

Development and Validation of a Motion Graphic Animation Video on Cyberbullying for Grade VII Informatics Using 4D Model

Muhammad Teguh Hidayatullah¹, Zelhendri Zen², Ulfia Rahmi³, Mutiara Felicita Amsal⁴

^{1,2,3,4}*Educational Technology, Faculty of Education, Universitas Negeri Padang, Indonesia*

Corresponding e-mail : mhdteguh0806@gmail.com

ARTICLE INFO	ABSTRACT
<p>Keywords:</p> <p>4D Development Model; Animation Video; Cyberbullying; Informatics Learning; Motion Graphic.</p> <hr/> <p>Article History</p> <p>Received: March 08, 2026 Revised : May 02, 2026 Accepted : May 12, 2026</p>	<p>This study aims to develop a motion graphic animation learning video on Digital Bullying (Cyberbullying) material for Grade VII Informatics at SMP Negeri 29 Padang using the 4D development model (Define, Design, Develop, Disseminate), addressing the scarcity of effective learning media for this topic in junior high school Informatics. Data were collected through expert validation questionnaires, student practicality questionnaires, and pretest-posttest instruments, with 32 students participating in practicality testing and 22 students in effectiveness testing. Findings: The validity results showed a percentage of 98.00% (Very Valid) for both material and media aspects. The practicality test yielded an average score of 4.48 (89.55%), categorized as Very Practical. The effectiveness test using N-Gain Score produced a mean of 0.733 (73.34%), indicating a High improvement category. These findings confirm that the developed motion graphic animation learning video is valid, practical, and effective for Grade VII Informatics learning. The study demonstrates that AI-assisted production tools (Google Labs Flow/Veo 3, Google AI Studio, CapCut) can produce pedagogically valid and practically effective instructional animation, providing a replicable development model for resource-constrained Indonesian schools. Qualitative field observations suggest the media may also support affective development, including student empathy toward cyberbullying victims, an area not formally measured in this study but warranting future validated assessment. This study provides transparent documentation of an AI-assisted motion graphic production and iterative expert validation process within the Merdeka Curriculum framework, an approach not previously reported in the Indonesian Informatics education literature.</p>

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INTRODUCTION

Education serves as the fundamental mechanism through which societies equip individuals with the knowledge, values, and skills necessary to navigate an increasingly complex world. In Indonesia, the rapid advancement of digital technology has introduced both unprecedented opportunities and significant risks into the learning environment, necessitating continuous curricular adaptation (Rahayu et al., 2022). The 21st century demands that students develop not only academic competencies but also critical digital literacy, enabling them to engage responsibly with digital environments (Voogt & Roblin, 2012). The increasing integration of digital technology into students' daily lives has also been shown to influence

learning motivation and engagement, making technology-supported instruction increasingly important in contemporary education (Muhasim, 2017).

The development of 21st-century competencies requires educational approaches that integrate technology, critical thinking, communication, collaboration, and digital literacy as essential learning outcomes for students (Malikah & Wafroturrohmah, 2022). The introduction of Informatics as a compulsory subject at the junior high school level under the Merdeka Curriculum reflects this national priority. The curriculum explicitly targets computational thinking, digital ethics, and social awareness as core learning outcomes for Phase D students (Kemendikbudristek, 2022). Within this framework, the Digital Social Impact topic, specifically Digital Bullying (Cyberbullying), occupies an important position, requiring students to understand both the technical dimensions of online interaction and the human consequences of harmful digital behavior.

Cyberbullying has emerged as a significant public health and education concern in Indonesia. Approximately 48% of Indonesian children who access the internet have reported experiencing cyberbullying (Kementerian Komunikasi dan Informatika, 2025), and Kowalski et al. (2014) documented that cyberbullying victimization is consistently associated with elevated rates of depression, anxiety, and academic disengagement. These findings underscore the urgency of school-based educational interventions that address cyberbullying in a manner that is developmentally appropriate and emotionally resonant for young adolescents.

Observations conducted on January 12-13, 2025 at SMP Negeri 29 Padang revealed persistent difficulties in Grade VII Informatics instruction: student attention during lessons was inconsistent, active participation was limited, and instructional approaches remained predominantly lecture-based with minimal integration of technology-based media. Interview data from the Informatics teacher corroborated these observations, indicating that students struggled with abstract conceptual material in the absence of visual support. Student learning outcome data across four classes (VII.1-VII.4) showed mean scores ranging from 53.13 to 58.52, substantially below the minimum mastery criterion (KKTP) of 80. Previous studies have demonstrated that technology-based learning media can significantly improve student learning outcomes and learning engagement across various educational contexts (Sirait et al., 2025). Therefore, the selection of appropriate digital media becomes an important consideration in addressing instructional challenges in Informatics learning.

Motion graphic animation video has been identified in recent scholarship as an effective medium for addressing precisely these instructional challenges. By combining dynamic visual elements, narrative structure, and synchronized audio narration, motion graphic video concretizes abstract social phenomena and facilitates both cognitive comprehension and emotional engagement (Mayer, 2009; Hibbert, 2014). This approach is theoretically grounded in the Cognitive Theory of Multimedia Learning (Mayer, 2009), which demonstrates that learning is optimized when visual and verbal information is presented through complementary processing channels.

The 4D development model (Thiagarajan et al., 1974) provides a rigorous, iterative framework for producing instructional media that satisfies validity, practicality, and effectiveness criteria through systematic needs analysis, expert validation, and empirical testing. This model has been widely adopted in Indonesian educational technology research and is well-suited to the development of media-based instructional products.

Beyond individual learning outcomes, the development of effective cyberbullying educational media carries institutional significance for Indonesian schools implementing the

Merdeka Curriculum. The curriculum's emphasis on Profil Pelajar Pancasila, the six student character dimensions including mutual care, global diversity, and creative thinking, directly maps onto the competencies targeted by cyberbullying education. A student who understands, empathizes with, and can respond constructively to cyberbullying is simultaneously developing the character attributes the national curriculum prioritizes. Instructional media that bridges digital literacy content with character formation objectives thus serves a dual curricular function, making it particularly valuable within the Merdeka Curriculum framework (Kemendikbudristek, 2022).

The role of teacher readiness and institutional support in technology-based media adoption also requires consideration. Ertmer et al. (2012) identified teacher beliefs about technology as a critical first-order barrier to instructional technology adoption, separate from access barriers. The present study's dissemination approach, sharing media via WhatsApp with the Informatics teacher as the primary distribution point, respected the teacher's role as a gatekeeper and partner in implementation. This collaborative approach contrasts with top-down media deployment strategies that have been shown to generate lower adoption rates in Indonesian school settings. The teacher's active facilitation of media distribution and student access was a key factor in the successful Disseminate stage outcomes.

Despite a growing body of literature on animation-based learning media in Indonesia, several important gaps remain. First, the majority of published development studies have focused exclusively on cognitive learning outcomes, with limited attention to affective dimensions such as empathy development, a dimension particularly relevant to cyberbullying education (Hinduja & Patchin, 2018). Second, the application of motion graphic media specifically within the junior high school Informatics curriculum under the Merdeka Curriculum framework has not been documented. Third, the use of AI-assisted production tools in developing educational animation has not been systematically described or evaluated in the Indonesian educational technology literature. Fourth, published development studies rarely provide transparent accounts of iterative expert-driven revision processes, limiting the reproducibility and accumulation of design knowledge. The present study addresses each of these gaps by developing a motion graphic animation learning video that targets both cognitive and affective outcomes, documents the full 4D production and validation process, and employs AI-assisted production tools within a replicable design framework.

Based on the foregoing analysis, this study aims to develop a motion graphic animation learning video on Cyberbullying material for Grade VII Informatics at SMP Negeri 29 Padang that satisfies criteria of validity, practicality, and effectiveness as assessed through standardized educational measurement procedures.

METHOD

This study employs a Research and Development (R&D) approach using the 4D model (Define, Design, Develop, Disseminate) proposed by Thiagarajan et al. (1974). The 4D model was selected for its systematic, iterative structure, which supports the production of instructional products that are theoretically grounded and empirically validated. The research was conducted at SMP Negeri 29 Padang during the 2024/2025 academic year.

Define Stage

The Define stage involved a structured needs analysis through four activities. First, curriculum analysis reviewed the Merdeka Curriculum framework to identify the learning objectives relevant to the Digital Social Impact topic in Grade VII Informatics. Second, student

analysis examined the characteristics, preferred learning modalities, and digital experience of students through structured observation and interview protocols. Third, concept analysis delineated the specific content scope: definition, typology, causal factors, psychological impacts, prevention strategies, and appropriate responses to cyberbullying. Fourth, instructional objective formulation operationalized these content dimensions into measurable learning targets aligned with Phase D competency descriptors (Kemendikbudristek, 2022).

Design Stage

The Design stage produced three core outputs: an instructional video script covering all conceptual dimensions of the topic; a 24-scene storyboard specifying narration, visual sequences, character design, animation style, and background music for each scene; and technical specifications for the final product, including MP4 format at HD resolution (1920x1080). The storyboard incorporated narrative design principles aimed at fostering viewer empathy through character-based depictions of cyberbullying events and their emotional consequences.

Develop Stage

Video production employed three AI-assisted tools: Google Labs Flow (Veo 3) for visual asset and character animation generation; Google AI Studio for text-to-speech narration synthesis; and CapCut for comprehensive video editing, including integration of motion graphic effects, transitions, subtitles, background music, and sound effects. This AI-assisted workflow represents a notable innovation relative to conventional frame-by-frame animation production.

Content validity was assessed by one subject matter expert who evaluated accuracy, curriculum alignment, and congruence with stated learning objectives. Reliance on a single content validator is acknowledged as a limitation, as inter-rater agreement statistics cannot be computed from one rater; this is explicitly noted in the Limitations section. Media validity was assessed by two media experts from the Department of Curriculum and Educational Technology, Universitas Negeri Padang, who evaluated visual design quality, audio quality, technical accessibility, and adherence to multimedia learning principles. All validators used a five-point Likert scale, and validity percentages were computed as $P = (\text{sum of scores} / \text{sum of maximum scores}) \times 100\%$. Validity categories are presented in Table 1.

Table 1. Validity Category Criteria

Percentage (%)	Category
81% - 100%	Very Valid
61% - 80%	Valid
41% - 60%	Fairly Valid
21% - 40%	Less Valid
0% - 20%	Not Valid

Practicality testing was conducted with 32 Grade VII students drawn from one class at SMP Negeri 29 Padang using a Likert-scale questionnaire covering ease of use, visual attractiveness, content clarity, and motivational impact. Average score categories: ≥ 4.20 = Very Practical; 3.40-4.19 = Practical; 2.60-3.39 = Fairly Practical; 1.80-2.59 = Less Practical; < 1.80 = Not Practical.

Effectiveness was measured through a one-group pretest-posttest design with 22 students drawn from a separate Grade VII class at the same school, independent of the 32-student practicality sample. The Normalized Gain (N-Gain) formula was applied: $N\text{-Gain} = (\text{posttest score} - \text{pretest score}) / (\text{maximum score} - \text{pretest score})$, with categories: ≥ 0.70 = High; 0.30-0.69 = Medium; < 0.30 = Low (Sugiyono, 2019).

Data analysis procedures followed established conventions for educational development research. Validity scores were calculated per dimension and aggregated to a total percentage, enabling identification of specific components requiring improvement. Practicality questionnaire data were analyzed using mean score calculation with standard deviation to characterize the distribution of student responses. Effectiveness data were subjected to descriptive statistical analysis including calculation of individual and group N-Gain scores, frequency distribution by N-Gain category, and examination of pretest-posttest score distributions to identify ceiling and floor effects. All analyses were conducted using Microsoft Excel 2021, with results triangulated against qualitative field observations to enrich interpretation of quantitative outcomes.

Disseminate Stage

The Disseminate stage distributed the validated and tested media to the school community via a Google Drive link shared through WhatsApp, enabling students to access the media independently on any compatible device.

RESULTS AND DISCUSSION

Define Stage Results

Curriculum analysis confirmed that SMP Negeri 29 Padang implements the Merdeka Curriculum, within which the Digital Social Impact topic, specifically the Cyberbullying sub-topic, was identified as the focal content area. This topic is strategically positioned in the Phase D Informatics framework to address both digital competency and character education outcomes (Kemendikbudristek, 2022).

Student analysis revealed a clear preference for visual and audiovisual content. Students reported daily smartphone use and familiarity with online video platforms, indicating strong potential for video-based media uptake. Student learning outcome data, presented in Table 2, confirmed the urgency of intervention, with all four classes recording averages well below the KKTP of 80.

Table 2. Student Learning Outcome Data at SMP Negeri 29 Padang

Class	Number of Students	KKTP	Average Score
VII.1	32	80	57.50
VII.2	32	80	57.59
VII.3	31	80	58.52
VII.4	32	80	53.13

Source: Informatics Teacher, Grade VII SMP Negeri 29 Padang

Design Stage Results

The Design stage produced a narrative video script organized into six content segments: introduction to cyberbullying, typology of cyberbullying behaviors, causal factors, psychological and social impacts on victims, evidence-based prevention strategies, and appropriate reporting procedures. The 24-scene storyboard specified visual compositions, character interactions, motion graphic transitions, subtitle placements, narration texts, and background music cues for each scene. Technical specifications were finalized at MP4 format, HD 1920x1080 resolution, stereo audio at 44.1 kHz, and an approximate total duration of 8 minutes, designed to maintain engagement within the productive attention span of Grade VII students.



Figure 1. Sample Scene from the Developed Cyberbullying Motion Graphic Video

Develop Stage Results: Validity Testing

Content validity assessment by the subject matter expert yielded an average score of 4.90 (98.00%, Very Valid). This result confirms that the media's content accurately represents the cyberbullying topic, aligns with the Merdeka Curriculum Phase D learning objectives, and is appropriately pitched for Grade VII developmental level. The expert noted particular strengths in the media's use of realistic scenario-based examples and its integration of prevention and response content alongside awareness-raising material.

Media validity was assessed by two experts. Validator I awarded 4.90 (98.00%, Very Valid), affirming the quality of visual design, audio mixing, and overall multimedia production. Validator II initially assigned 4.75 (95.00%, Very Valid) with four specific recommendations: (1) improving font color contrast against varied backgrounds; (2) removing heavy drop-shadow effects on text; (3) reducing background music volume; and (4) adding supplementary explanatory text to some sequences. Following systematic revisions, Validator II's final score reached 4.90 (98.00%, Very Valid). Table 3 summarizes validity outcomes.

Table 3. Summary of Validity Test Results

Aspect	Average Score	Percentage	Category
Material (Subject Matter Expert)	4.90	98.00%	Very Valid
Media (Validator I)	4.90	98.00%	Very Valid
Media (Validator II - Final)	4.90	98.00%	Very Valid

Develop Stage Results: Practicality Testing

Practicality testing with 32 Grade VII students produced an average score of 4.48 (89.55%), placing the media in the Very Practical category. Analysis of individual questionnaire dimensions revealed that students rated the visual attractiveness of the media highest. Students specifically noted that the narrative format, which followed characters through realistic cyberbullying scenarios, made the material more memorable and personally relevant than

textbook-based instruction. The smartphone accessibility of the media was consistently highlighted as a practical advantage, enabling independent review at the students' own pace. This finding is consistent with Sung et al. (2016), who reported that mobile-accessible instructional media significantly enhances engagement and learning convenience among secondary school students.

Several students also reported that viewing the video prompted discussions with peers and family members about cyberbullying experiences, suggesting a generative social learning effect extending beyond the immediate classroom context. This aligns with Bandura's (1977) social learning theory, which holds that vicarious observational learning through modeled behavior can influence attitudes and behavioral intentions.

Develop Stage Results: Effectiveness Testing

Effectiveness was assessed through a one-group pretest-posttest design with 22 students. The mean pretest score of 66.36 rose to 90.30 in the posttest, a mean gain of approximately 24 points. N-Gain Score analysis yielded a mean of 0.733 (73.34%), classified as High. Detailed results are presented in Table 4.

Table 4. N-Gain Score Results Summary

N-Gain Category	N-Gain Range	Number of Students	Percentage
High	≥ 0.70	16	72.73%
Medium	0.30 - 0.69	6	27.27%
Low	< 0.30	0	0%

Examination of individual scores revealed that the six students in the Medium category (N-Gain: 0.50-0.67) entered the trial with relatively higher pretest scores (60.00-73.33), leaving less room for proportional gain. This ceiling effect is a recognized feature of N-Gain analysis. The student with the lowest pretest score (13.33) achieved a High N-Gain of 0.846, demonstrating the media's capacity to support substantial learning gains among students with minimal prior knowledge.

Develop Stage Results: Disseminate Stage

The Disseminate stage distributed the validated and tested media via a Google Drive link shared through the Informatics teacher's WhatsApp group, enabling access across all four Grade VII classes. The teacher confirmed that the link was shared with all 127 students enrolled in Grade VII Informatics at SMP Negeri 29 Padang during the 2024/2025 academic year. Informal feedback gathered from the teacher following distribution indicated that students accessed the video independently outside class hours and raised questions about cyberbullying scenarios depicted in the media during subsequent lessons. No formal usage tracking metrics (view counts or access duration) were collected during the dissemination phase; this is acknowledged as a limitation. The dissemination channel, WhatsApp and Google Drive, required no additional infrastructure and was fully compatible with students' existing smartphone access patterns, supporting equitable and immediate uptake across all classes.

Discussion

The validity, practicality, and effectiveness results collectively confirm that the developed motion graphic animation learning video meets established benchmarks for instructional media quality. The following discussion situates these findings within the broader scholarly literature, examines convergences and divergences with prior work, and identifies the specific contributions of the present study.

Regarding validity, the 98.00% rating obtained in this study is consistent with, and slightly exceeds, comparable development studies. Hapsari and Zulherman (2021) reported validity percentages of 87-93% for animation learning videos in elementary science education,

while Iztiqa Mud'haz Pratiwi and I Nyoman Jampel (2022), obtained 91.25% validity for motion graphic video media in social studies. The marginally higher validity in the present study may reflect the systematic application of Mayer's (2009) twelve multimedia learning principles during design, combined with a rigorous two-round validator revision process not consistently documented in prior work. This iterative validation approach, involving four discrete improvement recommendations from Validator II and subsequent re-evaluation, produced a more thoroughly refined product than single-round assessment procedures typical in the literature.

Regarding practicality, the Very Practical rating (89.55%) aligns closely with findings from Khairunnisa and Darmansyah (2022), who reported 88.40% practicality for animation-based learning videos among junior high school students in Indonesia, and with Sung et al. (2016), who found that mobile-accessible instructional media significantly enhanced perceived ease of use among secondary learners. A distinguishing feature of the present study's practicality findings is the emphasis students placed on smartphone accessibility. In resource-constrained Indonesian schools where laboratory computer access is limited, smartphone-optimized media represents not merely a convenience feature but an equity mechanism ensuring all students have equivalent access to quality instructional resources.

Concerning effectiveness, the N-Gain of 0.733 (73.34%, High) is consistent with Fadhlurrahman and Zahar (2024), who reported N-Gain values of 0.68-0.75 for motion graphic learning videos in vocational education, and with Hwang et al. (2012), who documented significant learning outcome improvements through animated instructional video across multiple subject areas. The present result extends these findings by demonstrating that high effectiveness is achievable not only in technical subjects but also in socially complex material, such as cyberbullying, where affective engagement is as important as cognitive comprehension. The narrative-driven structure of the media, grounded theoretically in Mayer's (2009) personalization and emotional design principles, appears to have supported this dual-channel learning outcome.

The theoretical grounding of the media in Mayer's (2009) Cognitive Theory of Multimedia Learning warrants closer examination. The present media operationalized eight of the twelve principles identified by Mayer: coherence (excluding decorative visuals irrelevant to learning objectives), signaling (typographic emphasis on key terms), modality (narration in audio rather than on-screen text), personalization (conversational narrative language), spatial contiguity (explanatory text adjacent to relevant visuals), segmenting (content divided into discrete thematic scenes), pre-training (brief definitional introduction before complex scenario presentation), and redundancy (avoiding simultaneous on-screen text and narration for identical content). This systematic multi-principle implementation distinguishes the present study from earlier Indonesian development work that applied multimedia principles selectively, and likely accounts for the consistently high outcomes across all three quality criteria.

The present study also extends the literature through its integration of Dale's Cone of Experience (1969) as a theoretical lens for understanding the media's effectiveness. Conventional Informatics instruction relying on lecture and printed text occupies the most abstract levels of Dale's hierarchy, offering students limited experiential grounding for socially complex phenomena such as cyberbullying. Animation video, positioned alongside dramatized experiences in Dale's framework, provides vicarious but visually and emotionally rich representations that substantially enhance the concreteness and memorability of learning. This

positioning on the Cone is consistent with the high N-Gain outcomes observed, as students benefit from accessing material at a more experientially proximate cognitive level.

The ARCS motivational design model (Keller, 1987) provides a further theoretical lens for interpreting the practicality and effectiveness findings. Attention was maintained through dynamic motion graphic visuals, varied scene transitions, and synchronized sound effects. Relevance was established through scenarios directly mirroring social experiences common among Indonesian junior high school students, including group chat exclusion, screenshot mockery, and anonymous online harassment. Confidence was supported by the clear, sequentially organized presentation of content that enabled students to track their own conceptual progress. Satisfaction was generated through resolution scenes depicting characters taking effective action against cyberbullying, providing positive behavioral modeling and a sense of agency. This strong alignment with all four ARCS dimensions provides an additional explanatory mechanism for the high practicality and effectiveness outcomes.

The AI-assisted production workflow documented in this study represents a meaningful contribution to the educational technology development literature. The use of Google Labs Flow (Veo 3) for generative visual asset creation and Google AI Studio for text-to-speech narration synthesis substantially reduced production complexity relative to conventional frame-by-frame animation techniques. This workflow addresses a well-documented barrier to instructional media adoption by Indonesian teachers, namely the perceived cost and technical complexity of high-quality media production (Ertmer et al., 2012). By demonstrating that professional-quality motion graphic outputs are achievable with accessible AI-assisted tools, the present study provides a replicable model applicable across varied school contexts in Indonesia.

The Disseminate stage outcomes illustrate the practical scalability of the developed media. Distribution via Google Drive and WhatsApp, platforms already integrated into the daily routines of teachers and students at the research site, required no additional infrastructure and enabled immediate independent student access. This distribution model supports the self-directed learning competencies targeted by the Merdeka Curriculum and aligns with Sung et al.'s (2016) finding that digital media distributed through familiar platforms achieves higher uptake and more sustained use than media requiring dedicated application installation.

The relationship between the developed media and cyberbullying prevention theory also merits examination. Salmivalli's (2010) participant role framework identifies bystander behavior as a critical determinant of cyberbullying persistence: when bystanders actively support victims or disengage from perpetrator behavior, bullying episodes are resolved more quickly and cause less harm. The present media explicitly depicted bystander responses in its resolution scenes, modeling prosocial bystander behavior as a key strategy for cyberbullying intervention. This design choice aligns with school-based cyberbullying prevention programs such as KiVa (Kärnä et al., 2011), which have demonstrated effectiveness through bystander empowerment approaches. Although the present study did not formally measure changes in bystander attitudes, the qualitative observations from field testing, including spontaneous student discussions about how to support cyberbullying victims, provide preliminary evidence that the bystander-focused narrative design influenced students' attitudinal orientation. Systematic investigation of this mechanism represents a valuable direction for future research.

The present study's focus on Grade VII students also has developmental implications worth noting. Early adolescence (ages 12-14) represents a period of heightened social sensitivity, peer orientation, and identity formation, factors that simultaneously increase vulnerability to cyberbullying victimization and enhance receptivity to peer-norm-focused

educational interventions (Eccles et al., 1993). The narrative animation format, which presented age-appropriate character interactions in recognizable digital social contexts such as group chat platforms, social media comment sections, and online gaming environments, was specifically designed to resonate with this developmental profile. The high practicality rating, driven partly by students' reports of personal relevance and emotional engagement, suggests that the developmental alignment was successful. This finding contributes to the growing literature on developmentally targeted digital safety education, which has found that interventions are most effective when they match the specific social concerns and communication contexts of the target age group (Kowalski et al., 2014).

The limitations of the present study should be acknowledged to contextualize the findings appropriately. First, the one-group pretest-posttest design used in the effectiveness trial does not permit attribution of learning gains solely to the media, as no control comparison was included. Future studies should employ randomized controlled or quasi-experimental designs to strengthen causal inferences. Second, the study was conducted at a single school in Padang, West Sumatra, limiting the generalizability of findings to other regional and socioeconomic contexts within Indonesia's diverse educational landscape. Third, as noted above, affective outcomes were assessed through qualitative observation rather than validated measurement instruments, and formal empathy and attitude change data were not collected. Fourth, the long-term retention of learning gains from a single media exposure session was not assessed; longitudinal follow-up studies would provide valuable evidence on durability of effects. Fifth, content validity relied on a single subject matter expert, which precludes the calculation of inter-rater reliability statistics; future studies should engage at least two content validators to enable inter-rater agreement analysis. Notwithstanding these limitations, the present study provides a rigorous and well-documented foundation for the development and evaluation of motion graphic animation video as an instructional medium in the Indonesian Informatics curriculum.

The contribution of this study to the broader field of educational technology in Indonesia should be understood within the context of the national Digital Transformation of Education agenda. The Ministry of Education's ongoing digitalization initiatives have created both opportunities and responsibilities for researchers and practitioners in the educational technology field: opportunities to develop and disseminate high-quality digital learning resources at scale, and responsibilities to ensure that such resources are grounded in sound pedagogical theory, rigorously validated, and accessible to students regardless of their school's resource profile. The present study's demonstration that AI-assisted tools can produce pedagogically valid, practically effective, and widely accessible instructional animation makes a direct contribution to this national agenda, offering a development methodology scalable across Indonesia's diverse school landscape.

Taken together, the findings confirm that motion graphic animation learning video, when developed through a theoretically grounded, iterative, and expert-validated process using AI-assisted tools, constitutes an effective and practical instructional solution for cyberbullying education in junior high school Informatics. The study's primary contributions are: (1) empirical validation of motion graphic video for cognitive learning outcomes, with preliminary qualitative indications of affective engagement in the cyberbullying domain; (2) documentation of an AI-assisted production workflow as a replicable, resource-efficient development model; and (3) transparent reporting of a multi-round expert validation process that demonstrably improved media quality prior to field testing.

CONCLUSIONS

This study has successfully developed a motion graphic animation learning video on Cyberbullying material for Grade VII Informatics using the 4D development model. The product achieved high quality ratings across all three criteria: validity (98.00%, Very Valid), practicality (89.55%, Very Practical), and effectiveness (N-Gain mean 0.733, 73.34%, High category). These outcomes confirm the suitability of the developed media for use in Informatics learning at the junior high school level under Indonesia's Merdeka Curriculum.

The study contributes three primary advances to the field: (1) empirical validation that motion graphic animation video effectively supports cognitive learning outcomes in cyberbullying education, with qualitative field observations providing preliminary evidence of potential affective engagement warranting formal measurement in future research; (2) documentation of an accessible AI-assisted production workflow applicable by teachers with moderate technical skills; and (3) provision of a transparent iterative validation methodology replicable in future development research.

The successful development of this media also highlights important policy implications for teacher professional development in Indonesia. The AI-assisted production workflow demonstrated in this study is not merely a research tool but a practical teaching capacity that can be cultivated through targeted professional development programs. If Informatics and educational technology teachers across Indonesia were equipped with the skills to develop motion graphic animation videos on locally relevant topics using accessible AI-assisted tools, the diversity and quality of instructional media available to Indonesian students would increase substantially. This observation aligns with the Ministry of Education's Platform Merdeka Mengajar initiative, which supports teacher capacity-building in technology-based instructional design, and suggests that the present study's production methodology could serve as a model competency for inclusion in teacher development curricula.

Future research directions include: (1) formal measurement of affective outcomes, particularly empathy development, using validated instruments in controlled pre-post designs; (2) expansion of the media framework to cover additional Informatics topics requiring concrete visualization under the Merdeka Curriculum; (3) incorporation of interactive features such as embedded formative quizzes to enable real-time assessment; and (4) testing media effectiveness with larger, geographically diverse student samples to assess generalizability across varied Indonesian school contexts.

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AUTHOR CONTRIBUTION STATEMENT

MTH contributed to the conceptualization of the study, research design, data collection, development of the instructional media, data analysis, and preparation of the original manuscript draft. ZZ contributed to research supervision, methodological guidance, project

administration, and manuscript review and editing. UR contributed to expert validation, academic feedback, interpretation of findings, and manuscript review and editing. MFA contributed to expert validation, review of the instructional media, interpretation support, and manuscript review and editing. All authors have read and approved the final version of the manuscript and agree to be accountable for the accuracy and integrity of the work.

AI DISCLOSURE STATEMENT

Generative AI tools were used in this study as part of the instructional media development process, not as autonomous tools for conducting the research or replacing scholarly judgment. Google Labs Flow/ Veo 3 was used to support the generation of visual assets and character animation for the cyberbullying motion graphic video. Google AI Studio was used to synthesize text-to-speech narration, while CapCut was used for video editing, subtitle integration, visual effects, transitions, and audio arrangement. The use of these tools was supervised, selected, reviewed, and revised by the authors to ensure alignment with the learning objectives, curriculum requirements, and expert validation feedback. The research design, data collection, data analysis, interpretation of findings, and final manuscript content remain the responsibility of the authors. No generative AI tool was used to make independent research decisions, analyze research data, or determine the conclusions of the study.

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