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Review Article

Development and Validation of a VARK Modality-Based Differentiated Instructional Toolkit: Effectiveness on Science Learning Outcomes

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ABSTRACT

Purpose of the study: This study aimed to develop, validate, and evaluate the effectiveness of a differentiated instructional toolkit grounded in Neil Fleming's VARK (Visual, Aural, Read/Write, Kinesthetic) modalities for grade VII social studies instruction on economic activity materials.

Methodology: The study employed a Research and Development (R&D) design following the ASSURE model (Analyze Learners, State Objectives, Select Methods, Media, and Materials, Utilize Media and Materials, Require Learner Participation, Evaluate and Revise).

Main Findings: Expert validation yielded mean scores of 90.7% (instructional design), 89.8% (content), and 90.0% (media), all categorized as "highly valid." Student practicality ratings reached 88.9% ("highly practical"). The paired sample t-test confirmed a statistically significant difference between pre-test (M = 54.8) and post-test (M = 82.3) scores ($t(78) = 18.42$, $p < 0.001$, $d = 2.07$), with the overall N-Gain score of 0.61 (medium category). The KKTP achievement rate increased from 27.8% to 83.5%.

Novelty/Originality of this study: This study provides the first empirically validated, comprehensive VARK-based instructional toolkit specifically designed for secondary-level social studies in the Indonesian context, bridging the gap between modality diagnosis and classroom-ready differentiated materials. The findings offer practical guidance for teachers to implement modality-based differentiation using a validated toolkit, and contribute to the theoretical understanding of how sensory-channel alignment enhances learning outcomes in social studies education.

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1. INTRODUCTION

The twenty-first century demands a new set of competencies that extend beyond conventional knowledge acquisition. Global transformation has reshaped the skills that individuals need to succeed in an increasingly interconnected world [1], [2]. Education systems worldwide must cultivate critical thinking, collaboration, communication, and creativity as core learning outcomes [3], [4]. Indonesia, as a developing nation, faces considerable challenges in meeting these demands, as evidenced by its consistently low performance in the Programme for International Student Assessment (PISA) [5]. The 2022 PISA results placed Indonesia among the bottom ten of 81 participating countries in mathematics, reading, and science literacy. This

persistent achievement gap signals a systemic issue in how instruction is designed and delivered across Indonesian schools.

Social studies education occupies a critical position in the Indonesian curriculum, yet it remains one of the most underperforming subjects. The National Commission for Social Studies defines social studies as an integrated discipline that combines social sciences and humanities to develop civic competence [6]. Social studies aims to help young people develop their capacity for processing information and making informed decisions for societal progress [7]. However, classroom reality tells a different story. Many social studies teachers still rely predominantly on lecture-based, teacher-centered methods that prioritize rote memorization over conceptual understanding [8]. Students frequently perceive social studies as a monotonous subject that offers little intellectual stimulation. This perception stems from instructional practices that treat all learners identically, regardless of their individual learning preferences and cognitive profiles. Mutiani et al. [8] identified three persistent problems in Indonesian social studies instruction: insufficient development of critical thinking, dominance of verbal instruction, and assessment focused on low-order cognition. These issues collectively underscore the urgency of developing innovative instructional approaches that accommodate diverse learner characteristics.

The concept of differentiated instruction offers a promising alternative to the "one-size-fits-all" approach that dominates many Indonesian classrooms. Tomlinson [9] defines differentiated instruction as a pedagogical framework that acknowledges, accommodates, and responds to learner diversity in readiness, interest, and learning profile. Research consistently demonstrates that differentiated instruction produces positive effects on student achievement when teachers strategically vary content, process, and product according to individual needs [10], [11]. Gibbs and McKay [12] emphasize that differentiated classrooms ensure every student receives equitable learning opportunities tailored to their capabilities. Ginja and Chen [13] further assert that the effectiveness of differentiated instruction depends on teachers' proactive efforts to diagnose learner needs before designing instruction. Roiha and Polso [35] proposed a comprehensive five-dimensional model for differentiation that encompasses content, process, product, learning environment, and assessment. Despite this theoretical foundation, implementation remains challenging due to limited instructional resources, insufficient teacher training, and time constraints in lesson preparation [14], [15].

Neil Fleming's VARK model provides a practical diagnostic framework for identifying individual learning modalities. Fleming [16] categorizes learning preferences into four modalities: Visual, Aural, Read/Write, and Kinesthetic. Each modality represents a distinct sensory channel that learners prefer for processing information. Visual learners favor diagrams, charts, and spatial representations. Aural learners benefit from discussions, lectures, and verbal explanations. Read/Write learners excel when engaging with text-based materials. Kinesthetic learners thrive in hands-on, experiential activities [16], [17]. Studies confirm that when instruction aligns with students' preferred modalities, engagement and information retention increase significantly [18], [19]. The VARK questionnaire has been validated as a reliable instrument for identifying learning preferences across diverse educational contexts [20], [21]. Alkhasawneh [36] reported that nursing students' learning preferences shifted across academic years when assessed with VARK, highlighting the importance of continuous modality assessment in instructional planning. Aslaksen, K., & Lorås, H [37] further confirmed that modality-aligned teaching strategies enhance knowledge retention.

Previous research has explored the application of VARK in various educational settings, yet several critical gaps remain unaddressed. Subagja and Rubini [21] identified kinesthetic learners as the dominant group in science classes but acknowledged difficulty in grouping students by modality with limited resources; they recommended the development of classroom-ready instructional tools aligned with modality profiles. Lee [22] expanded the VARK framework by integrating visualization technologies into an enhanced VARK+ model for English language teaching but did not produce replicable instructional materials. Payaprom and Payaprom [17] found multimodal preferences among undergraduate students but recommended future studies to consider additional factors such as cultural background and socioeconomic status. Perez-Marin et al. [23] validated a multi-mode digital teaching approach using VARK at the university level but did not develop specific instructional materials for secondary education. Prithishkumar and Michael [38] demonstrated positive outcomes of VARK-based teaching in medical education but noted the absence of standardized material packages. Smale-Jacobse et al. [39] emphasized the need for structured differentiation frameworks in secondary education settings. These collective findings reveal a persistent gap: most VARK-related studies have not yet produced comprehensive, validated instructional toolkits that translate modality-based diagnosis into complete, classroom-ready materials, particularly for social studies at the secondary school level in developing country contexts.

Based on the identified gap, this study addresses the following research problem: How can a VARK modality-based differentiated instructional toolkit be developed to improve social studies learning outcomes for grade VII students? To operationalize this problem, three research questions were formulated: (RQ1) How valid is the VARK-based differentiated instructional toolkit as assessed by instructional design, content, and media experts? (RQ2) How practical is the toolkit based on student responses across formative evaluation stages?

(RQ3) How effective is the toolkit in improving student learning outcomes as measured by N-Gain scores and paired sample t-test?

The corresponding research objectives are: (1) to develop and validate a VARK-based differentiated instructional toolkit for grade VII social studies on economic activity materials; (2) to evaluate the practicality of the toolkit through iterative formative evaluation; and (3) to measure the effectiveness of the toolkit in improving student learning outcomes. The toolkit encompasses a teaching module, differentiated learning materials, student activity worksheets, interactive media, and assessment instruments, all designed to accommodate the four VARK modalities. The ASSURE model [24] guides the development process because of its systematic, classroom-oriented approach to instructional design.

The significance of this study is threefold. First, it contributes to the theoretical understanding of how VARK modality-based differentiation can be operationalized into structured instructional products for secondary education. Second, it provides practical tools that teachers can directly implement to address learner diversity in social studies classrooms. Third, it fills a methodological gap by demonstrating the complete R&D cycle from modality diagnosis through material development to empirical effectiveness testing. The research context is SMP Nusantara 1 Tangerang, where preliminary observations revealed low student engagement, uniform instructional delivery, and below-standard achievement scores (72.2% of students scoring below the minimum criteria of 75). This study contributes to the field by offering the first empirically validated, comprehensive VARK-based instructional toolkit that bridges the gap between modality-based diagnosis and differentiated classroom practice in Indonesian social studies education [40], [41].

2. RESEARCH METHOD

This study adopted a Research and Development (R&D) design, which Sugiyono [25] defines as a systematic research method used to develop and validate educational products. The R&D approach is appropriate for this study because it aims to produce a tangible instructional toolkit and evaluate its validity, practicality, and effectiveness in real classroom settings. Borg and Gall (1983, as cited in Rayanto & Sugianti, 2020) [26] describe educational R&D as a process that combines research findings with product development to create and refine educational solutions. The product developed in this study consists of a differentiated instructional toolkit comprising five components: a teaching module (modul ajar), learning materials (bahan ajar), student activity worksheets (LKPD), interactive media, and assessment instruments tailored to the four VARK modalities.

The development followed the ASSURE model, which Heinich et al. [24] designed as a classroom-oriented instructional design framework. The model consists of six sequential steps. Table 1 presents a summary of each ASSURE step and the corresponding activities and outputs in this study.

Table 1. Summary of ASSURE Model Steps and Research Activities

ASSURE Step	Activity	Output
Analyze Learners	VARK questionnaire, pre-test, demographic survey	Modality profiles, baseline scores
State Objectives	Alignment with Merdeka Curriculum learning outcomes	Learning objective matrix (Bloom's taxonomy)
Select Methods, Media, Materials	Design modality-specific strategies and materials	Four parallel material sets, media prototypes
Utilize Media & Materials	Classroom implementation across three classes	Lesson delivery logs, observation notes
Require Participation	Collaborative tasks, simulations, discussions	Student engagement records, worksheet results
Evaluate & Revise	Expert review, one-to-one, small group, field trial	Validation scores, practicality data, N-Gain

The first step, Analyze Learners, required the researcher to identify students' general characteristics, prior knowledge, learning modalities, and motivation. Prior knowledge was assessed using a pre-test that measured students' understanding of economic concepts. Learning modalities were identified using the VARK questionnaire administered to all participants. The second step, State Objectives, involved formulating learning objectives aligned with the Merdeka Curriculum's learning outcomes for grade VII social studies, specifically the economic activity unit covering production, distribution, and consumption. The third step, Select Methods, Media, and Materials, guided the researcher in choosing differentiation strategies matched to each modality. Visual learners received infographics, concept maps, and illustrated charts depicting economic activity flows. Aural learners engaged in recorded explanations, group discussions, and oral presentations. Read/Write learners worked with structured text-based materials, summary worksheets, and written analyses. Kinesthetic learners participated in economic simulations, role-playing activities, and hands-on market exercises. The fourth step,

Utilize Media and Materials, involved implementing the developed toolkit in actual classroom instruction. The fifth step, Require Learner Participation, ensured active engagement by incorporating collaborative discussions, simulation activities, and modality-specific tasks. The sixth step, Evaluate and Revise, employed formative evaluation involving expert review and iterative field testing to refine the toolkit.

The study was conducted at Junior High School Nusantara 1 Tangerang during the even semester of the 2025/2026 academic year. The population consisted of all grade VII students at the school. The sample comprised 79 grade VII students distributed across three classes (VII A: 27 students, VII B: 26 students, and VII C: 26 students). Purposive sampling was employed to select the research site and participants based on the following criteria: (a) the school had not previously implemented modality-based differentiated instruction; (b) teachers lacked diagnostic data on students' learning modalities; (c) instructional materials did not accommodate individual learning differences; and (d) semester examination results showed that 57 out of 79 students (72.2%) scored below the minimum learning achievement criteria (KKTP) of 75, with a class average of 68 [42]. The sample included 37 males and 42 females, with ages ranging from 12 to 13 years.

Data collection employed four categories of instruments, each of which underwent reliability testing before administration. Table 2 presents the instrument specifications.

Table 2. Instrument Specifications and Reliability

Instrument	Source	Type	Items	Cronbach's α	Respondents
VARK Questionnaire	Adopted from Fleming [16]	Multiple choice (16 items)	16	0.83	79 students
Expert Validation Questionnaire	Adapted from Sugiyono [25]	4-point Likert scale	24	0.87	3 experts
Student Response Questionnaire	Adapted from Smaldino et al. [30]	4-point Likert scale + 3 open-ended questions	20 + 3	0.91	One-to-one: 3; Small group: 9; Field trial: 79
Pre-test/Post-test	Developed by researcher, validated by content expert	Multiple choice + essay	30 + 5	0.85	79 students

The expert validation questionnaire was adapted from Sugiyono [25] and modified to assess six evaluation aspects: learning objective clarity, instructional strategy, content accuracy, media appropriateness, assessment alignment, and language readability. The adaptation involved adding modality-specific items related to VARK differentiation criteria. The student response questionnaire was adapted from Smaldino et al. [30] and comprised 20 Likert-scale items measuring four practicality dimensions (ease of use, content clarity, engagement, and relevance) plus three open-ended questions asking students to describe their learning experience, identify strengths and weaknesses of the materials, and provide improvement suggestions. The pre-test and post-test instruments were developed by the researcher and validated by the content expert; they assessed cognitive outcomes on economic activity concepts across Bloom's revised taxonomy levels of remembering, understanding, applying, and analyzing [27].

Data analysis employed three techniques. First, validity was analyzed using the percentage formula recommended by Sugiyono [25], with scores classified into four categories: highly valid (81–100%), valid (61–80%), moderately valid (41–60%), and invalid (0–40%). Second, practicality was analyzed using the same percentage formula applied to student response data. Third, effectiveness was determined using two analyses: (a) the Normalized Gain (N-Gain) formula by Hake [28], calculated as N-Gain = (Post-test Score – Pre-test Score) / (Maximum Score – Pre-test Score), with values interpreted using the criteria by Sukarelawa et al. [29]: high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), and low ($g < 0.3$); and (b) a paired sample t-test at $\alpha = 0.05$ significance level to determine whether the difference between pre-test and post-test scores was statistically significant. The normality of the data was assessed using the Shapiro-Wilk test prior to conducting the paired t-test. All statistical analyses were performed using SPSS version 26 [43].

The formative evaluation followed a four-stage process. The first stage involved expert review, during which three experts (one instructional design expert, one subject matter/content expert, and one media expert) independently assessed the toolkit using the validation questionnaire and provided written feedback for revision. The second stage was a one-to-one evaluation with three students representing high, medium, and low ability levels, selected based on their pre-test scores. The third stage comprised a small-group trial with nine students (three from each ability level). The fourth stage was a field trial involving the full participant group of 79 students. At each stage, feedback was collected, analyzed, and incorporated into revisions before proceeding to the next stage [44], [45].

3. RESULTS AND DISCUSSION

3.1 Learner Analysis: VARK Modality Distribution

The first stage of the ASSURE model produced a comprehensive learner analysis. The VARK questionnaire revealed the distribution of learning modalities among 79 grade VII students. Table 3 presents the detailed modality distribution.

Table 3. Distribution of VARK Learning Modalities among Grade VII Students (N=79)

VARK Modality	Number of Students	Percentage (%)	Male	Female
Visual (V)	21	26.6	9	12
Aural (A)	15	19.0	8	7
Read/Write (R)	17	21.5	6	11
Kinesthetic (K)	26	32.9	14	12
Total	79	100.0	37	42

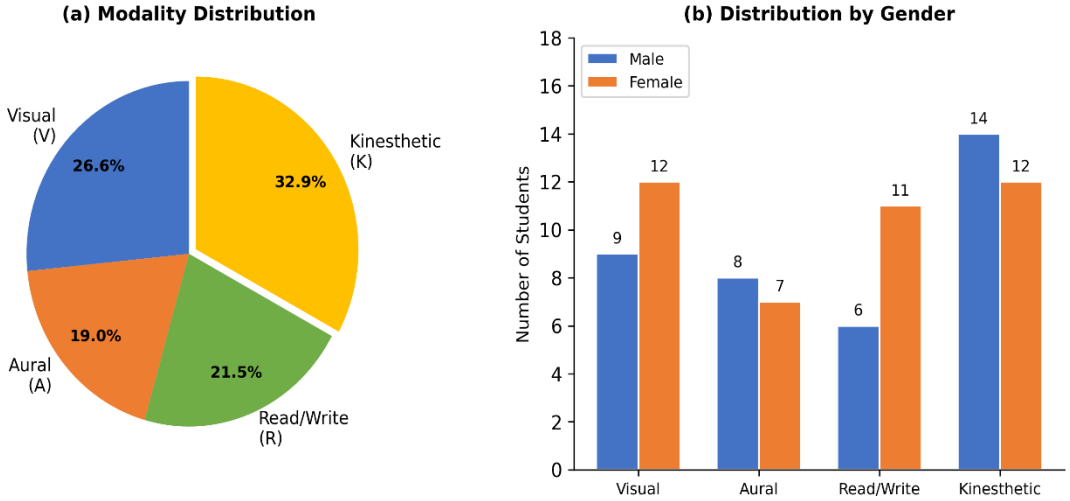

Figure 1. VARK Modality Distribution: (a) Proportional Representation and (b) Gender Breakdown

Kinesthetic learners constituted the largest group at 32.9% (26 students), followed by visual learners at 26.6% (21 students), read/write learners at 21.5% (17 students), and aural learners at 19.0% (15 students). This distribution aligns with previous findings by Subagja and Rubini [21], who also identified kinesthetic learners as the most prevalent group among Indonesian secondary school students. The gender distribution showed relatively balanced representation across modalities, although kinesthetic learners included a higher proportion of male students (14 of 26). The modality analysis informed all subsequent decisions regarding media selection, activity design, and material development for the differentiated instructional toolkit.

3.2 Product Development: Toolkit Components

The development process produced five interrelated toolkit components, each designed to serve the differentiated learning needs identified in the learner analysis. Table 4 summarizes these components and their modality alignment.

Table 4. Components of the VARK-Based Differentiated Instructional Toolkit

Component	Description	VARK Modality	Format
Teaching Module	Lesson plans with differentiated strategies per modality	All (V, A, R, K)	Print & Digital
Learning Materials	Four parallel content versions per topic	Modality-specific	Print & Digital
Student Worksheets	Guided activities aligned to modalities	Modality-specific	Print
Interactive Media	Infographics, audio, text templates, simulations	V, A, R, K respectively	Digital
Assessment	Pre-test, post-test, formative checks	All (V, A, R, K)	Print

3.3 Validity Analysis: Expert Evaluation

Expert validation confirmed the quality of the developed toolkit across three evaluation domains, directly answering Research Question 1. The instructional design expert awarded a mean score of 90.7%, the content expert provided a mean score of 89.8%, and the media expert scored 90.0%. All three scores placed the toolkit in the "highly valid" category (81–100%). Table 5 presents the detailed validation results across six evaluation aspects.

Table 5. Expert Validation Results of the Differentiated Instructional Toolkit

Evaluation Aspect	Design Expert (%)	Content Expert (%)	Media Expert (%)	Category
Learning Objective Clarity	92.5	90.0	87.5	Highly Valid
Instructional Strategy	90.0	87.5	90.0	Highly Valid
Content Accuracy	90.0	92.5	87.5	Highly Valid
Media Appropriateness	92.5	90.0	92.5	Highly Valid
Assessment Alignment	91.5	88.5	90.0	Highly Valid
Language & Readability	87.5	90.0	92.5	Highly Valid
Mean Score	90.7	89.8	90.0	Highly Valid

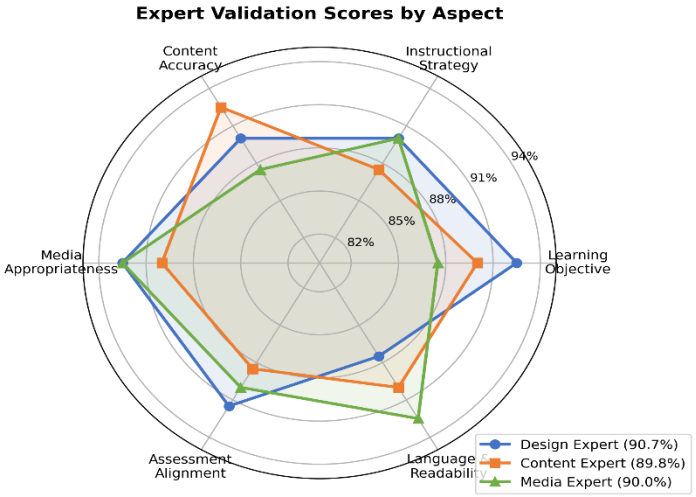

Figure 2. Radar Chart of Expert Validation Scores Across Six Evaluation Aspects

All three experts provided constructive suggestions that led to revisions in visual layout consistency, additional scaffolding prompts for kinesthetic activities, and simplified vocabulary in certain reading passages. The revised toolkit incorporated all expert recommendations before field testing. These high validity scores are consistent with findings by Smaldino et al. [30] and Pribadi [31], who demonstrated that structured instructional design models produce higher-quality educational materials.

Regarding validity (RQ1), the high expert validation scores (mean 90.2% across all domains) indicate that the toolkit meets rigorous standards of instructional design quality and content accuracy. This finding is consistent with previous research demonstrating that structured instructional design models produce higher-quality educational materials [30], [31]. The ASSURE model proved particularly suitable because its learner-analysis step directly facilitated the integration of VARK diagnostic data into material design decisions. Heinich et al. [24] originally designed ASSURE for classroom-level application, and this study validates its continued relevance for developing differentiated instructional products. Compared with the findings of Tas and Minaz [32], who developed learning style-based activities without a comprehensive validation protocol, the present study's multi-expert validation process provides stronger evidence of content and design quality.

3.4 Practicality Analysis: Student Response

The practicality assessment, answering Research Question 2, progressed across three iterative stages. Table 6 presents the practicality scores obtained at each evaluation stage.

Table 6. Practicality Scores Across Formative Evaluation Stages

Evaluation Stage	Respondents (n)	Mean Score (%)	Category	Revision Status
One-to-One	3	84.2	Practical	Minor revision
Small Group	9	87.4	Highly Practical	Minor revision
Field Trial	79	88.6	Highly Practical	No revision

The field trial with the full group of 79 students yielded detailed practicality data across four dimensions. Table 7 presents these scores disaggregated by modality group.

Table 7. Student Practicality Ratings by VARK Modality Group (Field Trial, N=79)

Modality Group	Ease of Use (%)	Content Clarity (%)	Engagement (%)	Relevance (%)	Mean (%)
Visual	90.5	88.1	91.4	89.0	89.8
Aural	87.3	86.7	88.0	85.3	86.8
Read/Write	88.2	89.4	86.5	88.8	88.2
Kinesthetic	89.6	87.7	92.3	90.4	90.0
Overall	89.1	88.0	89.9	88.6	88.9

From Table 6 and 7, the strong ratings from students (overall 88.9%) suggest that modality-aligned materials enhance the subjective learning experience. Students reported feeling more engaged when instructional activities matched their preferred sensory channels. This finding resonates with Dutsinma and Temdee [18], who found that modality-responsive instruction increases engagement and information retention. The present study extends these findings by demonstrating that practicality remains high even when differentiation is implemented across four modality groups simultaneously, a challenge that previous researchers identified as logistically difficult [13], [11]. Qualitative responses from the open-ended questions revealed that students particularly valued the variety of materials available and the opportunity to learn through their preferred modality. These findings are further supported by Roiha and Polso [35], who emphasized the importance of addressing multiple dimensions of differentiation, and by Alkhasawneh [36], who demonstrated that students' learning preferences evolve and require ongoing diagnostic assessment.

3.5 Effectiveness Analysis: Learning Outcomes

The effectiveness analysis, addressing Research Question 3, demonstrated significant improvement in learning outcomes. Prior to conducting the paired t-test, the Shapiro-Wilk test confirmed that both pre-test ($W = 0.976$, $p = 0.153$) and post-test ($W = 0.981$, $p = 0.287$) scores were normally distributed, satisfying the parametric test assumption. Table 8 presents the pre-test and post-test N-Gain scores by VARK modality group.

Table 8. Pre-test, Post-test, and N-Gain Scores by VARK Modality Group

Modality Group	Pre-test Mean	Post-test Mean	Gain	N-Gain	Category
Visual (n=21)	55.2	83.5	28.3	0.63	Medium
Aural (n=15)	56.1	81.0	24.9	0.58	Medium
Read/Write (n=17)	57.3	80.8	23.5	0.55	Medium
Kinesthetic (n=26)	52.1	84.6	32.5	0.68	Medium-High
Overall (N=79)	54.8	82.3	27.5	0.61	Medium

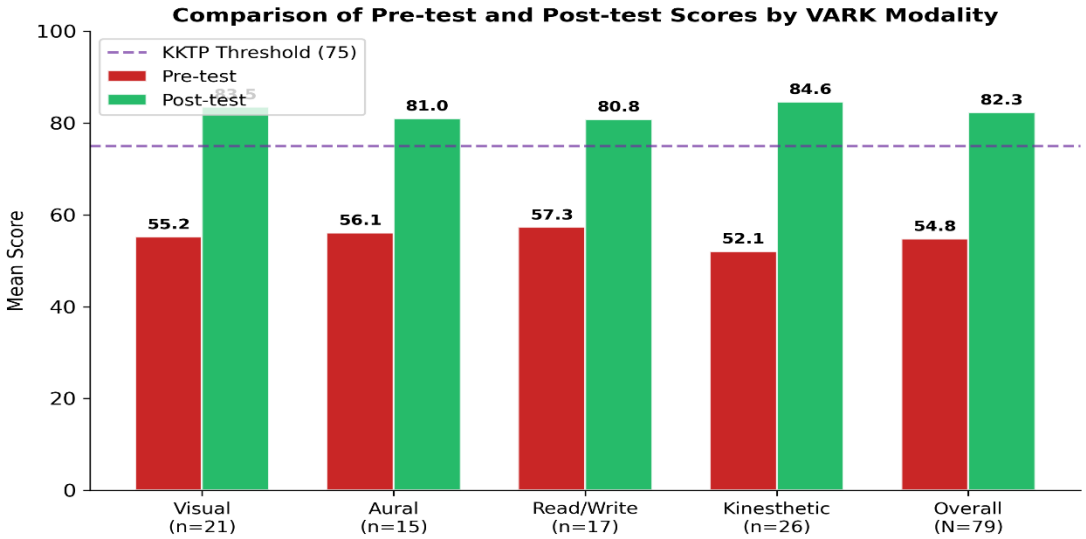

Figure 3. Comparison of Pre-test and Post-test Scores by VARK Modality Group

To confirm statistical significance, a paired sample t-test was conducted. Table 9 presents the paired t-test results.

Table 9. Paired Sample T-Test Results for Pre-test and Post-test Scores

Assessment	N	Mean	SD	t	df	p	Cohen's d
Pre-test	79	54.8	12.34	18.42	78	<0.001	2.07
Post-test	79	82.3	8.56				

The paired sample t-test revealed a statistically significant difference between pre-test and post-test scores, $t(78) = 18.42$, $p < 0.001$. The effect size, measured by Cohen's $d = 2.07$, indicated a very large practical significance. These results confirm that the VARK-based differentiated instructional toolkit produced a meaningful and statistically significant improvement in student learning outcomes.

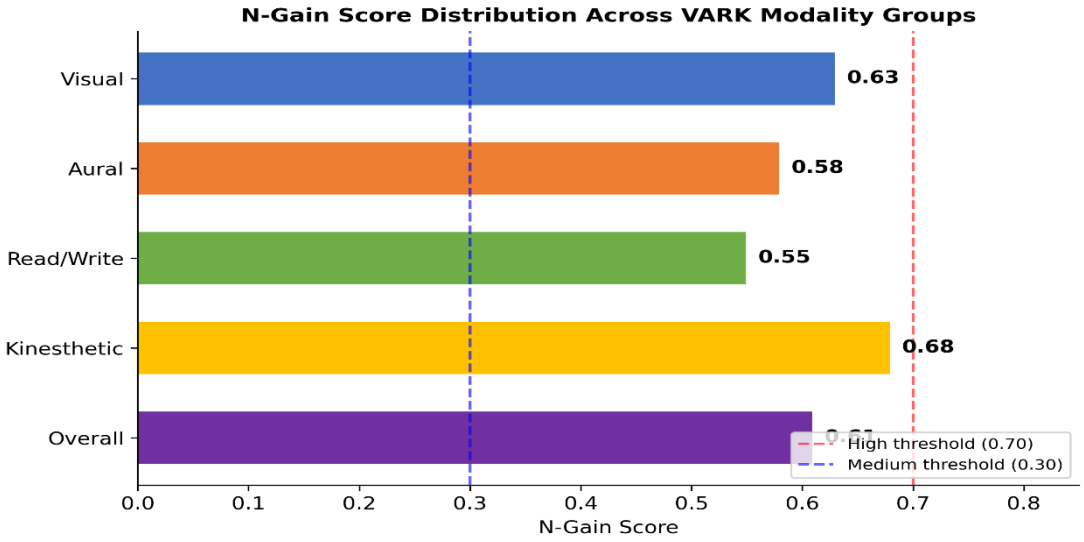

Figure 4. N-Gain Score Distribution Across VARK Modality Groups

The overall N-Gain of 0.61 falls in the medium category. When analyzed by modality group, kinesthetic learners showed the highest N-Gain at 0.68, followed by visual learners at 0.63, aural learners at 0.58, and read/write learners at 0.55.

Table 10. Comparison of KKTP Achievement Rates Before and After Intervention

Assessment Phase	Students ≥ 75	Students < 75	Achievement Rate (%)	Mean Score
Pre-test	22	57	27.8	54.8
Post-test	66	13	83.5	82.3
Improvement	+44	–44	+55.7	+27.5

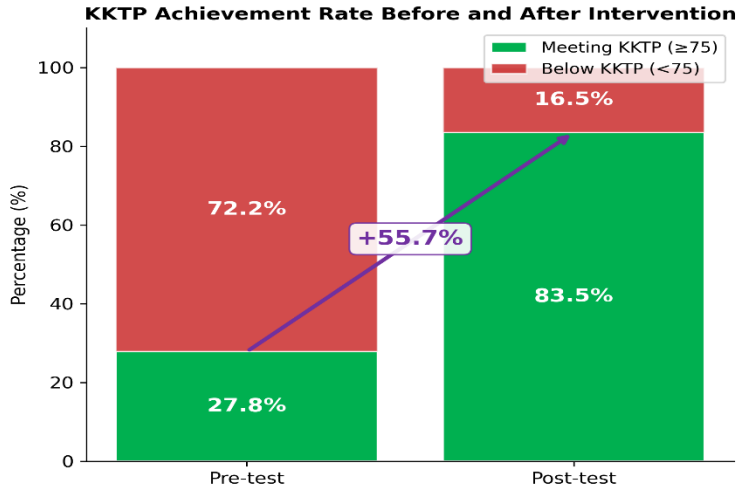

Figure 5. KKTP Achievement Rate Before and After Intervention

The findings of this study confirm that a systematically developed, VARK-based differentiated instructional toolkit can effectively improve social studies learning outcomes in secondary school. The

discussion is organized around the three research questions and their implications for theory and practice. Regarding effectiveness, the N-Gain analysis and paired t-test results provide converging quantitative evidence that the toolkit produces meaningful improvements. The overall N-Gain of 0.61 and the highly significant t-test result ($p < 0.001$, Cohen's $d = 2.07$) demonstrate both practical and statistical significance. The modality-specific analysis reveals an interesting pattern: kinesthetic learners achieved the highest gains (0.68), which aligns with the VARK distribution showing kinesthetic learners as the largest group. This pattern suggests that the economic activity topic, which involves tangible processes of production, distribution, and consumption, may naturally favor experiential, hands-on learning approaches. Payaprom and Payaprom [17] noted a similar trend. The relatively lower but still positive N-Gain among read/write learners (0.55) may reflect the traditionally text-heavy nature of social studies, which these learners already encounter in conventional instruction [46], [47].

The differentiated approach addressed several challenges identified in the literature. Mutiani et al. [8] documented persistent problems in Indonesian social studies: insufficient critical thinking development, dominance of verbal instruction, and low-order assessment. The toolkit directly confronts these issues by offering varied cognitive pathways and incorporating higher-order assessment items. Langelaan et al. [33] argue that effective differentiation requires proactive planning rather than reactive adjustments, and the ASSURE model's systematic structure ensured that differentiation was embedded in the design phase. This study also responds to the specific calls by Subagja and Rubini [21] for instructional tools aligned with learning modalities, and by Perez-Marin et al. [23] for extending VARK-based research beyond university-level studies to encompass material development at the secondary level [48], [49].

The novelty of this study lies in its comprehensive integration of VARK modality diagnosis with a complete, classroom-ready instructional toolkit for secondary-level social studies—a combination that previous studies have not achieved. While prior research has examined VARK preferences or developed isolated materials, this study is the first to produce a validated five-component toolkit (teaching module, learning materials, worksheets, interactive media, and assessment instruments) that translates diagnostic data into differentiated practice within a single, coherent instructional design framework.

Despite these positive findings, the study has several limitations that should be acknowledged. First, the study was conducted in a single school with 79 students, which limits the generalizability of the findings to other educational contexts. Second, the quasi-experimental design without a control group prevents causal attribution solely to the toolkit; other factors such as novelty effect or increased teacher attention may have contributed to the improvement. Third, the study measured short-term learning outcomes through a single post-test, and long-term retention was not assessed. Fourth, the VARK model categorizes learners into discrete modality groups, whereas many learners may have multimodal preferences that the current toolkit does not fully address. Fifth, the expert validation relied on three experts, which, while adequate for formative evaluation, may benefit from a larger panel in future studies [50].

4. CONCLUSION

This study demonstrates that a VARK-based differentiated instructional toolkit developed using the ASSURE model is valid, practical, and effective for grade VII social studies instruction on economic activity materials. Expert validation placed the toolkit in the "highly valid" category across instructional design (90.7%), content (89.8%), and media quality (90.0%) dimensions. Student responses confirmed its practicality with an overall score of 88.9% ("highly practical"). The paired sample t-test revealed a statistically significant improvement in learning outcomes ($t(78) = 18.42$, $p < 0.001$, $d = 2.07$), and the N-Gain analysis yielded a medium-category score of 0.61, with the KKTP achievement rate rising from 27.8% to 83.5%. The study carries several implications for educational practice and theory. For practitioners, teachers should conduct diagnostic assessments of learning modalities before designing instructional materials, as this data enables targeted differentiation. School administrators should support the provision of diverse instructional resources that accommodate multiple modalities rather than relying solely on textbook-based delivery. Teacher professional development programs should include training on modality diagnosis and differentiated material design to build capacity for classroom-level implementation. For theory, this study extends the application of the VARK framework from diagnostic assessment to instructional product development, demonstrating that modality-aligned differentiation produces measurable learning gains in social studies education within the Indonesian context. Future research should extend this work in several directions. Researchers could replicate the study across different social studies topics and grade levels with larger samples and true experimental designs including control groups to assess the generalizability and causal impact of the findings. Longitudinal studies could examine whether modality-based differentiation produces sustained improvements over an entire academic year. Comparative studies could investigate the relative effectiveness of VARK-based differentiation against other frameworks such as Multiple Intelligences or Universal Design for Learning. Additionally, studies should explore multimodal learner profiles and the interaction between learning modalities and other variables including socioeconomic background, prior achievement, and motivation.

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CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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