WOMEN, EDUCATION, AND SOCIAL WELFARE
VOL. 3 NO. 2 (2026)

ISSN: 3064-2469

Audio-Visual Media in Differentiated Economics Instruction: Effects on Students' Critical and Creative Thinking

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To cite this article: M. Irsan, Husamah, and A. Restian, "Audio-Visual Media in Differentiated Economics Instruction: Effects on Students' Critical and Creative Thinking," *Women, Educ. Soc. Welf.*, vol. 3, no. 2, pp. 642–655, 2026. https://doi.org/10.70211/wesw.v3i2.483

Published online: June 28, 2026

OPEN ACCESS

https://doi.org/10.70211/wesw.v3i2.483

Women, Education, and Social Welfare Vol 3 No 2 (2026)

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Research Article

Audio-Visual Media in Differentiated Economics Instruction: Effects on Students' Critical and Creative Thinking

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Received: April 14, 2026	Revised: April 23, 2026	Accepted: June 25, 2026	Online: June 28, 2026

Abstract

Developing higher-order thinking through equitable learning design remains a challenge in secondary economics education. This quasi-experimental study tested whether audio-visual media embedded in differentiated instruction improved critical and creative thinking among eleventh-grade students at State Islamic Senior High School (Madrasah Aliyah Negeri [MAN]) 3 Mataram, Indonesia. Two intact classes (N = 60) participated in a non-equivalent pretest-posttest control-group design. The experimental class received six 90-minute sessions integrating video, animation, infographics, economic cases, flexible learning processes, and product choice; the control class received conventional instruction. Critical-thinking essays and a creative poster project were scored using validated rubrics. MANCOVA, controlling for both pretests, showed a significant multivariate instructional effect, Pillai's Trace = .400, $F(2, 55) = 18.303$, $p < .001$, partial eta squared = .400. Univariate effects favored the experimental group for critical thinking, $F(1, 56) = 5.662$, $p = .021$, partial eta squared = .092, and creative thinking, $F(1, 56) = 32.118$, $p < .001$, partial eta squared = .364. The findings indicate that accessible multimodal resources coupled with differentiated learning pathways can strengthen higher-order thinking, particularly creative problem solving in unemployment-related economic cases.

Keywords: Audio-Visual Media; Creative Thinking; Critical Thinking; Differentiated Instruction; Economics Education; Equitable Learning Opportunities.

INTRODUCTION

Education systems increasingly expect learners to evaluate evidence, generate alternatives, and communicate defensible solutions to complex social and economic issues. Critical thinking enables reasoned interpretation, analysis, evaluation, inference, and explanation, whereas creative thinking supports fluent, flexible, original, and elaborated problem solving. These capabilities are central to higher-order thinking and to students' capacity to engage with changing educational and employment contexts [1], [2], [3], [4], [5], [6].

This expectation is especially consequential in economics education, where young people must interpret labour-market information, examine unemployment, compare policy responses, and judge the feasibility of alternative solutions. Yet classrooms are heterogeneous: learners enter with different levels of prior knowledge, interests, confidence, language resources, and preferred ways of engaging with material. Differentiated instruction responds to this diversity by proactively varying content, process, product, assessment, and learning environment while maintaining shared learning goals [7], [8], [9], [10], [11], [12], [13], [14]. In this sense, equitable learning opportunity does not mean identical instruction; it means access to appropriately challenging routes toward meaningful participation and achievement.

Audio-visual media can make such routes more accessible when it is pedagogically designed rather than used as a decorative add-on. Cognitive Theory of Multimedia Learning explains how coordinated verbal and visual representations can support active meaning making within limited working-memory capacity [15], [16], [17], [18]. Research on instructional video further indicates that learning benefits depend on design features such as signalling, segmentation, pacing, interaction, and alignment with a purposeful learning task [19], [20], [21], [22]. Recent work also cautions that multimedia can impose unnecessary cognitive load when information is poorly segmented or visually overloaded, making instructional design quality essential [23], [24], [25], [26].

Prior research has linked audio-visual resources with motivation and higher-order thinking [27], [28], and has documented that multimedia embedded in problem-based tasks can support analytical and creative performance [29], [30]. Nevertheless, the evidence is not uniformly positive when media are introduced without a sufficiently structured learning process, and broad innovation claims do not clarify which instructional mechanisms support particular forms of thinking [31], [32]. Collaborative, student-centred, and technology-supported approaches are more likely to develop higher-order outcomes when learners must interpret authentic information, compare alternatives, justify decisions, and construct products that make their reasoning visible [33], [34], [35], [36]. Emerging meta-analytic evidence on interactive visual technologies likewise suggests that learning gains are shaped by the pedagogical approach surrounding the tool rather than by the technology alone [37], [38].

At State Islamic Senior High School (Madrasah Aliyah Negeri [MAN]) 3 Mataram, preliminary classroom observation indicated that Economics instruction on employment and unemployment relied predominantly on teacher exposition, printed materials, and presentation slides. The school context therefore offered a relevant opportunity to test an inclusive instructional design that combined differentiated learning pathways with carefully selected audio-visual resources. The study addresses a specific gap: few quasi-experimental studies have examined critical and creative thinking simultaneously after pretest adjustment in upper-

secondary Economics education, particularly in an Indonesian Islamic senior-secondary setting. The study investigates whether six sessions of audio-visual media integrated into differentiated instruction improve students' critical and creative thinking compared with conventional instruction. Its contribution lies in testing an instructional bundle that connects equitable access, multimodal representation, and divergent economic problem solving within one multivariate model.

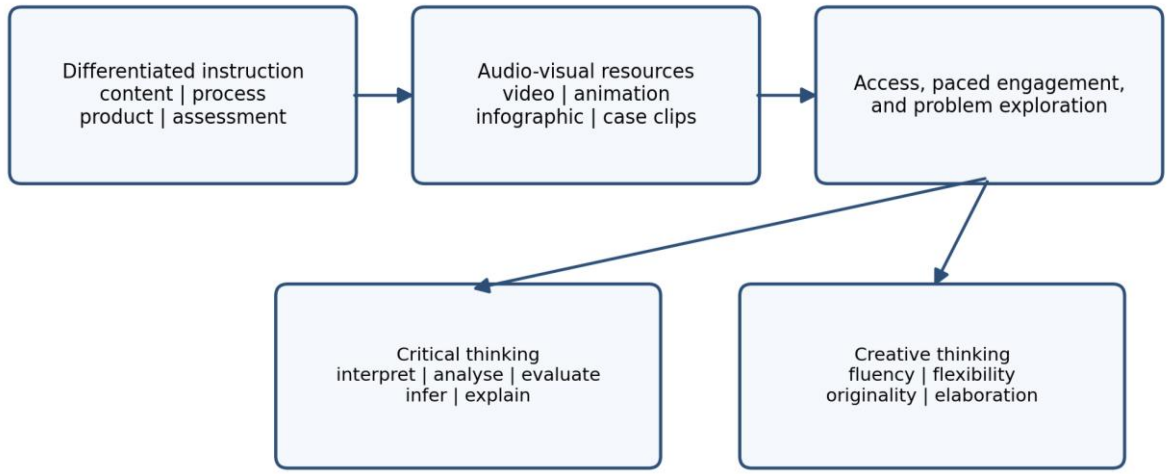

Figure 1. Conceptual framework of audio-visual media in differentiated Economics instruction [7], [15], [17].

METHODS

Research design and setting

The study employed a quantitative, quasi-experimental non-equivalent pretest-posttest control-group design. The independent variable was differentiated instruction supported by audio-visual media. The dependent variables were students' critical-thinking and creative-thinking scores. Both pretest scores were entered as covariates so that posttest comparisons reflected adjusted group differences rather than initial score differences. The research was conducted in the second semester of the 2025/2026 academic year at MAN 3 Mataram, West Nusa Tenggara, Indonesia.

Participants and sampling

The population comprised eleventh-grade students enrolled in Economics at the school. Purposive sampling selected two intact classes that the Economics teacher identified as academically comparable in curriculum coverage and scheduling. The experimental group comprised 30 students and the control group comprised 30 students. Because the class groups already existed, individual random assignment was not feasible. The same teacher taught both groups, and both covered the same employment and unemployment unit over six meetings. This design improves practical comparability while requiring cautious causal interpretation.

Instructional conditions and treatment procedure

Each group completed six 90-minute meetings (2 x 45 minutes). In the experimental group, the teacher acted primarily as a facilitator, organising multimodal resources, prompting analysis, and offering differentiated learning supports. Differentiation was implemented through varied content representations, flexible learning processes, options for demonstrating understanding, and varied assessment evidence. Audio-visual materials included short explanatory videos, animations, infographics, documentary excerpts, government-programme clips, and current economic cases. In the control group, learning followed the school's conventional pattern of exposition, question-and-answer, textbook and presentation use, individual exercises, and end-unit review. Student worksheets (Lembar Kerja Peserta Didik [LKPD]) in the experimental group contained video-observation prompts, case-analysis questions, solution-design tasks, and reflection prompts.

Table 1. Six-session instructional design and differentiated supports

Meeting	Economics topic	Experimental-group learning design	Control-group learning design
1	Employment concepts	Animated explanation, infographic, short reading; readiness-sensitive group discussion on labour, workforce, and employment opportunities.	Teacher explanation using slides, guided question-and-answer, and note taking.
2	Employment issues in Indonesia	News/documentary clips and cases; groups analyse employment issues at different levels of task complexity.	Guided lecture and teacher-provided examples of employment issues.
3	Unemployment and its types	Interactive animation and video; self-paced worksheet completion with differentiated prompts.	Lecture on concepts followed by individual practice questions.
4	Economic consequences of unemployment	Documentary excerpts; students select a presentation, concept map, or short report to explain impacts.	Lecture and question-and-answer about individual and national impacts.
5	Responses to unemployment	Government and entrepreneurship clips; groups evaluate shown responses and formulate alternatives.	Teacher explanation followed by individual assignment completion.
6	Case analysis and solution presentation	Current-case video; product choice (poster, presentation, or report) and rubric-guided feedback.	Review of material and end-unit practice questions.

Operational definitions and instruments

Critical thinking was assessed using a 10-item constructed-response test, with two prompts aligned to each indicator: interpretation, analysis, evaluation, inference, and explanation. Each prompt was scored from 0 to 4 using an analytic rubric, yielding a possible total of 0 to 40. Creative thinking was assessed through a poster-based performance task. The rubric comprised 12 performance descriptors, three descriptors for each of fluency, flexibility, originality, and elaboration; each descriptor was scored from 0 to 4, yielding a possible total of 0 to 48. The

poster task required students to formulate a feasible response to an unemployment-related economic problem.

Table 2. Operational definitions, assessment evidence, and scoring

Construct	Indicators	Assessment evidence	Score range and quality evidence
Critical thinking	Interpretation; analysis; evaluation; inference; explanation	10 constructed-response prompts contextualised to employment and unemployment.	0-40; content reviewed by two Economics-education lecturers and one school Economics teacher; pilot internal consistency alpha = .969.
Creative thinking	Fluency; flexibility; originality; elaboration	Poster-based solution task with 12 performance descriptors.	0-48; two independent assessors; ICC(2,2), absolute agreement = .892, 95% CI [.791, .948], $p < .001$.
Implementation evidence	Engagement with media, case analysis, product development, reflection	Student worksheets and learning-observation sheets.	Used to support monitoring of treatment implementation; not entered as dependent variables.

Instrument validation and reliability

Content validity was established through expert judgement by two Economics-education lecturers and one Economics teacher experienced at the senior-secondary level. Experts evaluated indicator alignment, wording clarity, contextual relevance, and representativeness of the intended construct. After revision, the instruments were piloted with students outside the research sample. Item-total correlations for the constructed-response assessment ranged from .946 to .982 ($p < .01$), and the overall internal-consistency coefficient was alpha = .969. The creative-thinking rubric was independently scored by two assessors using a two-way random-effects, absolute-agreement intraclass correlation approach. The ICC of .892 indicates strong agreement and supports the reliability of the performance assessment.

Data collection and analysis

Data collection proceeded in four stages: instrument preparation and review; pretesting in both groups; implementation of the six-session instructional conditions; and posttesting after the final meeting. All 60 participants provided complete pretest and posttest data. The analysis began with descriptive statistics, followed by normality, homogeneity of variance, covariance-matrix equality, linearity, and homogeneity-of-regression-slope checks. A one-way MANCOVA then tested the omnibus effect of instructional condition on the two posttest outcomes while controlling for critical-thinking and creative-thinking pretests. Significant

multivariate results were followed by univariate ANCOVA tests. Gain scores are reported descriptively; formal inference is based on adjusted posttest scores.

Study hypothesis

H1: Audio-visual media embedded in differentiated instruction has a significant multivariate effect on students' critical-thinking and creative-thinking posttest scores after controlling for their corresponding pretest scores.

Ethical considerations

Ethical safeguards were applied throughout the study. Participants were informed about the study purpose, procedures, voluntary participation, and right to withdraw without penalty. Data were anonymised before analysis, and no direct personal identifiers were reported. The research team maintained confidentiality in the storage, analysis, and presentation of all classroom data.

RESULTS AND DISCUSSION

Results

Data completeness and descriptive profile

All 60 enrolled participants were retained in the analysis; no student was absent from either test administration and no score was incomplete. Table 3 presents raw pretest and posttest means, adjusted posttest means, and descriptive gain scores. The experimental group entered the study with higher raw pretest scores on both outcomes. This baseline imbalance makes pretest adjustment essential. After adjustment, the experimental group retained higher estimated posttest means for critical thinking and creative thinking. The gain pattern is consistent with this adjusted result, although gain scores are presented only as descriptive evidence.

Table 3. Descriptive and adjusted outcome scores by instructional group

Outcome	Group (n)	Pretest M (SD)	Posttest M (SD)	Adjusted posttest M (95% CI)	Gain M (SD)
Critical thinking	Experimental (30)	17.67 (3.20)	23.60 (2.37)	22.37 (21.12, 23.62)	5.93 (3.42)
Critical thinking	Control (30)	13.57 (3.18)	18.50 (2.66)	19.73 (18.48, 20.98)	4.93 (2.32)
Creative thinking	Experimental (30)	23.20 (2.93)	35.17 (2.95)	31.12 (30.56, 31.68)	11.97 (0.18)
Creative thinking	Control (30)	15.73 (1.64)	24.27 (2.50)	28.32 (27.76, 28.87)	8.53 (1.38)

MANCOVA assumption checks

The MANCOVA assumptions were examined before hypothesis testing. Shapiro-Wilk tests showed no statistically significant departure from normality for the four pretest and posttest distributions. Levene's tests supported homogeneity of variance for both posttest outcomes, Box's M supported equality of covariance matrices, and the group-by-pretest interactions were

nonsignificant. The two posttest outcomes were positively correlated, r = .696, p < .001, supporting joint multivariate analysis while indicating that the outcomes were not redundant.

Table 4. Assumption checks for the multivariate analysis

Assumption	Statistic	p-value	Decision
Critical-thinking pretest normality	Shapiro-Wilk W = .979	.382	Supported
Creative-thinking pretest normality	Shapiro-Wilk W = .935	.374	Supported
Critical-thinking posttest normality	Shapiro-Wilk W = .975	.244	Supported
Creative-thinking posttest normality	Shapiro-Wilk W = .929	.267	Supported
Critical-thinking posttest variance equality	Levene's F(1, 58) = .297	.588	Supported
Creative-thinking posttest variance equality	Levene's test	.547	Supported
Covariance-matrix equality	Box's M = 1.653	.661	Supported
Critical-thinking slope homogeneity	Group x pretest F(1, 58) = .919	.342	Supported
Creative-thinking slope homogeneity	Group x pretest F(1, 58) = .035	.852	Supported

Multivariate effect of instructional condition

The omnibus MANCOVA result showed a statistically significant effect of instructional condition on the combined critical-thinking and creative-thinking posttest scores after both pretests were controlled, Pillai's Trace = .400, F(2, 55) = 18.303, p < .001, partial eta squared = .400. Thus, the null component of H1 was rejected. The result indicates that instructional condition accounted for a meaningful proportion of the adjusted multivariate outcome variation. Both pretests were also significant multivariate covariates, confirming that initial skills were strongly related to posttest performance and validating the decision to use adjusted comparisons.

Table 5. Multivariate MANCOVA results

Source	Pillai's Trace	F (df)	p-value	Partial eta squared	Interpretation
Critical-thinking pretest	.238	8.607 (2, 55)	.001	.238	Significant covariate
Creative-thinking pretest	.873	189.006 (2, 55)	< .001	.873	Significant covariate
Instructional condition	.400	18.303 (2, 55)	< .001	.400	Significant multivariate effect

Adjusted univariate effects

Follow-up univariate tests demonstrated statistically significant adjusted group differences for both outcomes. The experimental group outperformed the control group on critical thinking,

F(1, 56) = 5.662, p = .021, partial eta squared = .092. The adjusted effect was stronger for creative thinking, F(1, 56) = 32.118, p < .001, partial eta squared = .364. The difference between the effect sizes indicates that the intervention was particularly associated with students' ability to generate and elaborate alternatives for unemployment-related problems, although it also supported the more evaluative and evidence-based processes assessed in the critical-thinking test.

Table 6. Adjusted univariate effects of instructional condition

Dependent variable	Experimental adjusted M	Control adjusted M	F (df)	p-value	Partial eta squared
Critical thinking	22.37	19.73	5.662 (1, 56)	.021	.092
Creative thinking	31.12	28.32	32.118 (1, 56)	< .001	.364

Discussion

The findings show that audio-visual media embedded in differentiated Economics instruction was associated with superior adjusted posttest performance in both critical and creative thinking. The multivariate result is important because it demonstrates that the intervention did not merely improve a single narrow outcome; after initial differences were statistically controlled, the experimental condition was related to a combined profile of stronger analytical judgment and more productive idea generation. This pattern is consistent with work positioning higher-order thinking as an interconnected set of capacities rather than an isolated test skill [1], [3], [5], [6]. It also supports research showing that differentiated instruction can contribute to more equitable learning outcomes when teachers vary the routes through which students access, process, and demonstrate learning [7], [9], [11], [13].

The critical-thinking effect was statistically significant but smaller than the creative-thinking effect. This difference is plausible because the critical-thinking test required disciplined evidence use across interpretation, analysis, evaluation, inference, and explanation. Video and animation can offer concrete representations of abstract economic relationships, but these representations only become critical-thinking opportunities when students are required to interrogate claims, compare evidence, and justify a decision. The experimental worksheets and case discussions were designed to impose precisely these demands. This interpretation aligns with Cognitive Theory of Multimedia Learning and cognitive-load research: integrated verbal and visual information can support conceptual processing, but learning gains depend on managing attention and avoiding extraneous processing [15], [17], [18], [23], [26].

The stronger adjusted effect for creative thinking is particularly noteworthy. Students in the experimental group were not confined to a single answer format; they could develop posters, concept maps, reports, or presentations while proposing responses to unemployment. This product choice likely widened the space for fluency, flexibility, originality, and elaboration. The mechanism is therefore not simply that participants watched videos. Rather, audio-visual cases supplied concrete stimuli and differentiated products required learners to transform those stimuli into alternative solutions. This explanation is consistent with studies reporting creative-performance benefits when multimedia learning activities require learners

to construct, modify, and communicate ideas rather than passively receive information [28], [30], [33], [34].

The results also help explain why the literature on media effects is mixed. A previous study reported that the medium alone did not necessarily produce stronger critical-thinking outcomes, particularly when instructional conditions did not fully exploit problem-centred activity [29]. The present design differs because audio-visual resources were embedded in a coherent sequence of observation, analysis, group negotiation, reflection, and product development. Evidence on instructional videos similarly stresses that segmentation, signalling, learner activity, and alignment with a task are decisive design features [19], [20], [21], [22], [24]. Accordingly, the novelty of this study is its treatment of audio-visual media as an enabling component of differentiated instruction rather than as a stand-alone technological intervention.

The study also contributes an inclusive education perspective relevant to education systems and social welfare. The instructional design treated learner diversity as a normal classroom condition rather than a deficit: students encountered the same economic concepts but could access information through multiple representations, work through tasks at a supported pace, and communicate understanding through differentiated products. Such design choices are compatible with Universal Design for Learning scholarship that foregrounds multiple means of representation, engagement, and expression [10]. They also complement evidence that differentiated instruction can support academic and psychosocial participation when it is implemented intentionally rather than as ad hoc individualisation [11], [12], [13], [14]. In an Economics unit on employment and unemployment, this approach has a further civic value: students learn to interpret social problems and formulate responses rather than memorise definitions alone.

For practice, the findings suggest that teachers should plan media and differentiation together. Short videos should be selected for a specific conceptual purpose; animations should be segmented and followed by prompts that require explanation; infographics should be used as evidence to compare alternatives; and student products should be assessed with rubrics that make thinking visible. School leaders can support this approach by allocating time for teachers to curate accessible media, design differentiated worksheets, calibrate performance rubrics, and discuss student work. Teacher professional learning should emphasise instructional design and assessment literacy, because technology-rich lessons remain ineffective when they lack structured opportunities for reasoning, feedback, and revision [16], [25], [35], [36].

Several limitations qualify the interpretation. The study involved two intact classes in one State Islamic Senior High School, so the findings cannot be generalised automatically to other regions, subjects, or student populations. The quasi-experimental design and observed baseline differences mean that MANCOVA reduces, but cannot eliminate, selection bias. The treatment also bundled differentiated instruction with audio-visual media, preventing isolation of the independent contribution of each component. In addition, the study did not include delayed posttests, cognitive-load measures, or an aggregate numerical fidelity score; consequently, retention and the precise mediating mechanism remain untested. Future multi-school research should use larger samples, delayed assessments, process measures, and mixed-method classroom observation to examine how representation, pacing, learner choice, and collaboration jointly explain critical and creative thinking development.

CONCLUSION

Audio-visual media integrated into differentiated Economics instruction produced significant adjusted advantages in students' critical and creative thinking relative to conventional instruction. The multivariate finding and the two univariate follow-up tests indicate that the intervention supported a broad higher-order thinking profile, with a particularly strong association with creative problem solving. The study's contribution is to demonstrate that equitable learning design, multimedia representation, authentic economic cases, and differentiated products can be combined within a feasible six-session upper-secondary intervention. For educators, the central implication is that media should be designed as part of a learning pathway, not added after the fact. When audio-visual representations are paired with analytic prompts, flexible pacing, collaboration, and meaningful product choices, students gain multiple ways to access economic concepts and make their reasoning visible. The findings offer a practical direction for more inclusive Economics instruction while underscoring the need for stronger multi-site and longitudinal evidence.

LIMITATIONS

This study was limited to eleventh-grade Economics students at MAN in Mataram and to the employment and unemployment unit. The sample comprised two pre-existing classes, and the intervention combined audio-visual media with multiple differentiated-instruction components; thus, the results should not be interpreted as the isolated effect of video-based media. Critical thinking was operationalised through interpretation, analysis, evaluation, inference, and explanation, whereas creative thinking was operationalised through fluency, flexibility, originality, and elaboration. The absence of random assignment, delayed outcome measurement, and direct measures of cognitive load, engagement, and implementation fidelity limits causal and process-level inference.

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AUTHOR CONTRIBUTION

M.I. conceptualised the study, developed the research design, coordinated the data collection, conducted the statistical analysis, interpreted the findings, and prepared the initial manuscript draft. H. contributed to instrument development, data management, classroom implementation support, and interpretation of the assessment evidence. A.R. provided theoretical and analytical guidance, refined the conceptual framework, and critically reviewed and revised the manuscript for important intellectual content. All authors approved the final manuscript and accept responsibility for all aspects of the work.

CONFLICT OF INTEREST

"The authors declare no conflict of interest."

DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors declare that generative artificial intelligence tools were used solely to support language refinement, grammar checking, and improvement of manuscript readability. The tools were not used to generate, manipulate, or fabricate research data, results, references, interpretations, or conclusions. All intellectual content, methodological decisions, data analysis, and final revisions were undertaken and critically reviewed by the authors, who assume full responsibility for the accuracy, integrity, and originality of the manuscript.

REFERENCES

[1] B. Thornhill-Miller *et al.*, "Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st-century skills for the future of work and education," *Journal of Intelligence*, vol. 11, no. 3, Art. no. 54, 2023. https://doi.org/10.3390/jintelligence11030054

[2] J. Khadka, N. Dahal, U. Acharya, G. Puri, N. Subedi, and M. K. Hasan, "Higher-order thinking skills in e-learning contexts in higher education: A phenomenological study," *Frontiers in Education*, vol. 10, Art. no. 1555541, 2025. https://doi.org/10.3389/feduc.2025.1555541

[3] C. P. Dwyer, M. J. Hogan, and I. Stewart, "An integrated critical thinking framework for the 21st century," *Thinking Skills and Creativity*, vol. 12, pp. 43–52, 2014. https://doi.org/10.1016/j.tsc.2013.12.004

[4] K. H. Kim, "Can we trust creativity tests? A review of the Torrance Tests of Creative Thinking (TTCT)," *Creativity Research Journal*, vol. 18, no. 1, pp. 3–14, 2006. https://doi.org/10.1207/s15326934crj1801_2

[5] I. Supena, A. Darmuki, and A. Hariyadi, "The influence of 4C (constructive, critical, creativity, collaborative) learning model on students' learning outcomes," *International Journal of Instruction*, vol. 14, no. 3, pp. 873–892, 2021. https://doi.org/10.29333/iji.2021.14351a

[6] S. Venkatraman, F. Benli, Y. Wei, and F. Wahr, "Smart classroom teaching strategy to enhance higher order thinking skills (HOTS): An agile approach for Education 4.0," *Future Internet*, vol. 14, no. 9, Art. no. 255, 2022. https://doi.org/10.3390/fi14090255

[7] B. N. Langelaan, L. Gaikhorst, W. Smets, and R. J. Oostdam, "Differentiating instruction: Understanding the key elements for successful teacher preparation and development," *Teaching and Teacher Education*, vol. 140, Art. no. 104464, 2024. https://doi.org/10.1016/j.tate.2023.104464

[8] S. Kara and A. Tekindur, "The effect of differentiated instruction on the academic achievement and opinions of 3rd-grade students in science education: A mixed-methods study," *Journal of Intelligence*, vol. 13, no. 10, Art. no. 126, 2025. https://doi.org/10.3390/jintelligence13100126

[9] N. Goyibova, N. Muslimov, G. Sabirova, N. Kadirova, and B. Samatova, "Differentiation approach in education: Tailoring instruction for diverse learner needs," *MethodsX*, vol. 14, Art. no. 103163, 2025. https://doi.org/10.1016/j.mex.2025.103163

[10] A. Bray *et al*., "What's next for Universal Design for Learning? A systematic literature review of technology in UDL implementations at second level," *British Journal of Educational Technology*, vol. 55, no. 1, pp. 113–138, 2024. https://doi.org/10.1111/bjet.13328

[11] A. Smale-Jacobse, A. Meijer, A. Helms-Lorenz, and R. Maulana, "Differentiated instruction in secondary education: A systematic review of research evidence," *Frontiers in Psychology*, vol. 10, Art. no. 2366, 2019. https://doi.org/10.3389/fpsyg.2019.02366

[12] M. I. Deunk *et al*., "Effective differentiation practices: A systematic review and meta-analysis of studies on the cognitive effects of differentiation practices in primary education," *Educational Research Review*, vol. 24, pp. 31–54, 2018. https://doi.org/10.1016/j.edurev.2018.02.002

[13] M. Pozas, V. Letzel, K.-T. Lindner, and S. Schwab, "DI (differentiated instruction) does matter! The effects of DI on secondary school students' well-being, social inclusion and academic self-concept," *Frontiers in Education*, vol. 6, Art. no. 729027, 2021. https://doi.org/10.3389/feduc.2021.729027

[14] S. Palieraki and K. Koutrouba, "Differentiated instruction in information and communications technology teaching and effective learning in primary education," *European Journal of Educational Research*, vol. 10, no. 3, pp. 1487–1498, 2021. https://doi.org/10.12973/eu-jer.10.3.1487

[15] R. E. Mayer, "Cognitive theory of multimedia learning," in *The Cambridge Handbook of Multimedia Learning*, 2nd ed., R. E. Mayer, Ed. Cambridge, U.K.: Cambridge University Press, 2014, pp. 43–71. https://doi.org/10.1017/CBO9781139547369.005

[16] R. E. Mayer, "The past, present, and future of the cognitive theory of multimedia learning," *Educational Psychology Review*, vol. 36, Art. no. 11, 2024. https://doi.org/10.1007/s10648-023-09842-1

[17] R. E. Mayer and R. Moreno, "Nine ways to reduce cognitive load in multimedia learning," *Educational Psychologist*, vol. 38, no. 1, pp. 43–52, 2003. https://doi.org/10.1207/S15326985EP3801_6

[18] R. E. Mayer and R. Moreno, "A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory," *Journal of Educational Psychology*, vol. 90, no. 2, pp. 312–320, 1998. https://doi.org/10.1037/0022-0663.90.2.312

[19] P. Zhang, L. Zhou, R. O. Briggs, and J. F. Nunamaker Jr., "Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness," *International Journal of Human-Computer Studies*, vol. 64, no. 1, pp. 15–27, 2006. https://doi.org/10.1016/j.ijhcs.2005.10.002

[20] C. J. Brame, "Effective educational videos: Principles and guidelines for maximizing student learning from video content," *CBE—Life Sciences Education*, vol. 15, no. 4, Art. no. es6, 2016. https://doi.org/10.1187/cbe.16-03-0125

[21] H. van der Meij and J. van der Meij, "Eight guidelines for the design of instructional videos for software training," *Computers & Education*, vol. 62, pp. 132–143, 2013. https://doi.org/10.1016/j.compedu.2012.10.015

[22] C. Evans and N. J. Gibbons, "The interactivity effect in multimedia learning," *Computers & Education*, vol. 49, no. 4, pp. 1147–1160, 2007. https://doi.org/10.1016/j.compedu.2006.01.008

[23] D. Liu, "The effects of segmentation on cognitive load, vocabulary learning and retention, and reading comprehension in a multimedia learning environment," *BMC Psychology*, vol. 12, Art. no. 4, 2024. https://doi.org/10.1186/s40359-023-01489-5

[24] S. La Torre and J. C. Désiron, "From research to practice: Are multimedia principles present in instructional videos used by teachers in science and history?," *Technology, Knowledge and Learning*, vol. 29, pp. 1993–2016, 2024. https://doi.org/10.1007/s10758-024-09753-2

[25] D. Mutlu-Bayraktar, "A systematic review of emotional design research in multimedia learning," *Education and Information Technologies*, vol. 29, pp. 24603–24626, 2024. https://doi.org/10.1007/s10639-024-12823-8

[26] F. Krieglstein, M. Beege, G. D. Rey, P. Ginns, M. Krell, and S. Schneider, "A systematic meta-analysis of the reliability and validity of subjective cognitive load questionnaires in experimental multimedia learning research," *Educational Psychology Review*, vol. 34, no. 4, pp. 2485–2541, 2022. https://doi.org/10.1007/s10648-022-09683-4

[27] S. Munawaroh, D. Ghany, and S. Patmanthara, "The effect of audio-visual media on students' learning motivation on Islamic history materials," *Nazhruna: Jurnal Pendidikan Islam*, vol. 5, no. 2, pp. 392–406, 2022. https://doi.org/10.31538/nzh.v5i2.2179

[28] F. W. Ginting, W. Widya, H. Sakdiah, N. Novita, S. Sulastri, and A. K. Damanik, "Interactive audio-visual learning media through Articulate Storylines containing problem-based contextual learning to improve students' HOTS and scientific attitudes," *International Journal of Religion*, vol. 5, no. 12, pp. 1031–1044, 2024. https://doi.org/10.61707/z5c4xg78

[29] L. E. W. Fajari, Sarwanto, and Chumdari, "The effect of problem-based learning multimedia and picture media on students' critical-thinking skills viewed from learning motivation and learning styles in elementary school," *Ilkogretim Online*, vol. 19, no. 3, pp. 1797–1811, 2020. https://doi.org/10.17051/ilkonline.2020.735165

[30] H. Kassim, H. Nicholas, and W. Ng, "Using a multimedia learning tool to improve creative performance," *Thinking Skills and Creativity*, vol. 13, pp. 9–19, 2014. https://doi.org/10.1016/j.tsc.2014.02.004

[31] R. Rosmaria, "Optimizing innovative learning strategies to improve elementary school students' learning outcomes: A literature review," *Ludi Litterarri*, vol. 1, no. 2, pp. 9–16, 2024. https://doi.org/10.62872/nhk27142

[32] A. Rathore, "Developing higher order thinking skills," *International Journal for Multidisciplinary Research*, vol. 7, no. 5, 2025. https://doi.org/10.36948/ijfmr.2025.v07i05.57426

[33] D. Ramdani, H. Susilo, Suhadi, and Sueb, "The effectiveness of collaborative learning on critical thinking, creative thinking, and metacognitive skill ability: Meta-analysis on biological learning," *European Journal of Educational Research*, vol. 11, no. 3, pp. 1607–1628, 2022. https://doi.org/10.12973/eu-jer.11.3.1607

[34] M. Nussbaum *et al*., "Taking critical thinking, creativity and grit online," *Educational Technology Research and Development*, vol. 69, no. 1, pp. 201–206, 2021. https://doi.org/10.1007/s11423-020-09867-1

[35] Sumarwati *et al*., "Developing mathematics learning media based on e-learning using Moodle on geometry subject to improve students' higher order thinking skills," *International Journal of Interactive Mobile Technologies*, vol. 14, no. 4, pp. 182–191, 2020. https://doi.org/10.3991/ijim.v14i04.12731

[36] S. Nadarajan *et al*., "Technology-based isometrical transformation flipped classroom to enhance students' higher order thinking skills," *IEEE Access*, vol. 11, pp. 4155–4172, 2023. https://doi.org/10.1109/ACCESS.2022.3230860

[37] A. Akçayır and G. Akçayır, "Advantages and challenges associated with augmented reality for education: A systematic review of the literature," *Educational Research Review*, vol. 20, pp. 1–11, 2017. https://doi.org/10.1016/j.edurev.2016.11.002

[38] J. Garzón and J. Acevedo, "Meta-analysis of the impact of augmented reality on students' learning gains," *Educational Research Review*, vol. 27, pp. 244–260, 2019. https://doi.org/10.1016/j.edurev.2019.04.001