Paedagogi: Jurnal Kajian Ilmu Pendidikan (e-journal)
Volume 12, Issue 1, Pages 27–39 June 2026 e-ISSN: 2407-7445 p-ISSN: 2085-9880
https://jurnal.unimed.ac.id/2012/index.php/PAEDAGOGI/issue/view/3637
: *https://doi.org/10.24114/paedagogi.v12i1*

Digital Pedagogy in Wind Instrument Learning: Integrating Visual Micro-Skills for Correcting Technical Misconceptions in Trumpet Performance

Ibnu Syahruroji Fiqriannur [1*]

Setya Yuwana Sudikan [2]

Trisakti [3]

Anik Juwariyah [4]

Harpang Yudha Karyawanto [5]

Grace Natalie [6]

[1,4] Program Studi Pendidikan Seni Budaya, Fakultas Bahasa dan Seni, Universitas Negeri Surabaya, Surabaya, Indonesia.

[2] Program Studi Sastra Indonesia, Fakultas Bahasa dan Seni, Universitas Negeri Surabaya, Surabaya, Indonesia.

[3] Program Studi Sendratasik, Fakultas Bahasa dan Seni, Universitas Negeri Surabaya, Surabaya, Indonesia.

[5] Program Studi Seni Musik, Fakultas Bahasa dan Seni, Universitas Negeri Surabaya, Surabaya, Indonesia.

[6] Berkley College of Music, Boston, Amerika Serikat

***email:** 24020865011@mhs.unesa.ac.id

Keywords:
Digital Pedagogy,
Wind Instrument,
Visual Micro-Skills,
Misconceptions,
Trumpet Performance.

Received: May 2026
Accepted: June 2026
Published: June 2026

Abstract

This study aims to analyze the role of *visual micro-skill* within *digital pedagogy* in correcting technical misconceptions in trumpet playing at the micro motor skill level, particularly in the coordination of *embouchure*, *airflow*, and breathing control. The study employed a convergent mixed-methods design within a *design-informed pedagogical inquiry* framework involving 25 university students and drum band members with basic trumpet-playing experience. Quantitative data were collected through *pre-test* and *post-test*, while qualitative data were obtained through structured observation, practice documentation, and reflective interviews with six purposively selected participants. Data were analyzed using normality testing, paired sample *t*-test, and thematic analysis. The findings revealed a statistically significant improvement in trumpet-playing technical skills following the intervention, with mean scores increasing from 62.00 (SD = 2.94) to 84.72 (SD = 2.62) (t = 25.03, p < 0.001). Reflective interview findings further indicated that video-based learning supported participants in observing, imitating, and correcting techniques through repeated visual access, particularly in *embouchure* positioning, airflow direction, and breathing coordination. Features such as *close-up*, *slow motion*, *replay*, and *pause* enabled micro-level technical processes to be observed more explicitly, which had previously been difficult to understand through verbal instruction alone. These findings suggest that *visual micro-skill* has the potential to support more structured, reflective, and accessible trumpet technique learning within *digital pedagogy*. Theoretically, this study offers *visual micro-skill* as a pedagogical framework for understanding trumpet technique learning at the micro motor level, while practically providing an alternative video-based learning model to improve technical precision and reduce instructional ambiguity.

INTRODUCTION

Trumpet learning constitutes a complex motor skill practice that requires precise integration of embouchure, airflow control, and respiratory muscle coordination to produce stable sound quality. This complexity makes the learning process highly susceptible to the emergence of technical misconceptions, particularly in the use of excessive lip pressure and inefficient airflow patterns. The accuracy of sound production in wind instruments fundamentally depends on specific physiological coordination that is highly sensitive to micro-level errors; thus, small deviations in technique can significantly affect pitch stability and sound quality (López-Pineda et al., 2023). In this context, the formation of improper motor habits from the early stages tends to lead to the internalization of incorrect movement patterns that are difficult to correct at more advanced stages (Nelkenstock et al., 2023). This phenomenon directly impacts performance quality, such as tone inconsistency, muscle fatigue, and decreased performance efficiency, and in the long term may even trigger neuromuscular disorders and hinder the optimal development of playing skills (López Requena et al., 2024; Macovei et al., 2023). Therefore, the primary issue in trumpet learning lies in its vulnerability to technical misconceptions that have systemic implications for the quality and sustainability of performance.

In line with the complexity of trumpet learning, which demands mastery of motor skills at the micro level, conventional pedagogy remains dominated by verbal instruction and limited demonstration, leading learners to imitate without deeply understanding the technical process. Verbal instruction and demonstration essentially represent only a general overview of movement, thereby potentially causing misinterpretation of technique as they fail to present detailed processes explicitly (Michałko et al., 2022). In the context of music learning, this limitation of representation results in an incomplete understanding of the relationship between physical actions and sound outcomes (Fredriksson et al., 2024). This condition becomes increasingly problematic when micro-processes such as embouchure coordination, airflow direction, and muscle activation cannot be directly observed, rendering instruction ambiguous and difficult to transfer effectively. Consequently, learners often construct understanding based on unverified interpretations and tend to repeat technical errors during independent practice (Acquilino & Scavone, 2022). The lack of clear feedback in conventional pedagogy also leads to delayed correction, allowing technical errors to persist and become internalized as repetitive motor habits (Michałko et al., 2022). Therefore, the main limitation of conventional pedagogy lies in its inability to explicitly represent micro-level processes, which results in instructional ambiguity and the recurrence of technical misconceptions in trumpet learning.

These limitations create opportunities for the application of digital pedagogy, which enables more explicit representations of technique through detailed visualizations, repetition, and asynchronous learning access, allowing musical processes that were previously abstract to be observed more concretely by learners (Behzadaval et al., 2026). Previous studies have demonstrated that the integration of digital technologies in music education positively influences learning outcomes, musical skills, motivation, engagement, and overall learning experiences (Weatherly et al., 2026; Yihan et al., 2025). Other studies have highlighted the potential of visualization and digital media development as tools to support music learning (Zhang et al., 2024), while digital intervention research has largely evaluated instructional effectiveness based on performance achievement and other learning outcomes (Fauzy Ananda et al., 2025; Rahmawati et al., 2026). Nevertheless, limited attention has been given to the pedagogical mechanisms through which digital visualization shapes technical understanding. More specifically, previous research has not adequately explained how visualization supports learners in observing, understanding, and correcting technical skills at the micro-motor level. Therefore, a significant research gap remains regarding the pedagogical mechanisms through which digital visualization reconstructs technical understanding through the underlying cognitive and motor processes.

Building upon this gap, the present study introduces the novel concept of visual micro-skill, defined as a representational framework that focuses on the visualization of motor skills at the micro level, including fine muscle coordination, embouchure control, airflow direction and pressure, as well as synchronized movements that occur rapidly and often beyond conscious awareness. Rather than viewing video merely as an instructional medium, visual micro-skill introduces a conceptual lens that treats micro-level motor processes as observable and teachable units of learning. Through detailed, layered, and repeatable digital visualizations, visual micro-skill enables the transformation of musical processes from abstract and implicit phenomena into concrete, segmented, and reflectively analyzable learning experiences. Furthermore, the novelty of this study lies in repositioning visualization from a mere representational medium or instructional aid to an active pedagogical mechanism that reconstructs technical understanding through the interaction of visual perception, cognitive processing, and motor responses. Within the framework of digital pedagogy, this study specifically investigates how visual micro-skill functions as an epistemological bridge connecting sensorimotor experiences with the construction of technical knowledge, thereby opening new possibilities for understanding music learning not only as an outcome-oriented process but also as an internal dynamic that can be visualized and systematically intervened.

Based on this proposed framework of novelty, this study aims to analyze the role of visual micro-skill within the context of digital pedagogy, particularly in facilitating a more precise understanding of instrument-playing techniques at the micro level. More specifically, this study seeks to explain how such visual representations function as pedagogical mechanisms in correcting technical misconceptions that have been difficult to identify through conventional approaches, as well as to identify changes in playing skills that emerge in terms of motor control, coordination, and learners' technical awareness. Thus, this study is oriented not only toward learning outcomes but also toward the process of transforming technical understanding through the interaction of visualization, cognition, and motor practice. Theoretically, this study deepens the discourse on wind instrument pedagogy by positioning visualization as an analytical medium to reveal and represent internal processes, such as embouchure dynamics and airflow regulation, which have previously been latent and difficult to access. Practically, this study provides a foundation for the development of more diagnostic and intervention-oriented learning strategies, enabling the identification and correction of technical misconceptions in a more specific, systematic, and evidence-based manner.

RESEARCH METHOD

This study employed a convergent mixed-methods design to integrate quantitative and qualitative data in order to obtain a comprehensive understanding of both learning outcomes and learning processes. In this design, quantitative and qualitative data were collected during the same phase, analyzed separately, and subsequently integrated during interpretation to explain the relationship between performance improvement and the pedagogical processes underlying such changes (Creswell & Poth, 2018). Conceptually, the study also adopted a *design-informed pedagogical inquiry* framework rooted in *educational design research*, in which instructional interventions are used to reveal and interpret learning dynamics within authentic contexts while simultaneously generating pedagogical understanding of how learning processes develop during implementation (Hoadley, 2022; McKenney & Reeves, 2019). The intervention was implemented within a digital pedagogy framework by integrating the concept of visual micro-skill to represent micro-level motor skills, enabling an examination of how video visualization facilitates the correction of trumpet-playing misconceptions and how learners respond to and adapt their playing techniques. Through this integrated approach, the study not only identified changes in trumpet performance but also explored the pedagogical mechanisms underlying such transformations, particularly the interplay between visual representation, cognitive processes, and motor responses.

This study is conducted within a semi-formal learning context that represents real practices in wind instrument instruction, where the learning process occurs through a combination of independent experience and limited guidance, leading learners to rely on practical experience without explicit technical explanation. This condition underscores the importance of instructional representations that can reveal technical processes more clearly, particularly in learning complex motor skills that are difficult to observe directly (dos Santos Silva & Marinho, 2025). Based on this framework, the intervention is designed using digital pedagogy through video as a representation of visual micro-skills, enabling structured, detailed, and repeatedly accessible presentation of techniques. Structured presentation helps learners understand the sequence and relationships among technical components systematically, while visual detail allows more precise observation of motor aspects that were previously difficult to perceive. In addition, repeated access provides opportunities for learners to reinforce understanding and gradually adjust their practice according to their learning needs. The material focuses on fundamental aspects of trumpet playing—embouchure control, airflow management, and technical coordination—visualized through close-up, replay, and comparisons between correct and incorrect techniques, so that the intervention not only presents information but also facilitates reflective understanding, error evaluation, and more accurate technical adjustment.

The study was conducted through a series of structured stages involving 25 participants consisting of university students and members of drum band communities in Surabaya who had basic experience in trumpet playing. Participants were selected purposively based on their involvement in wind instrument learning practices, making them relevant for identifying and examining technical misconceptions. This approach emphasizes the selection of individuals with direct experience and contextual relevance to the research focus, thereby enabling the collection of rich and context-specific data (Campbell et al., 2020). The sample size was considered adequate to capture variations in learning experiences while allowing for an in-depth examination of skill development and the pedagogical mechanisms emerging throughout the intervention. Consistent with the study's objective of understanding learning processes and transformations within a specific context, participant selection was guided by the relevance of experience and the depth of information obtained rather than statistical representativeness (Creswell & Poth, 2018). The initial stage of the study involved dichotomous checklist-based observation to identify participants' initial technical skills and misconceptions related to *airflow to mouthpiece* and *breathing for brass instrument*. The observation findings served as the basis for a *visual micro-skill*-based video intervention incorporating *close-up*, *slow motion*, *replay*, and *pause* features, combined with two hours of guided practice. Changes in trumpet-playing skills were assessed through *pre-test* and *post-test*. Quantitative data were obtained from assessments of *embouchure control*, *airflow control*, and *breathing control*, while qualitative data were collected through observations, practice documentation, and reflective interviews with six purposively selected participants to explore skill development and the process of correcting technical misconceptions during the intervention.

Data analysis was conducted in stages based on the structure of the research questions. In the first stage, initial observational data were analyzed descriptively to identify technical misconceptions in trumpet playing related to *how to airflow to mouthpiece* and *how to breath for brass instrument* using a dichotomous checklist, which served as the basis for designing the *visual micro-skill* intervention. In the second stage, quantitative data were analyzed using a normality test followed by a *paired sample t-test* to identify differences in trumpet-playing skills between the *pre-test* and *post-test* across the dimensions of *embouchure control*, *airflow control*, and *breathing control*. In the third stage, qualitative data derived from practice documentation and reflective interviews with six purposively selected participants were analyzed using thematic analysis to explore participants' experiences during *visual micro-skill*-based learning, particularly in relation to technical observation, repeated practice, self-correction, the use of visual representations, and differences from verbally instructed learning. The analysis was further strengthened through a literature review within the framework of *digital pedagogy*, while data integration was conducted by linking findings from the initial observations, changes in technical skill scores, and participants' learning experiences to provide a more comprehensive explanation of the process of correcting technical misconceptions in trumpet playing.

RESULTS AND DISCUSSION

Technical Misconceptions in Trumpet Performance

The qualitative findings in this study were used to identify the characteristics of technical misconceptions in trumpet playing that emerged prior to the implementation of the *visual micro-skill* intervention. Data were collected through structured observation involving 25 participants during the initial stage of learning using a dichotomous checklist-based observation instrument (*yes/no*) to identify the presence of technical misconceptions in trumpet-playing practice. The observation focused on two fundamental aspects, namely *how to airflow to mouthpiece* and *how to breath for brass instrument*, encompassing indicators related to *embouchure* position, airflow direction and stability, and diaphragmatic breathing mechanisms. Each indicator was directly observed during participants' trumpet-playing practice to identify forms of technical misconceptions at the micro-motor level related to the coordination of *embouchure*, *airflow*, and breathing control. The observation results were subsequently accumulated into frequencies and percentages of participants experiencing technical misconceptions to provide a basis for understanding patterns of technical errors that developed prior to the intervention. Table 1 presents the observed technical misconceptions identified during the initial stage of learning.

Table 1. Observation Results of Technical Misconceptions in Trumpet Playing (Pre-Intervention)

Technical Aspect	Observed Misconception Indicators	Participants with Misconceptions (n=25)	Percentage
How to Airflow to Mouthpiece	Lip position too forward toward the mouthpiece	20	80%
	Lower lip folded inward	18	72%
	Excessive lip pressure	21	84%
	Uncontrolled airflow direction	19	76%
How to Breath for Brass Instrument	Dominant chest breathing	22	88%
	Lack of diaphragm control	20	80%
	Unstable air supply	19	76%
	Poor synchronization between breathing and sound production	18	72%

The observation results presented in Table 1 indicate that the most dominant technical misconceptions were found in the aspect of *how to breath for brass instrument*, particularly the dominance of chest breathing (88%) and the limited involvement of diaphragmatic control (80%). These findings suggest that most participants still relied on shallow breathing patterns, resulting in insufficient airflow stability during sound production. In the aspect of *how to airflow to mouthpiece*, the high prevalence of excessive lip pressure (84%) and overly forward lip positioning toward the mouthpiece (80%) indicates a tendency among participants to rely on compensatory strategies based on mechanical pressure rather than efficient coordination between lip vibration and airflow. Overall, these patterns suggest that *embouchure*, *airflow*, and breathing control had not yet functioned as an integrated system, making sound production more vulnerable to pitch instability, reduced resonance, and limited endurance in trumpet playing. To further illustrate how these misconceptions manifested in participants' playing practices, visual documentation from the observation was used to represent the technical forms observed in the aspects of *airflow to mouthpiece* and *breath for brass instrument*, as shown in Figure 1.

Figure 1. Examples of Embouchure and Breathing Technical Misconceptions

Figure 1 illustrates how the technical misconceptions identified in Table 1 were visually manifested in participants' trumpet-playing practices. In the aspect of *airflow to mouthpiece*, an imbalance in *embouchure* positioning was evident through the excessive use of lip pressure—previously identified in 84% of participants—as well as overly forward lip positioning toward the mouthpiece (80%). These patterns indicate that sound production relied more heavily on mechanical pressure rather than effective coordination between lip vibration and airflow, resulting in airflow that was not free-flowing or efficient. This condition was associated with participants' limited ability to maintain resonance, pitch stability, and flexibility in tone control. In several cases, tension in the facial and jaw areas was also observed as a compensatory response to maintain sound quality during blowing. In the aspect of *breath for brass instrument*, visual documentation revealed the dominance of chest breathing, which was also identified as the most prevalent misconception in the initial observation results (88%), accompanied by limited diaphragmatic involvement (80%). Most participants tended to use shallow breathing patterns, resulting in restricted and unstable air supply, particularly when performing sustained notes or passages requiring consistent air pressure. As a consequence, coordination between breathing mechanisms and airflow had not yet functioned optimally, leading participants to compensate through increased pressure in the *embouchure* area to maintain sound stability. This condition contributed to reduced resonance, unstable intonation, and limited endurance in trumpet playing.

These two misconceptions—both in *airflow to mouthpiece* and *breath for brass instrument*—directly affected trumpet-playing quality and the efficiency of micro-level motor skills. Inaccurate *embouchure* that relied excessively on pressure, combined with non-diaphragmatic breathing patterns, resulted in unstable airflow, leading to dampened sound production, inaccurate intonation, and limited dynamic control (Jesus, 2024; Watson & Price, 2020). In addition, players were more likely to experience fatigue due to inefficient energy use, particularly as a result of compensatory facial muscle tension and excessive physical pressure (Acheson et al., 2020). From a performance perspective, these conditions may hinder the development of technical flexibility, playing endurance, and consistency of sound quality across different pitch registers

(Kula et al., 2016; Türk-Espitalier et al., 2024). Physiologically, repeated engagement in such practices may also contribute to muscular tension in the orofacial and respiratory regions and, over time, may increase the risk of problems such as lip muscle fatigue, excessive pressure on soft tissues, and unhealthy breathing patterns (López Requena et al., 2024; Macovei et al., 2023; Nelkenstock et al., 2023). The occurrence of these misconceptions at the micro level is particularly critical because they affect not only musical performance but also biomechanical efficiency and physical well-being in wind instrument practice.

Technique Transformation through Visual Micro-Skill Pedagogy

Building on the initial observation findings regarding technical misconceptions in the aspects of *airflow to mouthpiece* and *breath for brass instrument*, the learning process was designed through a *visual micro-skill*-based intervention that positioned video as a means of representing technique more explicitly at the micro-motor level. Video enabled detailed visualization through features such as *close-up*, repetition, and time control (*pause* and *slow motion*) (Mödinger et al., 2022; Youssef et al., 2023), allowing participants to observe more accurately the coordination between *embouchure*, airflow direction, and breathing mechanisms in sound production. This approach aligns with the principles of *observational learning*, which emphasize the importance of visual models in skill acquisition (dos Santos Silva & Marinho, 2025; Economidou Stavrou, 2026; Utermohl de Queiroz et al., 2025), as well as *motor learning* theory, which suggests that clear visual representations can accelerate movement coordination and the correction of technical errors (Behzadaval et al., 2026). In addition, the use of video reinforced the characteristics of *digital pedagogy* by providing flexible, repeatable access and supporting self-directed learning (Wan et al., 2023; Zhang et al., 2024). Specifically, the visual materials focused on the techniques of *how to airflow to mouthpiece* and *how to breath for brass instrument* to clarify airflow direction, *embouchure* stability, and diaphragmatic breathing mechanisms. Figures 2 and 3 present excerpts from the instructional videos used during the intervention.

Figure 2. Video Excerpt "How to Airflow to the Mouthpiece"

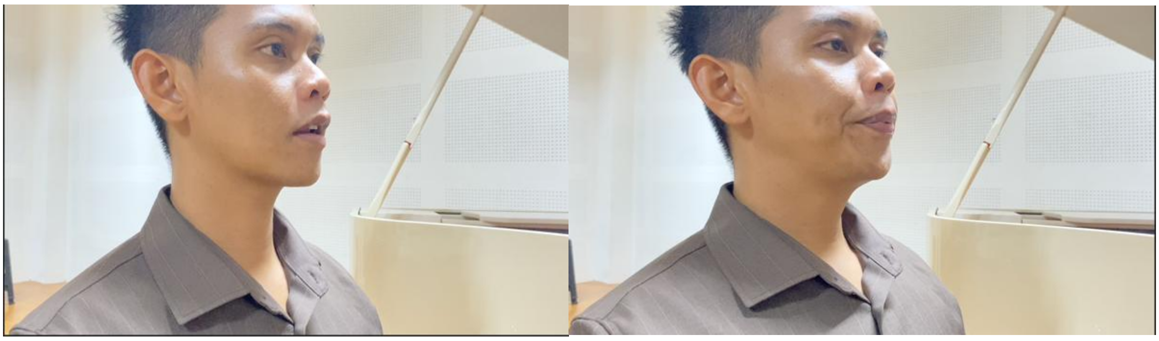

Figure 3. Video Excerpt "How to Breathe for Brass Instruments"

As illustrated in Figures 2 and 3, visual representations of technique were presented in detail, particularly in relation to *embouchure* and breathing mechanisms, enabling participants to directly observe the coordination among lip position, airflow direction, and diaphragmatic activation as an integrated system in sound production. This visualization not only reduced the ambiguity of verbal instruction, which is often general and interpretative, but also provided more explicit technical representations to support the development of structured mental models. Through *close-up*, repetition, and time-control features, the videos were designed not merely to display the final technical outcome but also to reveal the micro-level processes underlying performance, enabling participants to compare their own practice with the visual model as a basis for self-correction. This process encouraged technical correction grounded in visual evidence rather than solely kinesthetic assumptions, positioning *visual micro-skill* not merely as a representational medium but as a pedagogical mechanism orchestrating the relationship among observation, imitation, and technical adjustment in the development and stabilization of motor skills (Han et al., 2022; Sakai et al., 2023). The implementation of these mechanisms in instructional practice was systematically organized through the learning stages presented in Table 2.

Table 2. Learning Stages and Pedagogical Mechanisms Based on Visual Micro-Skill

Learning Stage	Activity	Pedagogical Mechanism	Duration
Learning Introduction (Misconception Awareness)	The facilitator explains that misconceptions often occur in micro-level motor skills (embouchure and breathing)	Activation of initial awareness as the foundation for learning and technique correction	10 minutes
Global Viewing (Initial Observation)	Participants watch the video in full without interruption	Global observation to build mental representation of technique and reduce ambiguity in verbal instruction	20 minutes
Focused Observation (Detailed Observation)	Participants observe techniques using *close-up* and *slow-motion* features	Detailed observation at the micro level to clarify coordination between embouchure and airflow	35 minutes
Guided Practice with Pause (Imitation and Self-Correction)	Participants practice while pausing the video to imitate and adjust their technique	Imitation of visual models, comparison between self-performance and model, and self-correction through visual feedback	40 minutes
Reflection and Evaluation (Reinforcement and Repetition)	Participants discuss their practice results and compare them with the visual model	Reinforcement of understanding through reflection and repetition as the basis for skill formation	15 minutes

The implementation of the *visual micro-skill*-based instructional intervention involved 25 participants consisting of university students and members of *drum band* communities in Surabaya, with a total duration of two hours. The learning stages presented in Table 2 indicate that technical transformation did not occur solely through repetitive practice but through pedagogical mechanisms that gradually developed coordination between visual observation, learning processes, and motor responses. The integration of detailed observation, imitation, and visual feedback enabled participants to identify technical misconceptions more concretely and compare their own practice with the demonstrated technical model. This condition supported a more reflective and directed process of self-correction, allowing micro-level motor skills to improve not only in performance but also through a more explicit and structured understanding of technique. To examine the extent to which these mechanisms contributed to improvements in trumpet-playing skills, *pre-test* and *post-test* assessments were conducted, focusing on trumpet-playing technical skills at the micro-motor level, operationalized through specific assessment dimensions and indicators.

Table 3. Dimensions and Indicators for Assessing Trumpet Technique Skills

Dimension	Indicators
Embouchure Control	1. Lip position on the mouthpiece (without excessive pressure) 2. Embouchure stability during sound production 3. Minimal facial muscle tension 4. Consistency of embouchure formation
Airflow Control	1. Direction of airflow toward the mouthpiece 2. Consistency of airflow 3. Tone stability (not cracked or fluctuating) 4. Efficiency of air usage
Breathing Control (Diaphragmatic)	1. Use of diaphragmatic breathing (not chest breathing) 2. Depth of inhalation 3. Control of exhalation during playing 4. Synchronization of breathing with sound production

The dimensions and indicators presented in Table 3 indicate that trumpet-playing technical skills were understood as a multidimensional form of motor coordination, in which *embouchure control*, *airflow control*, and *breathing control* function simultaneously to produce optimal sound quality. The separation of dimensions was intended to identify more specifically the technical changes occurring after the intervention, particularly in micro-motor aspects that had previously demonstrated misconceptions. This approach enabled evaluation not only of sound quality as a final outcome but also of changes in the technical coordination underlying trumpet sound production, including shifts from compensatory practices toward more stable and efficient control. Prior to hypothesis testing, the assumption of normality for the difference scores between *pre-test* and *post-test* was examined using the Shapiro–Wilk test due to the relatively small sample size (*n* = 25). The results of the normality test are presented in Table 4 as the basis for determining the use of parametric analysis through a *paired sample t-test*.

Table 4. Normality Test of Difference Scores

Variable	Shapiro–Wilk Statistic	df	Sig.
Difference Score (*Post-test* – *Pre-test*)	0.972	25	0.684

The normality test results presented in Table 4 indicate that the difference scores between the *pre-test* and *post-test* met the assumption of normality. This was demonstrated by the Shapiro–Wilk significance value, which was greater than 0.05 (*p* = 0.684), indicating that the data distribution could be considered normal. These findings suggest that the variation in changes in trumpet-playing technical skills following the intervention did not exhibit significant distributional deviations, supporting the appropriateness of using parametric analysis. Based on the fulfillment of this assumption, subsequent analysis was conducted using a *paired sample t-test* to identify the significance of differences in trumpet-playing technical skills before and after the *visual micro-skill*-based instructional intervention.

Table 5. Descriptive Statistics and Paired Sample T-Test Results

Measurement	N	Mean	Std. Deviation	Mean Difference	t	Sig. (2-tailed)
Pre-test	25	62.00	2.94			
Post-test	25	84.72	2.62	22.72	25.03	< 0.001

Table 5 presents a significant improvement in trumpet-playing technical skills following the *visual micro-skill*-based instructional intervention. The participants' mean score increased from 62.00 in the *pre-test* to 84.72 in the *post-test*, indicating a substantial improvement in technical performance. The reduction in the standard deviation from 2.94 to 2.62 also suggests greater consistency in participants' performance following the learning process. Inferentially, the *paired sample t-test* results showed that the difference was statistically significant (*t* = 25.03, *p* < 0.001), with a mean difference of 22.72. These findings indicate that the *visual micro-skill*-based instructional intervention was associated with improvements in trumpet-playing technical skills at the micro-motor level, particularly in the aspects of technical coordination targeted during instruction.

The quantitative improvement further indicates changes in the technical skill components that constituted the focus of assessment in this study. In the dimension of *embouchure control*, performance improvement was reflected in more stable lip positioning on the mouthpiece, reduced excessive pressure, and lower facial tension during sound production. In terms of *airflow control*, participants demonstrated more focused airflow direction and continuity, contributing to greater pitch stability and more efficient air use during performance. Meanwhile, in the dimension of *breathing control*, there was a tendency toward more coordinated breathing mechanisms, particularly in inhalation management, exhalation control, and synchronization between breathing and sound production. These findings suggest that skill improvement was reflected not only in sound quality as the final outcome but also in the coordination of micro-level motor techniques targeted by the *visual micro-skill* intervention.

Digital Pedagogy in Wind Instrument Technique Learning

The improvement in trumpet-playing technical skills demonstrated through the *pre-test* and *post-test* results indicates that the *visual micro-skill*-based intervention was associated with changes in technical coordination at the micro-motor level. However, these quantitative findings do not fully explain how the process of technical change occurred during learning or how participants experienced technical correction through visual media. Therefore, reflective interviews were conducted with six purposively selected participants based on variations in skill improvement following the intervention to explore their learning experiences in greater depth. The interviews focused on participants' experiences in observing, imitating, and correcting trumpet-playing techniques through video-based learning, particularly in relation to *embouchure*, *airflow*, and breathing mechanisms. To obtain a more systematic understanding of how the characteristics of *digital pedagogy* supported the technical learning process, the interview findings were classified into the aspects of *asynchronous learning*, *repeatability*, *self-directed learning*, *video as pedagogical tool*, *standardization of technique*, and *comparison with conventional learning*.

Table 6. Digital Pedagogy Aspects and Reflective Interview Findings in Trumpet Technique Learning

Digital Pedagogy Aspect	Pedagogical Function	Reflective Interview Evidence	Implication in Trumpet Learning (*Micro-Skill*)
Asynchronous Learning	Flexibility of time and access to learning	*"I could replay the video anytime when practicing at home, so I learned at my own pace."* (P5)	Learners repeatedly observed *embouchure* and *airflow* techniques according to their individual pace of learning.
Repeatability (Repetition)	Reinforcement of understanding through repetition	*"Replaying the video helped me realize mistakes in my blowing direction and lip position."* (P2)	Technical visuals could be replayed to gradually improve motor coordination through repeated observation and correction.
Self-directed Learning	Facilitation of independent learning	*"I often paused the video and compared my position with the model."* (P5)	Learners independently evaluated and corrected their techniques based on visual comparison.
Video as Pedagogical Tool	Explicit representation of technical processes	*"The close-up section helped me understand lip position more clearly."* (P1)	*Close-up* and *slow-motion* visualizations helped reveal micro-level technical processes that were previously difficult to observe.
Standardization of Technique	Alignment of technical references	*"Watching the same example helped me understand what the correct technique should look like."* (P6)	Visual models provided consistent and measurable technical references across learners.
Comparison with Conventional Learning	Reduction of instructional ambiguity	*"Usually explanations are only verbal and difficult to understand, but the video made it clearer."* (P5)	Reduced reliance on verbal instruction, which was often perceived as general and non-specific.

Table 6 demonstrates that the characteristics of *digital pedagogy* in trumpet learning functioned not merely as technological attributes but also had direct implications for technical learning mechanisms at the micro-motor level. The aspect of *asynchronous learning* showed that flexibility in time and access to video provided participants with opportunities to regulate the pace of observation and practice according to their individual learning needs. Participant 5 stated, *"I could replay the video anytime when practicing at home, so I learned at my own pace,"* indicating that flexible access to learning supported participants in revisiting technical observations outside formal instructional sessions, particularly regarding *embouchure*, *airflow*, and breathing coordination. The availability of anytime access enabled learning processes to develop more independently, as participants had opportunities to adjust the intensity of observation and practice based on the technical difficulties they encountered. Previous studies have shown that asynchronous learning enhances learning flexibility, engagement, and learner comfort in independent study (Saluky & Bahiyah, 2023; Wang et al., 2023), while also strengthening learner autonomy and self-management in digital learning contexts (Wang et al., 2023). Such flexibility may provide learners with opportunities to gradually and adaptively develop technical coordination according to their own learning pace, particularly when refining micro-level technical details.

The self-regulated management of learning pace was further reinforced through the aspect of *repeatability* (repetition), which enabled participants to build more consistent cycles of observation, imitation, and correction during practice. Participant 2 stated, *"Replaying the video helped me realize mistakes in my blowing direction and lip position,"* indicating that the *replay* feature helped participants identify technical errors that had previously been difficult to observe, particularly in relation to airflow direction, *embouchure* positioning, and sound production stability. The ability to repeatedly view technical visualizations enabled participants to make gradual motor adjustments, as errors could be observed and compared with the visual model in greater detail. Previous studies have shown that repeated access to digital media improves understanding and skill quality through iterative reflection (Navarrete et al., 2025). The use of instructional videos with replay features has also been found to contribute to improvements in practical skill accuracy, learning retention, and the gradual refinement of procedural skills in technology-enhanced learning environments (Li et al., 2023; Luciani et al., 2022; Qi et al., 2026). Such repetitive learning patterns may enable learners to develop motor coordination in a more structured and stable manner, particularly when refining the relationship between *embouchure*, *airflow*, and sound quality at the micro level.

The intensity of repeated practice subsequently developed further as participants moved beyond merely repeating techniques and began to take an active role in regulating their own learning process through the mechanism of *self-directed learning*. Participant 5 stated, *"I often paused the video and compared my position with the model,"* indicating that participants began to evaluate and correct their techniques independently through comparison between their own performance and the visual model. Features such as *pause*, *replay*, and detailed observation enabled participants to establish more directed cycles of observation, imitation, and correction, allowing motor coordination adjustments to occur gradually and with increasing precision. Research suggests that self-directed learning in digital contexts enhances learners' self-regulation and metacognitive abilities (Li et al., 2023; Wan et al., 2023). Active engagement in monitoring and self-correction also strengthens evaluative capacities that contribute to deeper skill mastery (dos Santos Silva & Marinho, 2025; Li et al., 2023). Such learning experiences suggest that video-based instruction not only helped participants identify technical errors but also provided opportunities for conscious adjustment based on individual learning needs.

The development of self-regulated learning was further strengthened through the aspect of *video as pedagogical tool*, in which explicit visual representations helped participants understand technical details that had previously been difficult to observe through conventional demonstrations. Participant 1 stated, *"The close-up section helped me understand lip position more clearly,"* indicating that the *close-up* feature enabled participants to identify *embouchure* positioning, airflow direction, and breathing coordination more clearly. Technical visualization through *close-up*, *slow motion*, and *replay* features allowed micro-level processes to be observed in greater detail, enabling participants not only to see the final performance outcome but also to understand the underlying movement stages. Previous studies suggest that explicit visual representations help clarify technical processes, strengthen the relationship between motor actions and sound outcomes, and make learning more concrete and directed (Luciani et al., 2022; Mödinger et al., 2022; Reybrouck & Schiavio, 2024). Studies in music education further indicate that structured, technology-supported visual learning environments contribute to greater technical precision, improved skill acquisition, and more effective instrumental practice (Shao, 2026; Schiavio & Nijs, 2022). In this context, video expanded the function of instructional media beyond demonstration, serving as a pedagogical tool that supported participants in observing, comparing, and adjusting trumpet-playing techniques more systematically.

The consistency of observational processes supported through visual representation subsequently required standardized technical references to prevent correction from becoming overly subjective. The aspect of *standardization of technique* showed that the use of the same visual model helped participants develop more consistent technical references in understanding *embouchure* positioning, airflow direction, and breathing coordination. Participant 6 stated, *"Watching the same example helped me understand what the correct technique should look like,"* indicating that the visual model provided a clearer reference for the expected technical form during practice. Consistent visual representations helped align technical perceptions, thereby reducing interpretative variation commonly found in demonstration-based learning (Behzadaval et al., 2026; McCrudden & Van Meter, 2021). Standardization through visual models also enhanced performance consistency, as participants referred to the same technical representation throughout practice (Navarrete et al., 2025). The availability of more measurable technical references provided opportunities for learners to develop more consistent practical understanding, particularly when adjusting technical coordination at the micro-motor level.

The emergence of clearer technical references subsequently revealed a fundamental difference from conventional learning approaches, which have traditionally relied more heavily on verbal instruction. The aspect of *comparison with conventional learning* demonstrated that video-based technical visualization helped reduce the ambiguity of instructions that participants had previously found difficult to understand. Participant 5 stated, *"Usually explanations are only verbal and difficult to understand, but the video made it clearer,"* indicating that visual presentation helped participants understand technical details that had previously been abstract or open to interpretation. Previous studies have shown that explicit technical visualization helps learners understand micro-level processes that are difficult to explain descriptively, thereby reducing reliance on subjective interpretation (Behzadaval et al., 2026; Mödinger et al., 2022). Visual presentation of technique also clarifies the relationship between motor actions and sound outcomes, allowing the learning process to become more concrete and directed (Luciani et al., 2022; Reybrouck & Schiavio, 2024). These differences suggest that video-based learning provides opportunities for participants to understand trumpet-playing techniques in a more explicit, structured, and easily reflected manner throughout the practice process.

Overall, the interview findings indicate that the characteristics of *digital pedagogy* in *visual micro-skill*-based learning not only expanded access to learning but also shaped more structured technical learning mechanisms through flexibility of time, repetition, self-directed learning, explicit visual representation, and consistency of technical references. The integration of these characteristics enabled participants to gradually develop coordination of *embouchure*, *airflow*, and breathing mechanisms through repeated processes of observation, imitation, and technical adjustment. Participants' experiences also revealed that video-based learning helped reduce the ambiguity of verbal instruction, which had often limited the understanding of technical details at the micro level. These findings suggest that *visual micro-skill* has the potential to support a more explicit, reflective, and accessible approach to wind instrument technique learning, particularly in facilitating more directed technical correction during practice.

CONCLUSION

This study demonstrates that trumpet learning faces fundamental challenges in the form of technical misconceptions at the micro-motor skill level, particularly in the coordination of *embouchure*, *airflow*, and *breathing control*, which are often difficult to explain adequately through conventional pedagogy based on verbal instruction. The implementation of *visual micro-skill* through video within a *digital pedagogy* framework was associated with improvements in these misconceptions, as evidenced by the significant increase in micro-level technical trumpet-playing skills (from 62.00 to 84.72; $p < 0.001$), accompanied by greater consistency in participants' performance following the intervention. Visual representation through *close-up*, *slow motion*, *replay*, and *pause* features enabled previously difficult-to-observe technical details to become more explicit, providing participants with greater opportunities to observe *embouchure* positioning, airflow direction, and breathing mechanisms in a more focused manner. Interview findings further revealed that repeatable visual access supported participants in independently adjusting their techniques through processes of observation, imitation, and correction during practice. These findings suggest that *visual micro-skill* functioned not merely as a medium for delivering instructional content but also had the potential to support more explicit, structured, and easily reflected pedagogical mechanisms in wind instrument learning. Theoretically, this study proposes *visual micro-skill* as a pedagogical framework for understanding trumpet technique learning at the micro-motor level within the context of *digital pedagogy*. Practically, the study offers an alternative video-based trumpet learning model that may help improve technical precision, reduce instructional ambiguity, and provide more consistent learning references.

REFERENCES

Acheson, L. S., Rogers, P. G., Thamrin, C., Peters, M. J., Farah, C. S., & Seccombe, L. M. (2020). Acute cardiopulmonary responses during expert trumpet performance. *Respiratory Physiology & Neurobiology*, *281*, 103493. https://doi.org/10.1016/j.resp.2020.103493

Acquilino, A., & Scavone, G. (2022). Current state and future directions of technologies for music instrument pedagogy. *Frontiers in Psychology, 13*, 835609. https://doi.org/10.3389/fpsyg.2022.835609

Behzadaval, B., Serra Marin, L., & Nijs, L. (2026). Application of Visual Information in Music Education Digital Technologies: A Scoping Review. *Education Sciences*, *16*(2), 309. https://doi.org/10.3390/educsci16020309

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing, 25*(8), 652–661. https://doi.org/10.1177/1744987120927206

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches (4th ed.)*. Sage Publications.

dos Santos Silva, C., & Marinho, H. (2025). Self-regulated learning processes of advanced musicians: A Prisma review. *Musicae Scientiae*, *29*(1), 89–108. https://doi.org/10.1177/10298649241275614

Economidou Stavrou, N. (2026). Reflecting on our music teaching and learning practices using video observations. *Frontiers in Education, 11*, 1725226. https://doi.org/10.3389/feduc.2026.1725226

Fauzy Ananda, R., Milyartini, R., & Sukmayadi, Y. (2025). Mapping the Use of Digital Game-Based Learning in Music Education: A Scoping Review. *Jurnal Pendidikan Indonesia*, *6*(11), 4982–4989. https://doi.org/10.59141/japendi.v6i11.8772

Fredriksson, K., Zandén, O., & Wallerstedt, C. (2024). Teaching and learning in music education – a meta-synthesis. *Music Education Research*, *26*(2), 193–204. https://doi.org/10.1080/14613808.2024.2319579

Han, Y., Syed Ali, S. K. Bin, & Ji, L. (2022). Use of Observational Learning to Promote Motor Skill Learning in Physical Education: A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(16), 10109. https://doi.org/10.3390/ijerph191610109

Hoadley, C. (2022). A short history of design-based research and a brief future outlook. *Educational Psychologist, 57*(4), 277–294. https://doi.org/10.1080/00461520.2022.2079128

Jesus, L. M. T. (2024). New Insights into Laryngeal Articulation and Breathing Control of Trumpeters: Biomedical Signals and Auditory Perception. *Applied Sciences*, *14*(19), 8957. https://doi.org/10.3390/app14198957

Kula, K., Cilingir, H. Z., Eckert, G., Dagg, J., & Ghoneima, A. (2016). The association of malocclusion and trumpet performance. *The Angle Orthodontist*, *86*(1), 108–114. https://doi.org/10.2319/111214-812.1

Li, W., Manoharan, P., Cui, X., Liu, F., Liu, K., & Dai, L. (2023). The effects of musical feedback training on metacognition and self-directed learning. *Frontiers in Human Neuroscience, 17*, 1304929. https://doi.org/10.3389/fnhum.2023.1304929

López Requena, A., Baño Alcaraz, A., Escolar Reina, P., Ferrández Gómez, E., & Cánovas Ambit, G. (2024). Effectiveness of a cervical treatment in wind-instrument musicians with temporomandibular dysfunction: A randomized clinical trial. *Journal of Bodywork and Movement Therapies*, *40*, 1867–1873. https://doi.org/10.1016/j.jbmt.2024.10.060

López-Pineda, J., Rodríguez-Martínez, M. C., Gómez-Rodríguez, R., García-Casares, L., & García-Casares, N. (2023). Biomechanical Assessments in Woodwind Musicians: A Systematic Review. *Healthcare*, *11*(11), 1621. https://doi.org/10.3390/healthcare11111621

Luciani, M. G., Cortelazzo, A., & Proverbio, A. M. (2022). The role of auditory feedback in the motor learning of music in experienced and novice performers. *Scientific Reports*, *12*(1), 19822. https://doi.org/10.1038/s41598-022-24262-x

Macovei, G., Minea, R., Dumitraş, I., Precup, C., Baroiu, L., Nechifor, A., Armencia, A., & Lese, A. (2023). Changes in Dento-Facial Morphology Induced by Wind Instruments, in Professional Musicians and Physical Exercises That Can Prevent or Improve Them—A Systematic Review. *Life*, *13*(7), 1528. https://doi.org/10.3390/life13071528

McCrudden, M. T., & Van Meter, P. N. (2021). Multimedia Learning with Visual Displays. In *The Cambridge Handbook of Multimedia Learning* (pp. 510–520). Cambridge University Press. https://doi.org/10.1017/9781108894333.052

McKenney, S., & Reeves, T. C. (2019). *Conducting educational design research* (2nd ed.). Routledge. https://doi.org/10.4324/9781315105642

Michałko, A., Campo, A., Nijs, L., Leman, M., & Van Dyck, E. (2022). Toward a meaningful technology for instrumental music education: Teachers' voice. *Frontiers in Education, 7*, 1027042. https://doi.org/10.3389/feduc.2022.1027042

Mödinger, M., Woll, A., & Wagner, I. (2022). Video-based visual feedback to enhance motor learning in physical education—a systematic review. *German Journal of Exercise and Sport Research*, *52*(3), 447–460. https://doi.org/10.1007/s12662-021-00782-y

Navarrete, E., Nehring, A., Schanze, S., Ewerth, R., & Hoppe, A. (2025). A Closer Look into Recent Video-based Learning Research: A Comprehensive Review of Video Characteristics, Tools, Technologies, and Learning Effectiveness. *International Journal of Artificial Intelligence in Education*, *35*(4), 1631–1694. https://doi.org/10.1007/s40593-025-00481-x

Nelkenstock, R., Iltis, P. W., Voit, D., Frahm, J., Passarotto, E., & Altenmüller, E. (2023). Movement patterns in tuba playing: Comparison of an embouchure dystonia case with healthy professional tuba players using real-time MRI imaging. *Frontiers in Neurology, 14*, 1106217. https://doi.org/10.3389/fneur.2023.1106217

Qi, Z., Wang, J., Du, Y., & Zhang, X. (2026). The effect of blended learning approaches on vocational school students' practical skills performance and learning behaviors: virtual simulations or hands-on activities while accessing instructional videos. *Instructional Science*, *54*(1), 39. https://doi.org/10.1007/s11251-026-09793-4

Rahmawati, G., Abduljabar, B., & Rozak, R. W. A. (2026). Project-Based Learning in Music Education: A Scopus-Based Bibliometric Review of Research Trends and Intellectual Structure. *Jurnal Paedagogy*, *13*(1), 266–277. https://doi.org/10.33394/jp.v13i1.19068

Reybrouck, M., & Schiavio, A. (2024). Music performance as knowledge acquisition: A review and preliminary conceptual framework. *Frontiers in Psychology, 15*, 1331806. https://doi.org/10.3389/fpsyg.2024.1331806

Sakai, K., Kawasaki, T., Ikeda, Y., Tanabe, J., Matsumoto, A., & Amimoto, K. (2023). Differences in the early stages of motor learning between visual-motor illusion and action observation. *Scientific Reports*, *13*(1), 20054. https://doi.org/10.1038/s41598-023-47435-8

Saluky, & Nurul Bahiyah. (2023). Revolutionizing Education: Unlocking the Potential of Asynchronous Video for Interactive Online Learning. *International Journal of Education and Humanities*, *3*(2), 187–196. https://doi.org/10.58557/(ijeh).v3i2.149

Schiavio, A., & Nijs, L. (2022). Implementation of a remote instrumental music course focused on creativity, interaction, and bodily movement: Preliminary insights and thematic analysis. *Frontiers in Psychology, 13*, 899381. https://doi.org/10.3389/fpsyg.2022.899381

Shao, J. (2026). Enhancing learning outcomes in violin music education: A systematic review. *Frontiers in Education, 10*, 1683580. https://doi.org/10.3389/feduc.2025.1683580

Türk-Espitalier, A., Bertsch, M., & Cossette, I. (2024). Effect of Expiratory Muscle Strength Training on the Performance of Professional Male Trumpet Players. *Medical Problems of Performing Artists*, *39*(1), 18–26. https://doi.org/10.21091/mppa.2024.1003

Utermohl de Queiroz, D., Foletto, C., & López-Íñiguez, G. (2025). Pedagogical approaches to promote self-regulation in musical instrument learning: A Prisma scoping review. *Psychology of Music*. https://doi.org/10.1177/03057356251348414

Wan, L., Crawford, R., & Jenkins, L. (2023). Digital Listening Tools to Facilitate Children's Self-Regulation of Instrumental Music Practice. *Journal of Research in Music Education*, *71*(1), 67–90. https://doi.org/10.1177/00224294221093521

Wang, Q., Wen, Y., & Quek, C. L. (2023). Engaging learners in synchronous online learning. *Education and Information Technologies*, *28*(4), 4429–4452. https://doi.org/10.1007/s10639-022-11393-x

Watson, A. H., & Price, K. (2020). Embouchure Muscle Activity in Student and Elite Trumpeters. *Medical Problems of Performing Artists*, *35*(1), 42–53. https://doi.org/10.21091/mppa.2020.1006

Weatherly, K. I. C. H., Wright, B., & Lee, E. Y. (2026). Digital game–based learning in music education: A systematic review from 2011 to 2023. *Research Studies in Music Education*, *48*(1), 6–24. https://doi.org/10.1177/1321103X241270819

Yihan, L., Cuong, T. Van, Kiss, B., Oo, T. Z., Szabó, N., & Józsa, K. (2025). The Use and Effectiveness of Digital Tools in Elementary Music Education: A Systematic Review. *Music & Science*, *8*. https://doi.org/10.1177/20592043251363338

Youssef, S. C., Aydin, A., Canning, A., Khan, N., Ahmed, K., & Dasgupta, P. (2023). Learning Surgical Skills Through Video-Based Education: A Systematic Review. *Surgical Innovation*, *30*(2), 220–238. https://doi.org/10.1177/15533506221120146

Zhang, Y., Beh, W. F., & Zhang, C. (2024). A Systematic Review of Blended Learning Strategies and Outcomes in Music Education. *Harmonia: Journal of Arts Research and Education*, *24*(2), 247–262. https://doi.org/10.15294/harmonia.v24i2.18523