Immersive Knowledge Transfer Through VR Glasses: Designing and Using Instructional Video-based Microlearning for Customer Self-repair and Technical Support

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Abstract: The growing complexity of technical products and increasing customer expectations for fast and autonomous problem resolution are driving the need for new approaches to knowledge transfer beyond traditional service channels. Virtual reality (VR), combined with immersive video-based microlearning, offers new possibilities for delivering procedural knowledge directly to end users. This study investigates the effectiveness of immersive, video-based microlearning delivered through VR glasses in supporting customer self-repair and technical support. The study adopts a quantitative research design based on a large-scale CAWI survey conducted among 11,318 users of technical products across three European countries. The analysis focuses on key constructs, including usability, learning effectiveness, task complexity reduction, customer confidence, and reduction in service interactions. The results indicate that immersive instructional content significantly enhances procedural understanding, reduces perceived task complexity, and increases customer confidence in performing basic maintenance and repair tasks. The findings also suggest a partial reduction in reliance on traditional service channels. This study contributes to the literature by extending immersive learning research to customer self-service contexts and by empirically validating relationships between usability, learning effectiveness, and customer confidence in VR-supported environments. The results offer practical implications for organizations seeking to redesign technical support models through immersive learning technologies.

Keywords: Virtual reality, Immersive learning, Customer knowledge transfer, Self-service innovation

1. Introduction

The increasing technological complexity of contemporary industrial products, combined with rising customer expectations for rapid and autonomous problem resolution, is transforming traditional approaches to technical support and knowledge transfer. Customers are no longer passive recipients of service but are becoming active participants in maintenance and repair processes. This shift creates a growing demand for accessible, effective, and user-centered forms of instructional support that go beyond conventional manuals and standard video tutorials (Żywiołek 2025a; Pandey et al. 2023).

In response to these challenges, immersive technologies—particularly virtual reality (VR)—are emerging as promising tools for enhancing the transfer of procedural and tacit knowledge. VR glasses, when combined with instructional video-based microlearning, enable users to engage with content in a highly contextualized and interactive manner. Unlike traditional learning formats, immersive environments can simulate real-world tasks, guide users step by step, and provide a sense of presence that facilitates deeper understanding and retention of knowledge (Żywiołek 2025b). This is especially relevant in the context of customer self-repair, where clarity of instruction and user confidence are critical factors determining successful task completion.

Despite growing interest in extended reality, research on its use in customer self-service and technical support remains limited. Most studies focus on training contexts, with little attention to empowering end users. There is also a lack of empirical evidence on how immersive microlearning affects user experience, task complexity, and knowledge transfer in real settings. This study addresses this gap by investigating the use of VR glasses as a medium for delivering instructional microlearning aimed at supporting customer self-repair in a manufacturing environment. The study adopts a quantitative research approach based on survey data collected from users of technical products (Sterbak et al. 2022; Zhong 2020). The study evaluates key dimensions such as usability, learning effectiveness, user engagement, and the impact of immersive guidance on reducing reliance on traditional service channels.

The main contributions of this research are threefold. First, it provides empirical insights into the effectiveness of immersive video-based learning in enhancing procedural knowledge and customer autonomy. Second, it identifies the practical benefits and limitations associated with implementing VR-supported self-repair systems in an industrial context. Third, it offers managerial implications for manufacturing firms seeking to redesign their technical support models by integrating immersive learning technologies, with the aim of improving customer experience while reducing service costs.

The remainder of the paper is structured as follows: the next section reviews the literature on immersive learning, virtual reality, and customer knowledge transfer. The subsequent section presents the research methodology (Koohang et al. 2023). This is followed by the presentation and analysis of empirical findings. The discussion section interprets the results in relation to existing research, and the final section concludes with practical implications and directions for future research.

2. Review of Literature

This section presents the theoretical background of immersive knowledge transfer, focusing on the use of virtual reality (VR) and video-based microlearning in the context of customer self-repair and technical support. It discusses the evolution of immersive learning technologies, the role of microlearning in procedural knowledge acquisition, and the growing importance of customer knowledge empowerment in industrial environments.

2.1 Immersive Technologies and Virtual Reality in Knowledge Transfer

Immersive technologies, particularly virtual reality, have gained increasing attention as tools for enhancing learning and knowledge transfer processes. VR enables users to interact with simulated environments in a way that closely resembles real-world experiences, thereby supporting experiential learning and improving cognitive engagement (Shang et al. 2024). Unlike traditional instructional formats, immersive environments allow users to perform tasks in a controlled yet realistic setting, which is particularly valuable for acquiring procedural and tacit knowledge.

Research indicates that immersion plays a critical role in learning effectiveness, as it increases user attention, reduces cognitive overload, and enhances memory retention. VR-based training has been widely applied in fields such as healthcare, aviation, and industrial operations (Żywiołek et al. 2025), where accurate task execution is essential. However, most existing applications focus on employee training, with relatively limited attention given to end users such as customers performing independent maintenance or repair tasks.

2.2 Video-based Microlearning and Procedural Knowledge Acquisition

Microlearning refers to short, focused learning units designed to deliver specific knowledge or skills in a concise and accessible format. In recent years, video-based microlearning has become particularly popular due to its ability to present complex procedures in a clear and visually guided manner. This approach aligns well with the concept of "just-in-time" learning, where users access information exactly when it is needed (Yordanova 2025).

In the context of technical tasks, video-based instruction has been shown to improve comprehension and task performance compared to text-based manuals. By breaking down procedures into manageable steps and combining visual and auditory cues, microlearning supports faster knowledge acquisition and reduces the likelihood of errors. When integrated with immersive technologies such as VR, video-based microlearning can further enhance learning outcomes by embedding instructional content within a realistic task environment (Khan et al. 2023).

2.3 Customer Self-Service, Self-Repair and Knowledge Empowerment

The increasing availability of digital technologies has contributed to the growing importance of customer self-service models. Customers are increasingly expected to perform basic maintenance and troubleshooting tasks independently, particularly in industries characterized by complex technical products. This shift reflects a broader trend toward customer empowerment, where users are equipped with the knowledge and tools necessary to manage products without direct assistance from service personnel (Żywiołek 2024).

Effective knowledge transfer is a key enabler of successful self-repair. Traditional support channels, such as printed manuals, call centers, or standard video tutorials, often fail to provide sufficient clarity or contextual guidance, leading to user frustration and increased reliance on service desks. In contrast, interactive and immersive forms of instruction have the potential to bridge this gap by delivering more intuitive and user-centered learning experiences (Gupta et al. 2019).

2.4 Research Gaps and Emerging Trends in Immersive Customer Support

Despite the growing interest in immersive learning technologies, several research gaps remain. First, existing studies have predominantly focused on VR applications in formal training settings, with limited empirical evidence on their effectiveness in customer-facing contexts. Second, there is a lack of research examining how immersive instructional content influences key outcomes such as user confidence, perceived task complexity, and independence in problem-solving.

Furthermore, the integration of VR with microlearning approaches in real industrial environments has not been sufficiently explored. Most studies rely on experimental or laboratory settings, which do not fully capture the complexity of real-world usage scenarios. There is also a need to better understand the organizational implications of implementing immersive support systems, including their impact on service efficiency and cost reduction.

In response to these gaps, this study investigates the application of VR-based instructional microlearning in a real manufacturing context, focusing on its role in supporting customer self-repair and transforming traditional technical support models.

The proposed research model is grounded in established theoretical perspectives on technology adoption and experiential learning. In particular, the relationships between usability, learning effectiveness, and customer confidence can be explained by the Technology Acceptance Model (TAM) and self-efficacy theory. Usability reflects perceived ease of use, which influences both learning outcomes and user confidence. At the same time, immersive learning environments support experiential learning processes, enhancing procedural understanding and reducing perceived task complexity. These theoretical foundations provide a basis for the formulation of the research hypotheses.

3. Research Model and Hypotheses

Based on the literature on immersive learning, usability, and customer self-service, a research model was developed to examine the relationships between key constructs influencing customer self-repair supported by VR-based microlearning.

The model assumes that the usability of VR solutions positively affects learning effectiveness, which in turn reduces perceived task complexity and increases customer confidence. Higher confidence is expected to reduce reliance on traditional service interactions.

The following hypotheses are proposed:

H1: Usability positively influences learning effectiveness.

H2: Learning effectiveness positively influences task complexity reduction.

H3: Task complexity reduction positively influences customer confidence.

H4: Learning effectiveness positively influences customer confidence.

H5: Usability positively influences customer confidence.

H6: Customer confidence positively influences reduction in service interactions.

Figure 1 presents the proposed research model.

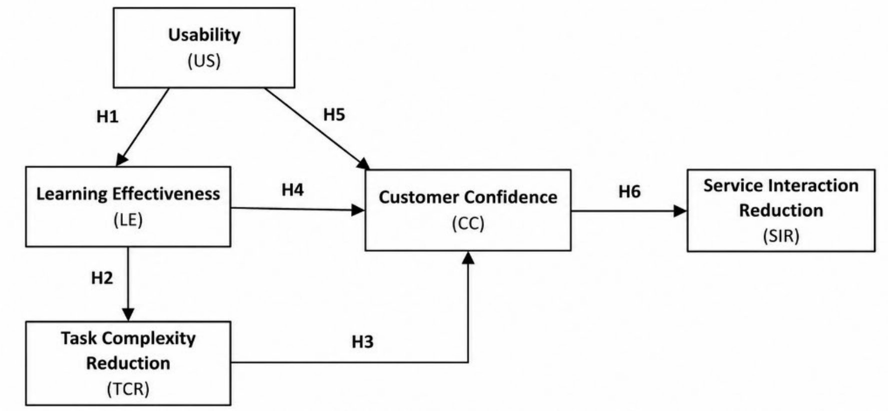

Figure 1: Research model

The proposed model reflects the interdependencies between usability, learning effectiveness, and customer confidence in VR-supported environments. It enables a structured examination of how immersive microlearning influences user autonomy and reduces reliance on traditional technical support.

4. Materials and Methods

This study adopts a quantitative research design to examine the role of immersive, video-based microlearning delivered through VR glasses in supporting customer self-repair and technical support. Data were collected using the CAWI method among respondents from Poland, Norway, and Portugal.

The study is based on quantitative data, enabling statistical analysis of relationships between key constructs using SEM-PLS. A total of 11,318 participants took part in the survey. The research instrument was a structured questionnaire with 26 items measured on a 7-point Likert scale, covering usability, learning effectiveness, task complexity reduction, customer confidence, and service interaction reduction.

Data were analyzed using PLS-SEM in SmartPLS, selected for its suitability in examining relationships between latent variables. The research process included four stages: literature review, questionnaire development, data collection, and statistical analysis. Figure 2 presents the stages of the research process.

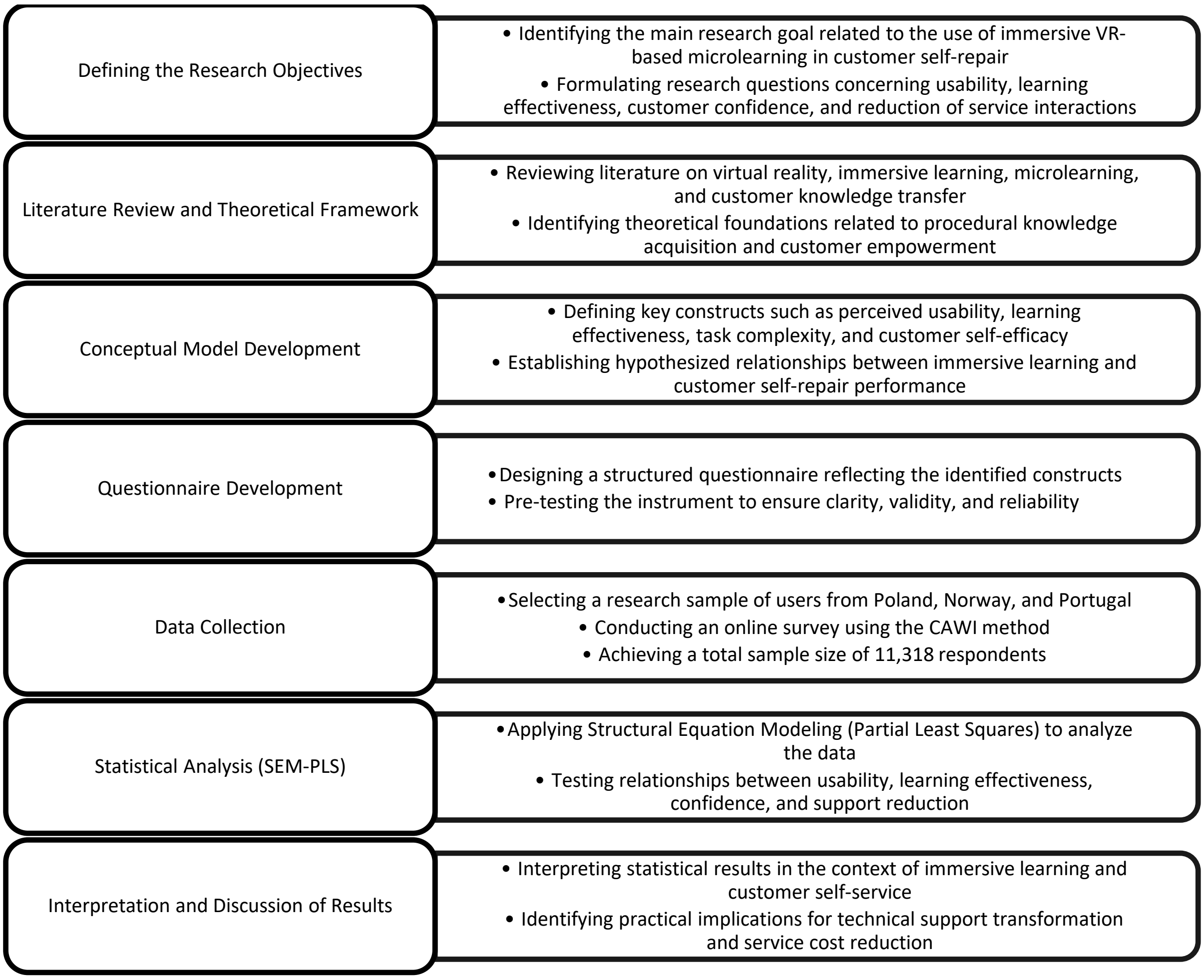

Figure 2: Research Steps

Figure 2 presents the stages of the research process, from problem identification to results interpretation. The empirical study was conducted on a large and diverse sample from Poland, Norway, and Portugal, with Table 1 summarizing the key characteristics of the respondents.

Table 1: Description of the research group

Category	Subcategory	Distribution (%)
Gender	Male	68%
	Female	32%
Age	18–29 years	21%
	30–39 years	26%

Category	Subcategory	Distribution (%)
	40–49 years	23%
	50+ years	30%
Education	Secondary education	46%
	Higher education	54%
Professional position	Technical specialists	34%
	Managers	27%
	Operational staff	23%
	Business owners / self-employed	16%
Experience with immersive / digital technologies		

The analysis confirms high demographic and professional diversity, providing a reliable basis for examining perceptions of immersive learning technologies. The sample consisted of 68% men and 32% women, with most respondents aged 30–49, representing active users of technical products. A notable share of participants was also aged 50+, capturing varying levels of technological familiarity. The sample was balanced in terms of education (54% higher, 46% secondary). Technical specialists formed the largest group (34%), followed by managers (27%), operational staff (23%), and business owners (16%), reflecting strong representation of users engaged in technical processes. Experience with digital technologies varied: 44% reported general familiarity with digital tools, 39% had knowledge of immersive technologies, and 17% had practical experience with VR. This allows for assessing both expectations and actual usability perceptions.

The questionnaire covered familiarity with VR, usability, clarity of instruction, learning effectiveness, task complexity, and customer confidence. It also examined the impact on service interactions and attitudes toward adoption, enabling the identification of key drivers and barriers to using VR-based support tools.

From a methodological perspective, the analysis was conducted with a high level of statistical rigor, applying a significance level of 0.01 and a maximum estimation error of d = 1%. The study was intentionally carried out in three European countries—Poland, Norway, and Portugal—representing different levels of digital maturity and technological adoption, which strengthens the comparative dimension of the research.

The statistical analysis was performed using Microsoft Excel, Statistica, and SmartPLS software. In particular, SmartPLS was used to conduct Structural Equation Modeling (SEM-PLS), allowing for the examination of complex relationships between latent variables such as perceived usability, learning effectiveness, customer confidence, and reduction in reliance on traditional support channels. This approach enabled robust validation of the research model and provided detailed insights into the role of immersive microlearning in supporting customer self-repair.

A quantitative approach was considered appropriate due to the study's objective of examining relationships between latent variables and testing a structured research model. The use of SEM-PLS enables the analysis of complex interdependencies between constructs such as usability, learning effectiveness, and customer confidence

5. Empirical Results

This section presents the empirical findings on the effectiveness of immersive, video-based microlearning delivered through VR glasses in customer self-repair and technical support. The analysis focuses on key constructs, including usability, learning effectiveness, task complexity reduction, customer confidence, and reduction in service interactions. Relationships between these variables are examined using SEM-PLS, with attention to differences across respondent groups. Table 2 presents mean values and Cronbach's alpha coefficients, confirming the reliability of the measurement scales. The results indicate that Learning Effectiveness achieved the highest evaluation ($M = 5.34$; $\alpha = 0.92$), suggesting that respondents perceive immersive video-based instruction as highly effective in supporting the understanding of procedural tasks. Participants emphasized that step-by-step guidance presented in a VR environment significantly improved their ability to follow and replicate maintenance and repair activities.

Similarly, Customer Confidence scored highly ($M = 5.08$; $\alpha = 0.89$), indicating that immersive learning not only enhances knowledge acquisition but also strengthens users' belief in their ability to independently perform technical tasks. This finding is particularly relevant in the context of self-repair, where confidence directly influences user engagement and task completion.

The construct Reduction of Task Complexity also received a strong evaluation (M = 4.96; α = 0.87), demonstrating that VR-based instructional content helps simplify the perception of complex procedures. By visualizing actions in a realistic environment, users reported a clearer understanding of task sequences and reduced cognitive effort.

Perceived Usability of VR solutions was rated positively (M = 4.72; α = 0.90), indicating that respondents generally found immersive systems intuitive and accessible. However, the slightly lower score compared to learning-related constructs suggests that usability challenges—such as device comfort or initial adaptation—may still exist for some users.

The lowest mean value was observed for Reduction in Service Interactions (M = 4.18; α = 0.85). While still positively evaluated, this result indicates that although immersive learning supports user independence, it does not entirely eliminate the need for traditional technical support. This may reflect the limitations of VR solutions in addressing more complex or unexpected technical issues.

Overall, the findings confirm that immersive, video-based microlearning delivered through VR glasses significantly enhances procedural understanding, reduces perceived task difficulty, and increases customer confidence. At the same time, the results suggest that further development of usability aspects and integration with existing support systems is necessary to fully realize the potential of immersive technologies in transforming technical service models.

Table 2: Mean values and Cronbach's α coefficient

Variable	Mean	Cronbach's Alpha
Learning Effectiveness	5.34	0.92
Customer Confidence	5.08	0.89
Reduction of Task Complexity	4.96	0.87
Perceived Usability of VR Solutions	4.72	0.90
Reduction in Service Interactions	4.18	0.85

Table 3 presents the analyzed factors, including mean values and reliability coefficients (Cronbach's alpha), related to immersive, video-based microlearning in customer self-repair. The variables cover key dimensions such as usability, learning effectiveness, task complexity reduction, customer confidence, and reduction in service interactions. The analysis also includes user engagement, clarity of guidance, and overall satisfaction, enabling the examination of relationships between usability, learning outcomes, and behavioral intentions toward VR-based support tools. To ensure the methodological rigor of the study, Cronbach's alpha coefficients were calculated for all constructs, confirming a high level of internal consistency and reliability of the measurement scales. This approach strengthens the validity of the results and supports further analysis of dependencies between variables within the proposed research model.

Table 3: Relationships between factors

	Usability	Learning Effectiveness	Task Complexity Reduction	Customer Confidence	Service Interaction Reduction
Usability	1	0.64	0.58	0.61	0.47
Learning Effectiveness	0.64	1	0.66	0.72	0.53
Task Complexity Reduction	0.58	0.66	1	0.68	0.55
Customer Confidence	0.61	0.72	0.68	1	0.59
Service Interaction Reduction	0.47	0.53	0.55	0.59	1

The analysis of the survey results provides empirical insight into the effectiveness of immersive, video-based microlearning delivered through VR glasses in supporting customer self-repair and technical assistance processes. The study examined five key variables: perceived usability of VR solutions, learning effectiveness, reduction of task complexity, customer confidence, and reduction in service interactions. All variables were measured using a 7-point Likert scale, and internal consistency was verified using Cronbach's Alpha coefficients.

Among the analyzed dimensions, the highest average score was recorded for Learning Effectiveness ($M = 5.34$; $\alpha = 0.92$), indicating that respondents perceive immersive instructional content as highly effective in facilitating the understanding of procedural tasks. The combination of visual guidance and contextual immersion significantly enhances users' ability to follow and replicate repair activities. Similarly, Customer Confidence achieved a high score ($M = 5.08$; $\alpha = 0.89$), confirming that improved understanding directly translates into greater self-efficacy in performing technical tasks independently.

The variable Reduction of Task Complexity also received a strong evaluation ($M = 4.96$; $\alpha = 0.87$), suggesting that immersive environments help simplify the perception of complex procedures by presenting them in a clear and structured manner. Perceived Usability of VR systems was rated positively ($M = 4.72$; $\alpha = 0.90$), indicating that users generally find such solutions intuitive, although some barriers related to initial adaptation and device handling may still exist. The lowest average score was observed for Reduction in Service Interactions ($M = 4.18$; $\alpha = 0.85$). While still above the neutral midpoint, this result suggests that immersive learning supports user independence but does not fully replace traditional technical support, particularly in more complex or unforeseen situations.

Correlation analysis revealed strong and statistically significant relationships among the examined variables. In particular, Learning Effectiveness was strongly correlated with Customer Confidence ($r = 0.72$) and Reduction of Task Complexity ($r = 0.66$), indicating that effective knowledge transfer directly enhances both user competence and perceived ease of task execution. Furthermore, Usability demonstrated meaningful relationships with both Learning Effectiveness ($r = 0.64$) and Customer Confidence ($r = 0.61$), confirming that the intuitive design of immersive systems plays a critical role in achieving positive learning outcomes. Moderate correlations were also observed between Customer Confidence and Reduction in Service Interactions ($r = 0.59$), suggesting that increased user autonomy contributes to a decreased reliance on external support. Overall, the results highlight that the effectiveness of immersive knowledge transfer depends not only on the quality of instructional content but also on system usability and user experience. The findings support the assumption that VR-based microlearning can significantly improve procedural understanding, enhance user confidence, and partially transform traditional technical support models.

The relationships between the analyzed constructs were further examined using Structural Equation Modeling (SEM-PLS). The following figure presents the estimated research model along with the path coefficients, illustrating the strength and direction of relationships between usability, learning effectiveness, customer confidence, and service interaction reduction (table 4).

Table 4: Results of the SEM-PLS analysis

Hypothesis / Relationship	Path coefficient (β)	t-value	p-value	Result
H1: Usability → Learning Effectiveness	0.64	18.72	< 0.001	Supported
H2: Learning Effectiveness → Task Complexity Reduction	0.66	19.85	< 0.001	Supported
H3: Task Complexity Reduction → Customer Confidence	0.68	20.43	< 0.001	Supported
H4: Learning Effectiveness → Customer Confidence	0.72	22.11	< 0.001	Supported
H5: Usability → Customer Confidence	0.61	17.36	< 0.001	Supported
H6: Customer Confidence → Service Interaction Reduction	0.59	16.94	< 0.001	Supported

To examine relationships between constructs, SEM analysis using PLS-SEM was conducted. The model tested the effects of usability and learning effectiveness on customer confidence, as well as the impact of confidence on reducing service interactions. The results show that learning effectiveness has the strongest positive effect on customer confidence ($\beta = 0.72$), indicating that immersive instruction significantly improves users' ability to perform repair tasks independently. Usability of VR Solutions also demonstrates a significant positive effect on both Learning Effectiveness ($\beta = 0.64$) and Customer Confidence ($\beta = 0.61$). This suggests that intuitive system design, ease of navigation, and overall user comfort are critical factors that support both the learning process and the willingness of customers to engage with self-repair tasks. In other words, even highly effective content may not achieve its full potential if the technological interface is perceived as difficult or unintuitive.

Furthermore, Learning Effectiveness strongly contributes to the Reduction of Task Complexity ($\beta = 0.66$), which in turn has a significant positive effect on Customer Confidence ($\beta = 0.68$). This indirect pathway indicates that immersive learning simplifies the perception of technical tasks, making them more accessible and manageable for users without specialized expertise.

The model also confirms that Customer Confidence has a meaningful impact on the Reduction in Service Interactions ($\beta = 0.59$), suggesting that users who feel more capable are less likely to rely on traditional technical support channels. However, the strength of this relationship indicates a partial rather than complete substitution effect, meaning that immersive solutions complement rather than fully replace conventional service models.

The coefficient of determination (R^2) values further support the explanatory power of the model. Learning Effectiveness reaches an R^2 of 0.41, Task Complexity Reduction 0.44, Customer Confidence 0.55, and Service Interaction Reduction 0.35, indicating moderate to strong levels of explained variance across the constructs.

The findings from the structural model demonstrate that the effectiveness of immersive VR-based microlearning is not solely dependent on the technology itself, but rather on the interaction between usability, instructional quality, and user perception. While technological accessibility is important, the primary driver of successful self-repair remains the ability of users to understand and confidently apply procedural knowledge. The results emphasize that user-centered design and knowledge-oriented implementation are crucial, beyond technology alone. Organizations should focus on clarity, usability, and alignment with user capabilities.Overall, the model confirms that immersive microlearning enhances customer autonomy, improves learning outcomes, and supports the shift toward more efficient, self-service-oriented support models.

6. Discussion and Conclusion

From a theoretical perspective, the study extends immersive learning research to customer self-service contexts and validates a model linking usability, learning effectiveness, and customer confidence in VR environments.

The findings confirm that immersive microlearning supports procedural understanding, reduces perceived task complexity, and increases customer confidence in performing repair activities (Zhou et al. 2024).

The strongest effects concerned learning effectiveness and customer confidence, showing that immersive instructional content supports the acquisition and application of procedural knowledge. This aligns with experiential learning theory, which stresses the value of contextualized interaction for knowledge retention. Unlike manuals or standard videos, VR instruction enables users to engage with simulated tasks, improving cognitive processing and learning outcomes (Hu and Zhao 2024).

The results highlight the critical role of usability in the success of immersive learning solutions. Despite advanced VR capabilities, effectiveness depends on intuitive and accessible design. The positive relationship between usability, learning effectiveness, and customer confidence confirms the importance of user-centered design in technology adoption.

The study also shows that immersive learning reduces perceived task complexity, acting as a mediator between knowledge acquisition and user confidence. By presenting procedures as clear, step-by-step visual instructions, VR-based microlearning makes technical tasks more accessible for non-expert users, extending prior research by demonstrating enhanced effectiveness within immersive environments (Dwivedi et al. 2022).

However, the results indicate that the reduction in service interactions, although significant, is not complete. This suggests that immersive solutions should complement rather than replace traditional technical support. In more complex situations, users may still require expert assistance, highlighting the need for hybrid support models integrating immersive and conventional channels.

From a broader perspective, the study contributes to the literature by shifting the focus of immersive technologies from employee training to customer-oriented knowledge transfer. It provides empirical evidence of VR's effectiveness in empowering end users beyond organizational settings, extending the concept of knowledge management toward more distributed and user-driven models.

From a managerial standpoint, the findings suggest that organizations aiming to implement VR-based support systems should prioritize three key areas. First, they should invest in the development of high-quality instructional content that is tailored to user needs and specific technical tasks. Second, ensuring usability and accessibility of VR solutions is essential to maximize adoption and effectiveness. Third, companies should integrate immersive learning into existing service ecosystems, creating hybrid support models that balance automation with human expertise (Onwubiko 2015).

This study examined the effectiveness of immersive, video-based microlearning delivered through VR glasses in supporting customer self-repair and technical support. The findings indicate that immersive learning enhances procedural understanding, reduces perceived task complexity, and increases customer confidence in performing basic maintenance tasks. The results also suggest a partial reduction in reliance on traditional service channels, supporting more autonomous and cost-efficient support models.

The study has several limitations. Although conducted across three European countries, the findings may not be fully generalizable to other contexts. The use of self-reported data may reflect subjective perceptions rather than actual performance. Additionally, the focus on relatively simple tasks limits applicability to more complex technical scenarios.

Future research should incorporate experimental designs to assess actual task performance and error rates. Qualitative approaches, such as interviews or user observations, could provide deeper insights into user experience and adoption barriers. Longitudinal studies would further help to evaluate the long-term impact of VR-based learning on user competence and reliance on technical support. In conclusion, immersive microlearning represents a promising direction for customer support and knowledge transfer. However, its effectiveness depends not only on technology, but also on usability, instructional design, and integration with existing support systems.

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AI Declaration: AI tools were not used to create this article.

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