Jurnal Pendidikan Vokasi
Volume 16, No. 2, 2026, pp. 161-173
Online: https://journal.uny.ac.id/index.php/jpv

BISINDO-based instructional videos in inclusive vocational welding learning: Preliminary evidence from a single-subject study

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ARTICLE INFO

Article History
Received:
5 June 2026;
Revised:
25 July 2026;
Accepted:
31 August 2026;

Keywords
Hearing impairment; Inclusive vocational education; Instructional video; Sign language; Single-subject research; Vocational welding

ABSTRACT

This study examined within-participant changes in procedural understanding, practical welding skills, and learning engagement following the introduction of Indonesian Sign Language (BISINDO)-based instructional videos for a vocational high school student with hearing impairment. The study employed an A–B single-subject design comprising three baseline sessions and three intervention sessions. Outcomes were assessed using structured observation rubrics and converted to scores on a 0–100 scale. The participant was a student with hearing impairment enrolled in a basic welding course at a vocational high school. Data were collected through repeated observations across six learning sessions, consisting of three baseline sessions and three intervention sessions. The instruments included observation sheets assessing procedural understanding, practical welding skills, learning engagement, and intervention implementation. Data were analyzed using visual analysis across conditions and the percentage of non-overlapping data (PND) to identify changes between the baseline and intervention phases. The results indicated positive within-participant changes across all observed variables following the introduction of BISINDO-based instructional videos. All intervention observations exceeded the highest baseline observation, resulting in a PND value of 100% for each outcome. However, these findings should be interpreted with caution due to the short duration of each phase and the absence of experimental replication. For the participant in this study, the introduction of BISINDO-based instructional videos was associated with higher observed scores in procedural understanding, practical welding skills, and learning engagement. Further research employing more rigorous single-case designs with additional participants is needed before broader conclusions can be drawn.

INTRODUCTION

Inclusive education in vocational high schools (VHSs) requires accessible, participatory, safe, and occupationally relevant learning experiences. However, students who are deaf and hard of hearing (DHH) continue to encounter limited institutional support, inconsistent accessibility services, communication barriers, and inadequate adaptation to visual communication needs, which affect their participation, engagement, social inclusion, self-determination, and career aspirations (Cheng et al., 2026; Chilton et al., 2025; Eichengreen et al., 2026; Hardebeck et al., 2026; Percival et al., 2025; Tannenbaum-Baruchi et al., 2025). In the Indonesian context, this study uses the term students with hearing impairments because it is considered more humanistic and person-centered.

Communication accessibility is particularly important in vocational education, where students must develop knowledge, work attitudes, and practical skills aligned with workplace

10.21831/jpv.v16i2.100441
ISSN: 2476-9401 (online) | 2088-2866 (print)

standards (Inderanata & Sukardi, 2023). Welding instruction involves sequential procedures, equipment operation, psychomotor coordination, risk assessment, and occupational safety, requiring close integration between theoretical explanation, demonstration, appropriate resources, and workshop practice (Canut-Montalva et al., 2025; Huerta-Gomez-Merodio & Requena-Garcia-Cruz, 2025; Siliņa-Jasjukeviča et al., 2025; Storonyanska et al., 2025). For students with hearing impairments, conventional demonstrations may be difficult to follow because verbal explanations, movements, tools, and safety information are presented simultaneously, dividing their visual attention and increasing the risk of missing essential information.

Sign-language-based instructional videos provide a practical alternative because demonstrations can be paused, repeated, and reviewed according to students' learning pace and needs. Sign language should be positioned as a legitimate pedagogical and linguistic resource in deaf education, given its relationship with written and spoken language development (Tang, 2024; Wilks & O'Neill, 2026; Zhang et al., 2024). Multimodal learning is also relevant because DHH students rely on demonstrations, gestures, facial expressions, captions, and written keywords, although these elements must be organized carefully to prevent excessive visual competition (Iturriaga, 2026; Loaiza-Ramírez & González-Beltrán, 2026; Pavani & Leonetti, 2026; Qin, 2025; Weber et al., 2025).

The intervention was based on a multimodal procedural-learning framework. Visual demonstrations made welding movements, tool positions, work sequences, and safety practices observable; BISINDO provided accessible explanations; concise captions reinforced technical terminology; segmentation reduced information complexity; and repetition supported review and retention. Workshop practice subsequently enabled students to translate visual and linguistic information into psychomotor performance. This combination was expected to improve procedural understanding, practical welding skills, and learning engagement by reducing communication barriers and increasing students' control over learning.

Previous studies have shown that asynchronous multimedia tutorials and sign-language-based e-learning can support learning pace, repetition, independence, satisfaction, and motivation. Accessible learning also depends on instructional design, communication, captioning, interaction, and teacher readiness rather than on technology availability alone (Gehret & Elliot, 2025; Hosni et al., 2025; Lima et al., 2025; Lomellini et al., 2025; Niksiar et al., 2025). Nevertheless, limited empirical evidence has examined the use of BISINDO-based videos in practical welding instruction at Indonesian VHSs. Previous studies have rarely investigated procedural understanding, psychomotor welding performance, and learning engagement simultaneously using a single-subject design.

METHOD

This study employed a quantitative single-subject research (SSR) approach involving one student with hearing impairment in vocational welding instruction. An A–B design was implemented through three baseline sessions without BISINDO-based instructional videos and three intervention sessions using the videos. The same dependent variables were measured consistently in each session to identify systematic within-participant changes over time (Ledford & Gast, 2024).

The transition between phases followed an a priori three-session schedule. Three observations per phase were selected because the study was designed as a preliminary, context-specific SSR evaluation embedded in the school's existing welding timetable. The six competency-based observations were conducted across three scheduled workshop days, with each day comprising one 60-minute workshop period covering two welding competencies. Extending either phase would have disrupted the predetermined curriculum schedule, workshop availability, and the participant's regular learning program. Methodologically, three data points were treated as the minimum required for a preliminary phase-level assessment of level, trend, and variability, provided that the observed pattern was sufficiently consistent to support a cautious prediction of subsequent performance (Ledford & Gast, 2024; Tate & Perdices, 2020). This decision was consistent with the methodological literature identifying three observations as a commonly cited minimum for a single-case phase, while acknowledging that longer phases can improve data stability and reduce bias in estimating intervention effects (Barnard-Brak et al., 2021; Peltier et al., 2023). The baseline data showed a relatively consistent level, limited variability, and no improving trend before the intervention. The intervention phase was completed within the same predetermined schedule, and continued improvement across the three observations indicated a developing positive response to the BISINDO-based instructional videos. Accordingly, the six observations were considered appropriate for the preliminary and exploratory purposes of the study, while longer phases and maintenance observations are recommended to confirm stability and longer-term performance patterns.

The A–B design was selected because it was appropriate for an initial, context-specific evaluation of an accessible instructional resource in vocational welding learning. Maintaining access to procedural and occupational safety information was considered important throughout the intervention. The design was also aligned with the study context, which involved one eligible participant and three interrelated outcomes—procedural understanding, practical welding skills, and learning engagement—assessed concurrently through integrated instructional activities. Accordingly, the findings were interpreted as evidence of within-participant change across the baseline and intervention phases.

The research team comprised experts in welding, vocational learning, and special education. The instruments were reviewed for technical relevance, alignment with vocational learning outcomes, occupational safety, accessibility, and the appropriateness of BISINDO expressions. Revisions were completed before implementation to improve the clarity and suitability of the instruments. Instruction was jointly conducted by the researcher and the classroom teacher, while session-level observation and assessment were performed by the classroom teacher, who was familiar with the study phases and intervention schedule. Measurement consistency was maintained through predefined indicators, standardized rubrics, coordinated procedures, and uniform scoring criteria across all sessions. Nevertheless, because the classroom teacher also served as the observer and assessor, observer expectancy bias could not be entirely excluded. Future studies should therefore involve independent assessors and additional reliability procedures to strengthen measurement objectivity.

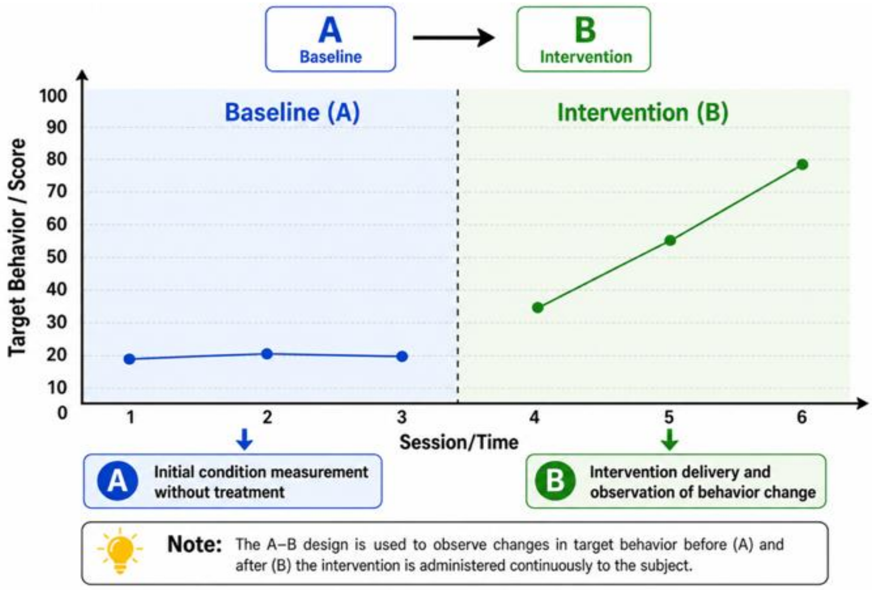

Figure 1. Schematic Representation of The A–B Single-Subject Design Used in The Study

Data were collected during six 60-minute basic-welding lessons conducted between January and March 2025 at a private vocational high school in the Special Region of Yogyakarta. The lessons comprised three baseline and three intervention sessions and formed part of the Grade XI welding subject within the Mechanical Engineering Expertise Program. The participant was a 17-year-old student with hearing impairment who communicated through a combination of Bahasa Isyarat Indonesia (BISINDO) and written language. The participant had completed theoretical instruction in welding and basic manufacturing engineering but had limited practical welding experience and was purposively selected based on participation in basic-welding instruction, a need for visual communication support, and availability throughout all study sessions.

Data were obtained through direct observation of procedural understanding, practical welding skills, and learning engagement, supported by documentation of welding activities and work products. Instruction and assessment were conducted by the vocational welding teacher using predefined indicators, standardized rubrics, and consistent procedures across sessions. Before implementation, the instruments and the BISINDO-based instructional video were reviewed by three experts in welding, vocational learning, and special education/BISINDO for technical accuracy, learning alignment, accessibility, BISINDO clarity, procedural sequencing, visual presentation, and occupational safety. Aiken's V coefficients ranged from 0.92 to 1.00, indicating strong content validity, and the instruments and video were revised according to the experts' recommendations before data collection.

The operational definitions, main indicators, and instruments for each study variable are summarized in Table 1, while Tables 2–5 present the intervention implementation checklist and the observation instruments used to assess procedural understanding, practical welding skills, and learning engagement.

Table 1. Operational Variables

Variables	Operational definition	Main indicators	Instruments
BISINDO Instructional Video	Learning media in the form of videos containing demonstrations of welding techniques, explanations in BISINDO, short texts, and an emphasis on work safety.	clarity of content, clarity of BISINDO, clarity of work steps, readability of text, visual suitability, emphasis on Occupational Safety and Health (OSH)	media validation sheet, intervention implementation sheet
Procedural Understanding of Welding Techniques	The ability of students with hearing impairments to understand work sequences, tools, materials, Personal Protective Equipment (PPE) functions, and safety procedures in welding.	identify tools and materials, understand tool functions, understand work sequences, understand PPE, understand OSH	procedural understanding observation sheet
Practical Welding Skills	The ability of students with hearing impairments to carry out welding practices according to procedures and safety standards.	work preparation, use of PPE, accuracy of work steps, work position, basic techniques, work results	practical skills observation sheet
Learning engagement	The level of attention, activity, response, and independence of students with hearing impairments during learning	focus, responding to instructions, enthusiasm, practical participation, repeating material	learning engagement observation sheet

Table 2. Intervention Implementation Sheet Instrument

Implementation Aspects	Indicators	Rating Scale
Video playback	The video is shown in full according to the session	1-4
Use of BISINDO	Students get explanations through BISINDO	
Visual reinforcement	The teacher directs attention to the work steps in the video	
Repetition	The video can be replayed at key points	
Integration of practice	Students practice the procedures after watching the video	
Emphasis on OSH	The teacher reiterates the elements of work safety	

Table 3. Procedural Understanding Instruments

Aspects	Indicator	Rating Scale
Tools and materials	Identifying tools and materials	
Tool function	Explaining tool functions	
PPE	Explaining the use of personal protective equipment	1-4
Work procedures	Listing/demonstrating work steps	
Work safety	Understanding safety and health symbols and warnings	
Work result	Understanding the characteristics of good welding results	

Table 4. Procedural Understanding Instruments

Aspects	Indicator	Rating Scale
Work Preparation	Preparing tools, materials, and work areas	
Work implementation	Following steps, using tools, and controlling movements	1-4
Work safety	Safe working positions and OHS compliance	
Work result	Completing tasks and demonstrating results	

Table 5. Learning Engagement Instruments

Aspects	Indicator	Rating Scale
Attention	Focus on the video	
Response	Responds to instructions	
Interest	Enthusiasm for learning	
Participation	Active participation during practice	1-4
Independence	Performs tasks without full assistance	
Learning Reinforcement	Reviews material	
Persistence	Persists until task completion	

Data were analyzed using visual analysis and the percentage of non-overlapping data (PND). Visual analysis examined changes in level, trend, variability, immediacy of effect, and data overlap between the baseline and intervention phases. Because higher scores represented improvement in all three outcomes, the highest baseline score was used as the PND reference. PND was calculated as the percentage of intervention data points that exceeded the highest baseline value:

$$PND = \frac{\sum_{j=1}^{n_B} I(B_j > \max(A))}{n_B} \times 100\%$$

where B_j represents each intervention score, n_B is the number of intervention observations, and I equals 1 when an intervention score exceeds the highest baseline score and 0 otherwise. Scores equal to or below the highest baseline value were classified as overlapping data.

RESULTS AND DISCUSSION

Results

Implementation of BISINDO Instructional Videos

This study used an A–B design with one student with hearing impairment in vocational welding learning. Observations were made on three variables: procedural understanding, welding practical skills, and learning engagement. The baseline phase (A) was conducted over three sessions to determine the student’s initial abilities before the intervention, whereas the intervention phase (B) was conducted over three sessions using a BISINDO-based instructional video. The intervention activities are illustrated in Figure 2.

a b c d

Figure 2. Intervention Activities: (a) Viewing the BISINDO-supported Welding Demonstration, (b) Reviewing Procedural Steps, (c) Preparing Welding Equipment, and (d) Performing Supervised Welding Practice

Procedural Understanding Outcomes

Observations showed that during the baseline phase, the student's procedural understanding scores were relatively low and stable. After the intervention was introduced, the observed scores increased across the three intervention sessions.

Table 6. Procedural Understanding Outcomes

Phase	Session			Mean
	1	2	3	
Baseline (A)	42	45	44	43.67
Intervention (B)	68	78	86	77.33

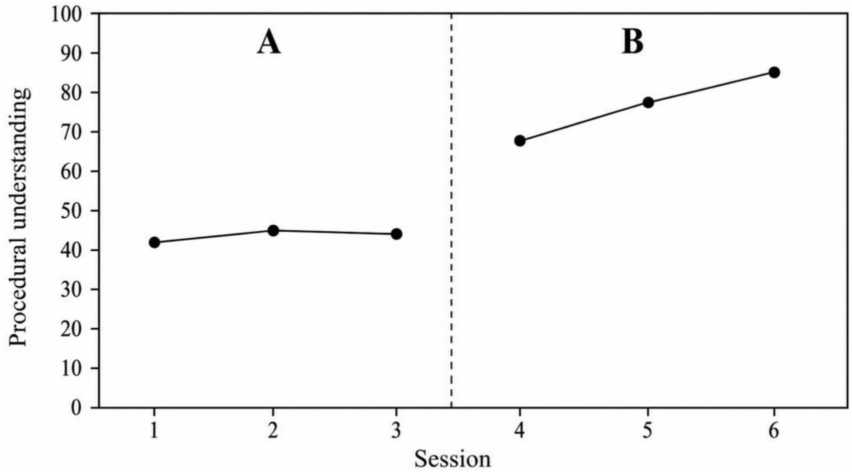

Figure 3. Procedural Understanding Outcomes

Based on Table 6, the mean procedural understanding score increased from 43.67 in the baseline phase to 77.33 in the intervention phase, yielding a mean phase difference of 33.66 points. The immediate level change, calculated by comparing the final baseline score of 44 with the first intervention score of 68, was 24 points. During the intervention phase, the scores showed a consistent positive trend, increasing from 68 to 78 and then to 86, with an overall within-phase increase of 18 points. The highest baseline score was 45, and all intervention scores exceeded this reference value;

therefore, the PND was 100%, indicating complete non-overlap and classification in the highly effective category. These findings demonstrate a substantial mean difference, an immediate level increase following the intervention, and continued improvement across the intervention sessions.

Welding Practical Skills Outcomes

During the baseline phase, the student's practical welding skills showed several limitations, particularly in the preparation of tools and materials, the use of personal protective equipment, and the accuracy of work steps. Following the introduction of the BISINDO-based instructional video, practical skills gradually improved across sessions.

Table 7. Welding Practice Skills Score

Phase	Session			Mean
	1	2	3	
Baseline (A)	40	43	45	42.67
Intervention (B)	65	74	84	74.33

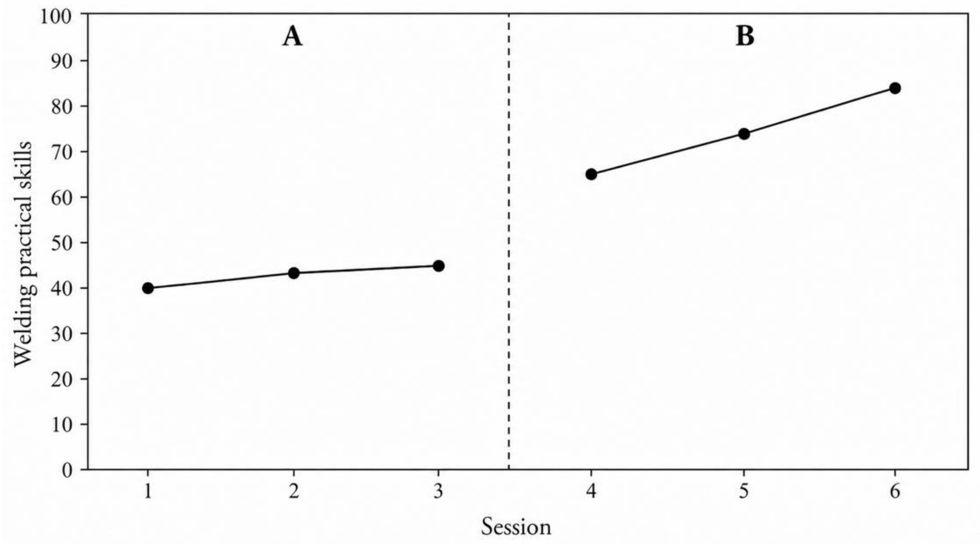

Figure 4. Welding Practice Skills Outcomes

The average practical skills score increased from 42.67 in the baseline phase to 74.33 in the intervention phase. In addition to the increase in the mean score, the intervention-phase data showed an upward trend. Because all intervention scores were higher than the highest baseline score, 45, the PND value for the practical skills variable was 100%, which is considered highly effective.

Learning Engagement Outcomes

During the baseline phase, the participant's learning engagement remained relatively stable, with scores of 46, 48, and 50 across the three sessions. Following the introduction of the BISINDO-based instructional video, engagement increased consistently to 70, 80, and 88, reflecting improvements in attention, response to instruction, interest, practical participation, independence, review of learning materials, and persistence in completing tasks. The mean score increased from 48.00 in the baseline phase to 79.33 in the intervention phase, representing a mean phase difference of 31.33 points. The immediate level change from the final baseline score of 50 to the first intervention score of 70 was 20 points, while the intervention phase showed a positive within-phase trend of 18 points. Because all intervention scores exceeded the highest baseline score, the PND was 100%, indicating complete non-overlap between phases.

Table 8. Learning Engagement Outcomes

Phase	Session 1	Session 2	Session 3	Mean
Baseline (A)	46	48	50	48.00
Intervention (B)	70	80	88	79.33

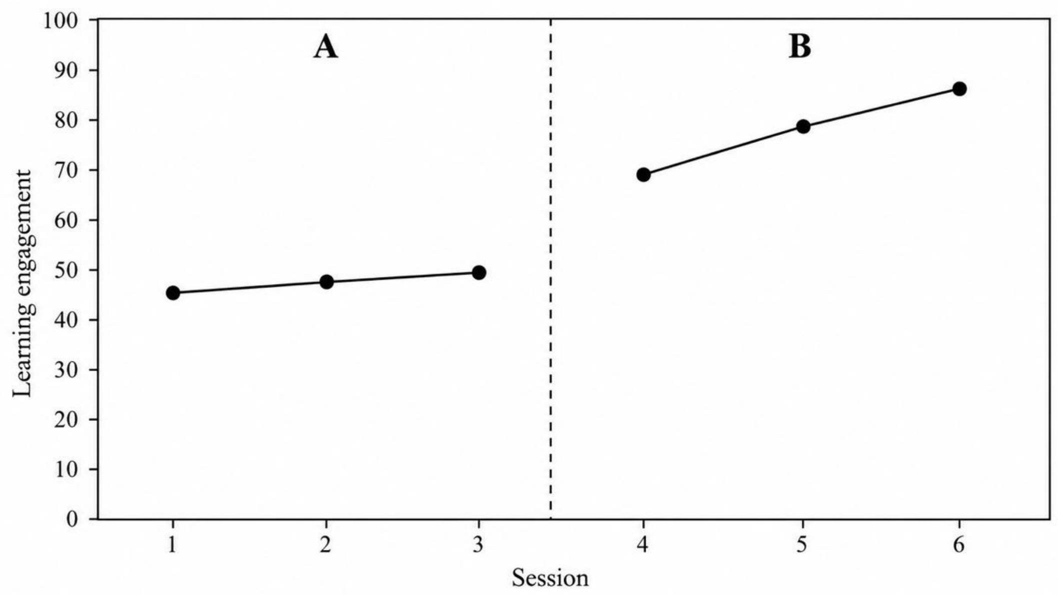

Figure 5. Learning Engagement Outcomes

Summary of Results Between Variables

The results demonstrated positive within-participant changes in all observed variables. Data from the intervention phase showed an increase in levels, an upward trend, and no overlap with data from the baseline phase. These findings indicate that the use of BISINDO-based instructional videos was associated with improved welding-learning outcomes for the participant.

Table 9. Summary of Data Changes Between Phases

Variable	Mean Baseline	Mean Intervention	Difference	PND	Category
Procedural understanding	43.67	77.33	33.66	100%	Very effective
Practical skills	42.67	74.33	31.66	100%	Very effective
Learning engagement	48.00	79.33	31.33	100%	Very effective

Discussion

The findings showed clear within-participant changes in procedural understanding, practical welding skills, and learning engagement following the introduction of BISINDO-based instructional videos. For all three outcomes, intervention scores exceeded baseline scores, accompanied by immediate level changes and positive within-phase trends. Complete non-overlap was observed between baseline and intervention data for all outcomes. This pattern is encouraging, although the short phases, continuing upward trends during intervention, and limited experimental control mean that the PND values should be interpreted as preliminary descriptive evidence rather than definitive evidence of intervention effectiveness. Because performance had not stabilized by the final intervention session, the results do not establish the student's eventual level of achievement or the maintenance of improvement over time.

One possible explanation for this pattern is that the BISINDO-based video may have reduced communication barriers by presenting technical information through visual demonstrations, sign language, concise written text, and repeatable procedural sequences. In conventional welding instruction, a student with hearing impairment may need to divide visual attention among the teacher, tools, workpiece, written information, and safety cues. The video presented these sources of information in a more structured format that could be paused and replayed. This design may have supported cognitive processing by making transient explanations and movements more observable, reducing the likelihood that essential procedural information would be missed, and allowing the student to process each work step at an appropriate pace. These features are consistent with evidence that students with hearing impairments value user-controlled playback, segmented presentation, and the coordinated availability of sign language, captions, text, and visuals because these features help them manage competing visual demands and recover information that may initially have been missed (Gehret & Elliot, 2025). Sign-language-based e-learning has also been associated with increased learning satisfaction and motivation among deaf learners (Niksiar et al., 2025).

However, the observed improvement should not be attributed exclusively to the instructional video. Given the single-participant A–B design, without withdrawal of the intervention or replication across participants, behaviors, or settings, several alternative explanations remain plausible. Repeated exposure to welding tasks, increasing familiarity with the assessment criteria and workshop procedures, cumulative teacher feedback, and general session experience may also have contributed to the improvement. The methodological literature cautions that a single baseline-to-intervention comparison may indicate a potential treatment effect but does not fully rule out maturation, testing or session-experience effects, and coincidental events occurring near the phase transition (Michiels & Onghena, 2019; Slocum et al., 2022). The student's initial responsiveness may also have been partly influenced by the novelty of receiving instruction through a BISINDO-based digital video, as Jeno et al. (2019) found that new educational technologies can temporarily increase learners' attention and motivation before they become familiar with them. Therefore, the findings are best interpreted as indicating that the BISINDO-based video was associated with, and likely contributed to, the observed improvement rather than demonstrating that the video was its sole cause.

The improvement in procedural understanding suggests that the student became more capable of identifying welding tools and materials, explaining their functions, recognizing work sequences, and understanding occupational safety procedures. One possible explanation is that BISINDO served not merely as a supplementary communication aid but as an accessible linguistic channel through which technical concepts were conveyed. The combination of sign-language explanations, written terminology, and visual demonstrations may have strengthened the connection between abstract welding concepts and observable actions. Tang (2024) similarly argued that sign language should be positioned as a legitimate linguistic and pedagogical resource in inclusive education. This interpretation is further supported by Zhang et al. (2024), who identified a positive relationship between sign-language proficiency and written or spoken language development among students with hearing impairments. Thus, the BISINDO-based video may have supported procedural comprehension by connecting technical vocabulary, visual representations, and sequential actions within the same learning resource.

Changes in practical welding skills indicated an increasing ability to translate procedural information into work preparation, tool use, movement control, occupational safety compliance, and task completion. Welding is both procedural and psychomotor; therefore, learning requires more than verbal explanation. Students must observe movement sequences, retain them, reproduce them, and adjust their actions during practice. The video may have supported this process by providing a stable visual model that could be repeatedly observed before and during practical activities.

Repetition may have reinforced the sequencing of actions, while the visual presentation of body position, equipment use, and work steps may have supported motor planning and execution. This interpretation is consistent with Almalhy (2022), who reported the benefits of sign-language video for procedural content, and with studies showing that sign-language-based educational videos can support knowledge and practical skills in first-aid and cardiopulmonary-resuscitation contexts (Elfar et al., 2024; Neto et al., 2023). Although these studies addressed different skills, they similarly suggest that visually accessible videos can help students with hearing impairments connect instructional information with practical performance.

The increase in learning engagement was reflected in greater attention, responsiveness, interest, participation, independence, review of learning materials, and persistence during workshop activities. This pattern suggests that engagement improved because the instructional format was more accessible and controllable, rather than simply because video technology was introduced. When communication demands are reduced, a student with hearing impairment may be better able to focus on the task, respond to instructions, participate independently, and persist when difficulties occur. Weber et al. (2025) emphasized that visually oriented multimodal pedagogy can strengthen educational interaction by aligning instruction with the perceptual experiences of students with hearing impairments. Similarly, Loaiza-Ramírez and González-Beltrán (2026) highlighted the importance of integrating sign language, captions, and nonverbal information into digital accessibility design. The present findings therefore suggest that accessible media may support engagement by helping the student understand expectations, anticipate subsequent steps, and participate with less dependence on repeated verbal clarification.

These findings have practical implications for inclusive vocational education. BISINDO-based instructional videos may be used before demonstrations to introduce terminology and safety procedures, during practice to reinforce work sequences, and after instruction to support independent review. Teachers can segment complex welding procedures into shorter steps, synchronize BISINDO explanations with demonstrated actions, emphasize essential personal protective equipment (PPE) and occupational safety information, and limit unnecessary visual elements that may compete for attention. Such videos should complement, rather than replace, direct teacher guidance and supervised workshop practice. At the school level, developing reusable accessible videos may offer a feasible strategy for improving instructional consistency, reducing communication barriers, and supporting safer participation by students with hearing impairments in practical subjects.

The study provides preliminary evidence that BISINDO-based instructional videos may support procedural understanding, practical welding skills, and learning engagement for a student with hearing impairment in an authentic vocational-school context. However, the findings should be interpreted cautiously because they were derived from one participant, three observations per phase, continuing intervention trends, and an A–B design with limited experimental control. Future studies should use longer phases, maintenance observations, independent assessors, and stronger single-case designs to determine whether the observed changes are stable, replicable, and functionally related to the intervention.

CONCLUSION

Based on visual analysis and the percentage of non-overlapping data (PND), the introduction of BISINDO-based instructional videos was associated with positive within-participant changes in vocational welding learning for one student with hearing impairment. Compared with the baseline phase, higher scores were observed during the intervention phase in procedural understanding, practical welding skills, and learning engagement. The student demonstrated improved recognition of tools and materials, understanding of work sequences and safety procedures, preparation and execution of welding tasks, use of personal protective equipment, attention, responsiveness, and participation. Complete non-overlap between baseline and intervention data provided encouraging descriptive evidence; however, the findings should be interpreted as preliminary because the A–B design, short phases, and absence of inferential testing do not establish statistical significance or a functional causal relationship. BISINDO-based instructional videos may therefore serve as a promising accessible medium for supporting inclusive welding instruction in VHSs.

Vocational teachers may integrate BISINDO-based instructional videos into practical learning to provide visually accessible explanations of procedures, technical terminology, and occupational safety. These videos may be combined with live demonstrations, supervised practice, concise written text, and visual reinforcement to support students with hearing impairments more comprehensively. Schools may also support the development of accessible video libraries and teacher training in visual-communicative instructional design. Future studies should involve additional participants, longer baseline and intervention phases, maintenance assessments, independent assessors, and stronger single-case designs, such as multiple-baseline or staggered-introduction designs. Further research could also examine the application of BISINDO-based videos across other vocational competencies and their longer-term contribution to skill retention and work readiness.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial or non-financial interests that could have appeared to influence the work reported in this paper.

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