, a quasi-experimental pre-test-post-test setup was conducted. Subsequently, qualitative focus group sessions were held to gain an in-depth view of perceived self-efficacy in PSTs, with data analyzed using a content analysis approach.

For the quantitative approach, the Spanish version of the Teacher Self-efficacy Scale (TSES, González et al., 2018) was used. The TSES, developed by Tschannen-Moran and Woolfolk Hoy (2001), is widely recognized for its reliability and validity in measuring TSE across various educational contexts and has been the most commonly used scale for TSE studies (Fackler & Malmberg, 2016; Ma et al., 2019; Wolters & Daugherty, 2007). Data regarding perceived self-efficacy were collected before and after student microteaching experience and subsequently analyzed employing the software SPSS (version 26) for descriptive and inferential procedures. The TSES is a 5-point Likert Scale (1= completely disagree / 5 = completely agree) comprising three four-item subscales:

- Instructional strategies (e.g., 'To what extent can you provide an alternative explanation or example when students are confused?').
- Classroom management (e.g., 'How much can you do to control disruptive behaviour in the classroom?').
- Student engagement (e.g., 'How much can you do to motivate students who show low interest in schoolwork?').

Additionally, with a total duration of 1 hour and 22 minutes, two focus group sessions were conducted through open-ended questions (e.g. 'What positive aspects of microteaching do you consider important for your development as a future teacher?') to explore and deepen the predictors of perceived self-efficacy and the most significant sources of changes in the perceived self-efficacy of PSTs. These interviews were audio recorded, transcribed using AI-powered transcription Sonix (<https://sonix.ai/es>), and reviewed and revised by the research team to ensure accuracy and fidelity to the original content. Qualitative data analysis was conducted following the principles of deductive and inductive content analysis (Hsieh & Shannon, 2005; Vaismoradi et al., 2013). An unconstrained matrix of analysis (Elo & Kyngäs, 2008) was developed, operationalizing the analysis structure

based on the categories comprised in the TSES: instructional strategies, classroom management, and student engagement. Various subcategories based on Bandura’s (1997) sources of self-efficacy were also identified, outlined in Table 1. Initial coding was performed using ChatGPT (version 3.5.) (Lopezosa & Codina, 2023; Perkins & Roe, 2024; Zhang et al., 2024;), with a researcher subsequently revising and refining the coding matrix. For data that did not fit the categorization frame, a new category, labelled as ‘other’, was generated based on the principles of inductive content analysis. Researchers convened to discuss and agree on the final data categorization, aligning with the recommendations of Graneheim and Lundman (2004) regarding the value of dialogue among co-researchers in labelling data. As well as that, the online software ReCal (<https://dfreelon.org/utills/recalfront/>) was employed to test inter-reliability, resulting in an overall percentage agreement of 80.43% and a Krippendorff’s Alpha of 0.761, indicating substantial agreement ($0.6 < \alpha \leq 0.8$, Hughes, 2021). Table 1 presents an overview of the categories and subcategories derived from the analysis.

Table 1
Categories and subcategories of content analysis

	Mastery experience
Instructional strategies	Vicarious modelling
	Verbal persuasion
Classroom management	Mastery experience
Student engagement	Mastery experience
Other	Transferability
	Context
	Physiological and emotional states

The microteaching experience was part of the regular schedule of one of the courses in the master's program. Specifically, it was part of the module dealing with designing a grammar/vocabulary activity, active methodologies, classroom management skills, and digital/online teaching resources. This module took 30 hours, of which 8 were dedicated to the microteaching sessions. Regarding the teaching procedure, before the microteaching practice, the participants were presented with the specific learning objectives, which were explained and exemplified in class by the instructor. After that, the instructor modelled a microteaching session, with a subsequent follow-up discussion, and presented the guidelines and assessment criteria. Microteaching training was then carried out by students.

Each participant performed a single micro-lesson and received immediate peer feedback. The instructor also provided detailed feedback to each student after their microteaching practice.

2.1. Research context and participants

The study was conducted at the School of Education Sciences at the state-run University of Las Palmas de Gran Canaria, Spain. This university offers a one-year Master's program for PSTs of diverse specialties, one of which is English language teaching.

The study population consisted of 27 (N=27) English language PSTs, selected through convenience sampling. The sample size aligns with prior quantitative investigations employing the TSES, as evidenced in Eğinli and Solhi (2021), and was complemented by qualitative analysis. One of the researchers was also the lecturer of the group. In terms of gender distribution, 74.07% (n= 20) of participants were female and 25.93% were male (n= 7). As for their entry qualifications, 62.96% (n= 17) followed English major studies, while 37.04% (n= 10) came from the BA of Translation and Interpreting. Of the total number of participants, 22.22% (n= 6) had previous teaching experience (in formal and/or informal contexts), whereas 78% (n= 21) did not. Stratified sampling was applied in the selection of ten participants for the focus group sessions, based on gender and entry bachelor's degree, as represented in Table 2. Previous experience in the educational field was not considered as a selection criterion due to the low number of participants with teaching experience.

Table 2

Cross-tabulated table illustrating a sample stratified by two variables: entry BA and gender

BA Studies / Gender	Male	Female
English major Studies	5 (50%)	5 (50%)
Translation & Interpreting Studies	5 (50%)	5 (50%)

3. Analysis and results

3.1. Quantitative data analysis

A five-point Likert scale from 1 (= strongly disagree) to 5 (= strongly agree) was used and Cronbach's Alpha was calculated to determine the reliability of the scales. Both in the pre-and post- tests the results for the three dimensions were highly reliable, all of them being above 0.80 (DeVellis, 1991) as conveyed in Table 3.

Table 3*Cronbach Alpha in the pre- and post- tests*

Self-efficacy dimensions	Cronbach's Alpha Pre-test	Cronbach's Alpha Post-test
Efficacy for instructional strategies	.877	.879
Efficacy for classroom management	.920	.929
Efficacy for student engagement	.879	.881

Descriptive statistics in terms of mean and standard deviation indicate that participants mostly agreed with the statements which make up each of the three self-efficacy components, and that in the post- phase agreement seems to have slightly increased regarding the three dimensions (Table 4).

Table 4*Descriptive statistics*

Self-efficacy dimensions	Pre-test		Post-test	
	Mean	SD	Mean	SD
Efficacy for instructional strategies	3.91	.766	4.22	.652
Efficacy for classroom management	3.50	.747	3.71	.843
Efficacy for student engagement	3.99	.702	4.28	.602

As far as correlations are concerned, apart from the three variables related to self-efficacy, age and gender were also analyzed. Table 5 reveals no correlation between age, gender and self-efficacy, and meaningful correlations between the three self-efficacy variables, with some variation between the pre- and post- phases.

Table 5*Correlations in the pre- and post- tests between gender, age and the self-efficacy dimensions*

Variables	Age	Eff. for instruct. str.	Eff. class. manag.	Eff sts. engagem.
Gender	.178 / .072	.213 / .061	.115 / -.011	-.023 / -.219
Age		.163 / .035	.086 / .089	-.041 / -.241
Eff. for instruct. str.			.752** / .639**	.722** / .482**
Eff. class. manag.				.651** / .680**

Note: **. Correlation is significant at the 0.01 level (2-tailed).

Furthermore, the KMO and Bartlett's test was performed, with KMO sampling adequacy = .730 and $p < .000$ (.000). Following García-Lázaro et al. (2022), the Wilcoxon signed-rank test was used as a nonparametric test to examine the difference between PSTS' perceived self-efficacy before and after the microteaching sessions (Table 6). Significant differences ($p < .05$) were found in relation to the construct efficacy for instructional strategies and in the items related to evaluation (1) and posing good questions to students (3). As well as that, two items belonging to efficacy for student engagement, namely, capacity to motivate students with little interest in the task provided (11) and assisting families to help their children to do well (12) show significant differences.

Table 6

Wilcoxon signed-rank test

Self-efficacy dimensions and items	Z	Sig
Efficacy for instructional strategies	-2.019 ^b	.043
1. To what extent can you use a variety of assessment strategies?	-2.072 ^b	.038
2. To what extent can you provide an alternative explanation or example when students are confused?	-1.213 ^b	.225
3. To what extent can you craft good questions for your students?	-2.486 ^b	.013
4. How well can you implement alternative strategies in your classroom?	-1.209 ^b	.227
Efficacy for classroom management	-1.611 ^b	.107
5. How much can you do to control disruptive behavior in the classroom?	-1.626 ^b	.104
6. How much can you do to get children to follow classroom rules?	-1.291 ^b	.197
7. How much can you do to calm a student who is disruptive or noisy?	-1.147 ^b	.251
8. How well can you establish a classroom management system with each group of students?	-1.328 ^b	.184
Efficacy for student engagement	-1.861 ^b	.063
9. How much can you do to get students to believe they can do well in schoolwork?	-.812 ^b	.417
10. How much can you do to help your students value learning?	-1.536 ^b	.125
11. How much can you do to motivate students who show low interest in schoolwork?	-2.055 ^b	.040
12.- How much can you assist families in helping their children do well in school?	-2.209 ^b	.027

3.2. Qualitative data analysis

As for the qualitative analysis, the primary dimensions of analysis align with the subscales of the TSES: instructional strategies, classroom management, and student engagement. Within these main categories, various subcategories were identified based on

Bandura's (1997) sources of self-efficacy, namely, mastery experiences, vicarious modelling and verbal persuasion. Additionally, data that did not fit neatly into these predefined categories were analyzed inductively, leading to the creation of an eclectic category. This category encompasses aspects such as transferability of skills, contextual influences on teaching practices, and physiological and emotional states (Bandura, 1997).

Microteaching significantly contributed to student teachers' skills in instructional strategies, with mastery experiences being the most impactful. Participants valued the hands-on teaching practice. Key aspects appreciated were organisational skills, clarity of instruction, and adaptability. For instance, one participant noted the importance of having a backup plan, saying, "in my case, especially organizing myself, ensuring clarity of the idea, and having a plan B. So, thanks to this, now I keep in mind that I sometimes need a plan B" (ID2). Innovative teaching methodologies, such as gamification, were also seen as enhancing learning outcomes, as expressed by a participant, "thinking of activities that can be gamified. I think it's also a way to force ourselves to make another click that isn't the typical activities" (ID10). Vicarious modelling emerged as another critical aspect, with participants valuing peer observations. One participant stated, "I found it very important to see the rest of my classmates because they gave me ideas for many classes" (ID9). This peer observation fostered a collaborative learning environment, providing insights from one another's strengths and areas for improvement. Finally, verbal persuasion, particularly through feedback, was also a significant subcategory under instructional strategies. As one participant noted, "I found it very useful from a learning standpoint. Seeing yourself teach and getting feedback from peers that helps you improve" (ID7). Another participant reflected on the constructive nature of teacher feedback, stating, "it's true that in the matter of instructions I beat about the bush a lot, and I saw it in the video. Also, you [the teacher] told me in the feedback I have to simplify more because the students can get lost" (ID1).

In the category of classroom management, participants' reflections highlight several key aspects for effective teaching practices, all related to mastery experience. Time management was one recurrent issue, as one participant noted, "the students' memory, or attention span, doesn't last for two hours. So, I think it's a good idea to have ten minutes of information that can be well-received by them and that is very well summarized" (ID9). Watching themselves after the microteaching session contributed to raising self-awareness of the participants' physical presence in the classroom and interaction with students. As one stated, "I move too much in class. Maybe that makes the kids get a bit lost because they focus more on what you're doing than what you're saying" (ID3). Another participant observed, "it is very positive to see yourself afterwards, with the class recorded, how you've interacted with the students" (ID5), highlighting the value of reviewing teaching practices to improve engagement and communication. One participant stressed the need to consider "all aspects of a session: arriving, greeting the students and also observing" (ID6).

Participants expressed concerns about engaging peers, as one noted, "I was also worried about the fact that obviously they are our classmates, but in the end, I think it went well" (ID1). Active student participation was viewed positively, reflected in the statement, "I did enjoy doing it and having volunteers come forward" (ID2). Engagement was often judged through student motivation and participation, as one participant noted, "you're always used to maybe judging whether what you're doing is right or wrong, perhaps by the motivation shown by the students or how they participate in class" (ID3). Observing student reactions provided valuable insights for improvement. One participant mentioned, "the fact that you're

being recorded and can see others' reactions can help you see what you need to improve" (ID4). The authenticity of engagement in a simulated teaching environment was a concern, as one participant remarked, "it was an activity for first-year of secondary school, and I was worried that when I presented it in class the reception of the activity by the students, after all, they are classmates from the master's program, they don't enter that role" (ID10). However, the microteaching sessions, watching the iVR recordings, and subsequent reflections were highlighted as key sources of mastery experience.

Under the category 'other', three subcategories were identified, namely transferability, context and physiological and emotional states. Participants emphasised the microteaching experience as valuable for developing teaching skills and professional growth, describing it as "a trigger to improve afterwards. It helps us a lot for the other teaching practice sessions we've had with other teachers" (ID1). The near-real experience was praised for offering "the opportunity to experience almost a real situation" (ID2) and was deemed universally applicable, "any teacher, from any subject, at any level, can do it" (ID3). The importance of a simulated learning environment for realism and effectiveness was stressed, with role-playing as 'real students' seen as crucial, as remarked by one participant, "it's important to say to them, hey, now you're going to be second-year secondary education students. I want disruptive behaviour" (ID8). Some suggested integrating real learning situations with actual secondary students to enhance realism (ID7), and the context provided by microteaching was also considered beneficial for career exploration, particularly for undergraduate students, for its potential to help students discern their vocational interests. As observed by a participant, "maybe there's someone who doesn't really realize whether they truly have a vocation or not. It can help them say, well, I liked this experience, so I want to pursue this path" (ID1). Additionally, participants expressed positive feelings about their experiences, noting they felt good, happy, and comfortable, "I felt comfortable, I really think it's very useful. I'd repeat the experience" (ID3). Despite initial inhibition and performance pressure, "I did notice a bit more pressure because I knew there would be a camera" (ID4), many reported becoming more comfortable and focused, with one stating, "I really enjoyed the experience, and if I were a teacher on the master's program, that's an activity I would do" (ID6).

4. Discussion

This study examined the impact of microteaching, using iVR cameras for video recording, on Spanish PSTs' self-efficacy in teaching, attempting to address a gap in the field of study. Notably, the study aimed to respond two research questions, that is, what were Spanish PSTs' levels of self-efficacy for teaching before and after participating in a microteaching practice, recorded with a 360-degree camera, and what were their insights concerning self-efficacy after the iVR microteaching experience.

In terms of the quantitative analysis, the Wilcoxon signed-rank test proffered significant differences concerning efficacy for instructional strategies, which bears resemblance to what has been attested to in previous research (Carcamo, 2023; Eğinli & Solhi, 2021). Nonetheless, the lack of divergence related to classroom management or student engagement between the pre- and post tests deviates from findings in Carcamo (2023), and Eğinli and Solhi (2021), who reported significant changes in these dimensions as well. Such findings might be related to the type of context where PSTs engaged in microteaching; the participants in the present study delivered the lessons to their own classmates before the

practicum, while in Carcamo (2023) PST collaborated with authentic students, assuming the role of educators on a weekly basis over the course of two months, and in Eğinli and Solhi (2021) the post test was carried out after the practicum. The qualitative analysis might offer a more sharply focused lens into the Spanish PSTs' perceived self-efficacy after the iVR microteaching experience.

The qualitative analysis revealed that the participants in this study found microteaching with iVR recordings highly beneficial for reflecting on their teaching performance. They did not feel threatened by the camera and appreciated the immersive nature of the 360-degree video, which enhanced their reflective practice and self-efficacy. These findings support Walshe and Driver's (2019) assertion that 360-degree videos improve reflective practice in microteaching, and López-Belmonte's et al. (2024) that VR technologies are beneficial in educational contexts, improving various outcomes for different learner groups. Participants also highlighted the usefulness of microteaching in understanding teaching complexities and bridging the theory-practice gap, echoing Pringle et al. (2003). Besides, participants endorsed microteaching as a useful, effective and beneficial practice (Benton-Kupper, 2001; Fernandez & Robinson, 2006). Despite some researchers' doubts about video recording hindering natural behaviour (Linman, 1980), the findings in this study indicate that participants valued the iVR recordings for their contribution to immersive reflection and self-efficacy enhancement.

The findings on the three dimensions of the TSES highlight that clear instructional strategies, such as planning and executing well-structured lessons, boosted participants' confidence, echoing Carcamo's (2023) insights on self-efficacy. Participants identified effective classroom and time management strategies as crucial for enhancing their teaching efficacy, aligning with findings by Carcamo (2023) and García-Lázaro et al. (2022). The present study also revealed that promoting student interactions through engaging activities was key to participants' success, underscoring the critical role of student engagement in self-efficacy, as noted by Carcamo (2023).

Participants highly valued the hands-on practice and immediate constructive feedback from peers and teachers, underscoring the importance of enactive mastery experiences and verbal persuasion (Bandura, 1997). This aligns with Aarsal's (2014) study on enhancing self-efficacy. Planning, implementing, and receiving feedback on lessons helped participants identify and correct issues, while peer observations provided insights from classmates' strengths and areas for improvement, supporting the role of vicarious experiences in developing self-efficacy (Aarsal, 2014). Participants reported feeling happy and comfortable with microteaching, overcoming initial inhibition and performance pressure, which positively impacted their self-efficacy, consistent with Carcamo's (2023) findings on physiological and emotional states.

5. Conclusions

In summary, the present study investigated self-efficacy in a group of Spanish PSTs, focusing on the impact of microteaching, recorded with iVR. The findings highlight that understanding the complex interactions among the different factors influencing self-efficacy can inform the design of more effective teacher training programs and educational interventions.

The findings in this study contribute to the theoretical understanding of self-efficacy development in PSTs by highlighting the significant role of iVR in microteaching. Future research can build on these findings to explore other advanced technologies in teacher training programs. Additionally, the context in which microteaching occurs, such as simulated versus real classrooms, significantly impacts self-efficacy outcomes. This suggests that future theoretical models should incorporate context as a critical variable in self-efficacy development. The mixed methods design employed in this study provides a comprehensive view of self-efficacy, and theoretical frameworks can be expanded to include both quantitative and qualitative measures to better capture the complexities of self-efficacy.

From a practical perspective, teacher training programs should consider integrating iVR technology into their curricula. This technology not only enhances reflective practices but also provides a realistic teaching environment that helps pre-service teachers improve their instructional strategies, classroom management, and student engagement skills. The importance of immediate and constructive feedback from both peers and instructors was emphasized, suggesting that training programs should develop structured feedback protocols to ensure that pre-service teachers receive timely and actionable insights into their teaching practices. Moreover, providing more extensive and varied practical teaching opportunities, including longer microteaching sessions and internships in diverse classroom settings, can further enhance PSTs' self-efficacy, as hands-on experience is crucial for professional growth.

Addressing the emotional and physiological states of PSTs during training can help mitigate initial nervousness and performance anxiety. Programs should incorporate stress management and confidence-building activities to create a supportive learning environment. Incorporating real students or more realistic role-playing scenarios into microteaching sessions can enhance the authenticity of the experience, helping pre-service teachers better prepare for actual classroom situations and improve their engagement strategies. Furthermore, promoting collaboration and peer learning through group discussions and shared teaching experiences can foster a supportive learning community, providing diverse perspectives and encouraging the sharing of best practices.

This study has several limitations. First, participants recommended real classroom environments to enhance the realism and effectiveness of microteaching. Second, more time for each session would be beneficial. Third, using students as role-playing pupils could make the experience more interactive. Fourth, the small sample size limits the generalisability of the results. Lastly, each participant delivered only one microteaching practice, highlighting the need for a study encompassing the six-stage cyclical process to observe PSTs' development. Addressing these limitations in future research could provide deeper insights into the effectiveness of microteaching.

In conclusion, this study confirms that microteaching with iVR recordings enhances self-efficacy among PSTs. The integration of hands-on practice, peer observation, and constructive feedback creates a robust framework for professional growth, preparing future educators for real classroom challenges. Understanding the factors influencing self-efficacy can inform the design of more effective teacher training programs, ultimately boosting the professional growth and confidence of future educators.

Authors' Contribution

Conceptualization, M. E. R. G., B. M. S., and B. S. P.; data curation, M. E. R. G., and B. M. S.; formal analysis, M. E. R. G., B. M. S., and B. S. P.; funding acquisition, M. E. R. G.; investigation, M. E. R. G., B. M. S., and B. S. P.; methodology, M. E. R. G., B. M. S., and B. S. P.; project administration, M. E. R. G., B. M. S., and B. S. P.; resources, B. S. P.; software, B. M. S.; supervision, M. E. R. G., B. M. S., and B. S. P.; validation, M. E. R. G., B. M. S., and B. S. P.; visualization, M. E. R. G., B. M. S., and B. S. P.; writing—original draft preparation, M. E. R. G., B. M. S., and B. S. P.; writing—review and editing, M. E. R. G., B. M. S., and B. S. P.

Funding Agency

This study is part of the educational innovation project “Mejora de la reflexión del docente en formación y su autoeficacia a través de la microenseñanza y la grabación con cámaras de 360°” (PIE 2023-11-65), funded by the Vice-Rectorate of Teaching Staff, Academic Organisation and Educational Innovation of the University of Las Palmas de Gran Canaria, through the 2023 call for educational innovation projects.

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