

Integrating Science, Technology, and Society Learning with Multimodal Digital Production for Progressive and Sustainable Digital Responsibility in Social Studies

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Abstract

The rapid development of digital technology creates new educational opportunities while also presenting complex challenges concerning the ethical, critical, and responsible use of digital technologies. This research aimed to examine the development of students' digital responsibility through an STS learning model integrated with multimodal digital production as a contextual and progressive learning approach in Social Studies on social change. A descriptive qualitative approach with performance observation, assessment of 60 digital products consisting of infographic posters and video campaign and in-depth interview as data collection techniques was used among 30 grade nine students at a junior secondary school in Bandung, Indonesia. The collected data were then analyzed using data reduction, data display, and conclusion drawing with the help of methodological and source triangulations. Four dimensions of digital responsibility were identified, namely digital etiquette, digital rights, digital literacy, and digital security, demonstrating how multimodal and context-based learning can integrate critical, ethical, and digital competencies. Overall success rate for digital responsibility dimensions were achieved at 88.3% for digital etiquette, 83.8% for digital rights, 86.8% for digital literacy, and 83.8% for digital security. Video products performed better than infographic posters on all indicators of digital responsibility especially in digital literacy and security dimensions. Qualitative findings showed that students practiced respectful communication, information verification, copyright acknowledgment, and personal information protection through authentic and collaborative digital production activities, indicating the potential of progressive and sustainable digital learning practices.

Keywords: multimodal digital production, digital literacy, sustainable digital learning, progressive learning, advanced learning process, designing learning experiences



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1. Introduction

The fast development of information and communication technology (ICT) in the era of Industry 4.0 and Society 5.0 changed the ways secondary school students communicate, get information, make knowledge, and interact socially. Access to the internet, social media, and the use of artificial intelligence-driven

platforms offer chances to improve the information literacy, expand global perspectives, and learn independently (Eshet-Alkalai, 2004). However, the increasing intensity of digital activity creates challenging learning conditions involving cyberbullying, misinformation, plagiarism, copyright infringement, inappropriate communication, and

breaches of personal privacy, requiring students to make critical and ethical decisions in authentic digital contexts (Bennett et al., 2012). Thus, ICT competence alone does not necessarily translate into ethical behavior in digital environments, highlighting the challenge of designing learning experiences that connect technological knowledge with critical judgment, ethical decision-making, and responsible digital practice.

One of the problems is the difference between students' technical skills and ethical awareness. Although adolescence is usually called the age of digital natives because of the great skills of adolescents with digital technologies, such skills do not imply critical evaluation of information and awareness of the consequences of actions in the digital world (Lankshear & Knobel, 2011). In this regard, digital responsibility includes competencies other than technological skills, namely, the verification of information, ethical communication, respect for the copyright, and protection of the privacy of personal data. In this case, schools are responsible for the formation of digital citizenship.

Social Studies education can provide an important curricular framework for this goal because it connects social interaction, social change, citizenship, technological development, and societal consequences, thereby enabling the design of contextual learning experiences that connect curricular knowledge with contemporary digital issues. In middle school, Social Studies education must not only convey the knowledge in history, geography, and economy but also help students develop their skills of interpreting social phenomena and responding ethically to the changing contemporary society (Sihotang & Wijaya, 2022). In particular, the topic of Social Change becomes highly relevant because digital technology is one of the most

influential forces that shape the process of communication, social interactions, the dissemination of information, and patterns of civic participation.

However, classroom practice is often dominated by texts, memorization, teacher-centered pedagogy, and textbooks as the major learning resources, creating a need for more progressive learning designs that engage students in authentic inquiry, collaboration, digital production, and reflection (Sardjiyo & Pannen, 2005). In this case, the learning of the topic of Social Change can become disconnected from the contemporary social reality if it is studied theoretically without the connection to students' digital experience. Consequently, digital responsibility can remain a conceptual learning outcome and not a part of the students' digital behavior.

Several studies revealed some problems with digital citizenship among students. For example, Komalasari et al. (2023) found moderate levels of online etiquette among middle school students in Bandung, while Ananto & Ningsih (2023) found differences between teachers' and students' perceptions of digital citizenship. Martin et al. (2020) reported that middle school students have high levels of technical awareness but lower engagement in communication etiquette and respect for privacy. Iskandar et al. (2025) found that digital privacy awareness of Indonesian students is affected by participation in digital social campaigns. Similarly, Fitri & Laela (2025) reported that digital literacy of students was more technologically oriented than evaluative and responsible, and Hidayat et al. (2024) reported that adolescents' digital interactions often included impolite communication caused by peer pressure.

Nevertheless, there is an important limitation of these studies. Many studies about digital citizenship used the quantitative

survey and self-reporting as the assessment approaches (Lankshear & Knobel, 2011). Although they help to measure students' perceptions and attitudes, these approaches are biased by the social desirability effect and cannot show students' ethical behavior in reality (Fraenkel et al., 2019). It means that there is a need in assessment approaches that would help to study students' ethical digital behaviors in practice and through their digital artifacts.

The same limitation can be found in research of the Science, Technology, and Society (STS) learning model. STS connects the scientific and technological developments to the social issues and human needs and is associated with good results in learning (Acut & Antonio, 2023). However, according to the meta-analysis of fourteen empirical STS studies, research is mostly conducted in quantitative experimental frameworks and is focused on cognitive outcomes (Acut & Antonio, 2023). In Social Studies, Sihotang & Wijaya (2022) and Subakti & Rahayu (2023) highlighted the integration of digital citizenship and technology-assisted learning but did not explore students' digital artifacts created during their learning.

The research about multimodal literacy also offers a complimentary point of view. Jiang et al. (2022) revealed that collaborative digital multimodal composition improves students' attention to the ethical implications of their messages although their study was conducted in language learning. Similarly, Zheng et al. (2024) found that digital etiquette is improved through digital game-based learning. Their approach, however, is based on simulation and not authentic students' artifacts. Thus, the integration of STS, Social Studies, multimodal production, and authentic assessment is not well studied in Indonesian middle schools.

According to the above-mentioned literature review, it is possible to formulate three research gaps. Firstly, the studies of digital citizenship of Indonesian students are mostly based on self-report measures and give little information about their ethical behavior (Ananto & Ningsih, 2023). Secondly, studies of STS are predominantly quantitative and cognitively oriented, providing limited insight into the ethical decision-making processes that emerge during technology-assisted learning and the challenges students encounter when applying knowledge in authentic contexts (Acut & Antonio, 2023). Thirdly, multimodal literacy research is not developed in Indonesian middle school Social Studies, especially in the context of Social Change and digital ethics (Jiang et al., 2022).

To fill these gaps, the current study combines the STS learning model with a multimodal artifact creation project to design contextual, collaborative, and progressive Social Studies learning on Social Change. Students produce infographic posters and digital campaign videos through collaborative activities related to the issues of technology. The theoretical basis of the study is the social constructivism of Vygotsky (1978) and the social semiotic theory of multimodality of Kress (2010). The participants are supposed to apply the principles of digital responsibility in practice, including the verification of information, respect for copyright, using proper language, and the protection of personal data (Buckingham, 2007; Grapss & Ilic, 2001).

The main value of the current study lies in the integration of the STS-based Social Studies learning with the analysis of authentic multimodal artifacts as an approach to the study of students' digital responsibility. Rather than using self-report and conventional tests, the study uses the analysis of students' digital products and processes of

creating them. In this regard, the study is aimed at describing the implementation of the multimodal project-based STS model in Social Studies learning on Social Change, analyzing the achievement of students in terms of digital responsibility indicators, and the patterns of their achievement in different formats (poster and video).

2. Method

This research applied the qualitative descriptive design with analytical orientation towards the implementation of the Science, Technology, and Society (STS) learning model in developing middle school students' digital responsibility in the Social Studies learning (Fraenkel et al., 2019; Sugiyono, 2018). The choice of qualitative approach was based on the ability of this methodology to investigate educational processes, interactions, experiences of students and behavioral practices within the natural context (Setiawan et al, 2020). An experimental and quasi-experimental design, control group, variable manipulation and inferential statistical testing have not been used. The focus was on the description and analysis of students' engagement with sociotechnological issues and their practice of digital responsibility in the process of learning (Huot et al., 2025).

The unit of analysis included STS-based Social Studies learning process and multimodal digital artifacts created by students during the Social Change (Perubahan Sosial) topic. The analysis has been done regarding four dimensions of digital responsibility: digital communication etiquette, copyright awareness, disinformation prevention and personal data privacy protection (Ribble, 2015).

a. Research Context and Participants

The study took place at SMP PGII 1 Bandung, West Java, Indonesia during the first semester of the 2026/2027 academic year, in late June – August 2026. The school has been purposively chosen due to its provision of functional computer laboratory, internet connectivity and support of using digital devices and project-based learning. The participants of the research were 30 ninth-grade students of one intact class (14 males and 16 females) aged 14–15 years.

Participants were purposively selected based on the criteria that were relevant to the research objectives (Sugiyono, 2018). The criteria included: (1) enrollment in Social Studies and involvement in the Social Change topic; (2) regular access to digital devices and internet connection at school and at home; (3) willing to participate in collaborative and technology-mediated learning activities. Being minors, the participants required some ethical procedures before the data collection. First, the approval of the institutional authority (school administration) has been received. Second, the informed consent from parents or guardians and assent from students have been obtained. Third, confidentiality, anonymity and privacy have been maintained throughout the whole research process (Fraenkel et al., 2019).

b. Learning Procedure

Learning activities were implemented through a four-stage modified STS model designed to connect Social Studies concepts with authentic sociotechnological issues, multimodal digital production, collaborative inquiry, and reflection. The STS model was modified to provide the connection of digital ethics and responsibility within the context of social change rather than science and environmental issues.

In the Initiation stage, students were introduced to the real sociotechnological issues related to digital transformation and social change (cyberbullying, online scams, misinformation, copyright infringement). They have chosen relevant sociotechnological issues in the digital environment and formulated the questions for investigation (Pratama et al., 2022).

In the Concept Formation stage, students had to investigate Social Studies concepts related to the social change, cultural adaptation and civic responsibility and verify the credibility of online sources and factual claims (Yager, 1996). In this way, the connection between students' experience with digital environment and curricular concepts was established.

In the Concept Application stage, students created multimodal digital artifacts using the principles of social semiotic multimodality, transforming conceptual knowledge into authentic digital production and progressively developing responsible decision-making skills. In particular, each group has created a static infographic poster using digital design applications (e.g., Canva) and one 1-2 minute digital campaign video using applications (e.g., CapCut, Premiere) (Kress, 2010). While creating multimodal artifacts, students have been supposed to demonstrate their digital responsibility, including attributions of sources, using the open-access or Creative Commons licensed materials, respectful language, avoiding hate speech and anonymization of personal information (Ribble, 2015).

In the Consolidation and Reflection stage, students presented their artifacts on the online learning platform of the school and participated in reflection activities. They have evaluated their own artifacts and the artifacts of peers in terms of digital communication etiquette, copyright awareness, factual

accuracy and personal data privacy protection (Iskandar et al., 2025). In this stage, there was a connection between the creation of the product and reflection on digital responsibility practices.

c. Data Collection and Research Instruments

Data have been collected through methodological triangulation using three research instruments: performance observation sheet, multimodal product evaluation rubric and semi-structured interview protocol (Fraenkel et al., 2019).

First, the Performance Observation Sheet was used to record the behaviors of students in four STS stages. Observations were performed regarding the information search practices, verification of sources, digital communication, selection and downloading of assets, decision-making, collaboration and ethical aspects of media production (Sugiyono, 2018).

Second, the Multimodal Product Evaluation Rubric was developed according to Ribble (2015) framework of Digital Citizenship and Buckingham (2007) criteria for media literacy. The rubric has been applied to the 60 multimodal digital artifacts (30 infographics and 30 videos). Every product has been evaluated on the basis of four indicators: (1) digital communication etiquette that was expressed through the respectful language and constructive messaging; (2) copyright awareness that was expressed through the proper attribution of sources and usage of permitted or public domain materials; (3) disinformation prevention that was expressed through the factual accuracy and credible source references; and (4) data privacy protection that was expressed through anonymization of personal information and proper consent of

visually identified people (Buckingham, 2007; Ribble, 2015).

Third, Semi-Structured Interviews were held with the representatives of students after the completion of the project. The interviews have been used to reveal the reasons for students' choices, ethical decision-making, problems in information and media selection and changes in understanding of digital responsibility (Fraenkel et al., 2019). The data obtained during interviews served for the complementation of the observational and product evaluation data but not for their substitution as a measure of students' digital responsibility.

d. Data Analysis

Data have been analyzed through the application of interactive model of qualitative data analysis proposed by Torres-Rivera et al. (2025) and including data reduction, data display, and conclusion drawing and verification. In data reduction, the notes about the observations, transcripts of the interviews and records of the product evaluation have been organized and systematically coded. The qualitative data have been categorized according to the four dimensions of digital responsibility defined on the basis of Ribble (2015): communication etiquette, copyright awareness, disinformation prevention and data privacy protection.

In data display, the qualitatively coded data have been organized into thematic matrices for finding the patterns in the process of four stages of learning, student groups and two types of artifacts. Descriptive statistics have been used in order to sum up the product evaluation scores and support the interpretation of qualitative data. The achievement score for each indicator was calculated with the following formula:

$$\text{Achievement Score} = \frac{\text{Earned Score}}{\text{Maximum Score}} \times 100\%$$

The obtained scores have been classified into four descriptive categories: Very High (85.0-100%), High (70.0-84.9%), Moderate (55.0-69.9%) and Low (<55.0%) (Sugiyono, 2018). These categories have been used only for the summarizing of the patterns in the data from the rubric but not for the inference and causation.

In conclusion drawing and verification, the patterns obtained from the observations, product evaluation and interviews have been compared and interpreted in order to obtain an integrated account of the digital responsibility of students. Special attention has been paid to the convergent and divergent evidences in three kinds of data and between posters and videos (Huot et al., 2025).

e. Trustworthiness

The trustworthiness of the results was ensured by means of methodological and source triangulations (Huot et al., 2025). Methodological triangulation has been reached through the comparison of the evidences obtained from the observations, multimodal artifact evaluations and interviews. Source triangulation has been conducted through the examination of the perspectives and behaviors of students with various group roles and of both males and females. Using several sources of evidences, the researchers could distinguish the reported understanding of students from their behavioral practices and artifacts' features.

3. Result and Discussion

The data were analyzed through combining the findings from the multimodal product evaluation, classroom performance observations, and semi-structured interviews. Four major aspects of students'

digital responsibility were considered including digital etiquette, digital rights, digital literacy, and digital security, and both the overall level of achievement in terms of digital responsibility and the differences between poster and video formats were considered. The qualitative evidence about the learning process and reflections of the students served to analyze the ethical behavior of the students in achieving digital responsibility. Hence, the presentation of findings and discussion will include the following four themes: (1) the overall achievement of the digital responsibility of the students in STS; (2) the comparison of digital responsibility in poster and video formats; (3) qualitative evidence of ethical decision-making and digital responsibility; and (4) STS, multimodal production, and Social Studies learning.

a. Overall Achievement of Students' Digital Responsibility in the STS Project

The implementation of the Science, Technology, and Society (STS) learning model led to a relatively high overall profile of students' digital responsibility with regard to four indicators: digital etiquette, digital rights, digital literacy, and digital security. The assessment included analysis of digital artifacts produced by students, observation of students' behavior during the learning process, and interviewing students after the completion of the STS project (Zheng et al., 2024). Consequently, the achieved level could be interpreted not only in terms of the results provided by the product but also in relation to observable practices and ethical reasoning of students (Sihotang & Wijaya, 2022). Based on the findings, Digital Etiquette was the best indicator with the achievement of 88.3%, followed by Digital Literacy (86.8%). Both Digital Rights and Digital Security achieved 83.8%. Thus, two dimensions were characterized by very high achievements, and two – by high achievements.

Table 1. Recapitulation of Students' Digital Responsibility Indicators in the STS Project

Digital Responsibility Indicator	Poster Score (%)	Video Score (%)	Combined Average (%)	Category
Digital Etiquette	86.5	90.0	88.3	Very High
Digital Rights (Copyright Understanding)	82.0	85.5	83.8	High
Digital Literacy (Disinformation Prevention)	84.0	89.5	86.8	Very High
Digital Security (Data Privacy Protection)	80.5	87.0	83.8	High

From the data represented in Table 1, it is clear that the level of digital responsibility of the students varied depending on the indicators. Digital Etiquette demonstrated the highest achievement with the result of 88.3%. It means that students had good enough abilities to use respectful and constructive communication principles when producing digital content (Sihotang & Wijaya, 2022). Digital Literacy also showed

the very high achievement with the result of 86.8%. Students demonstrated their engagement in the factual verification and evaluation of the information. However, both Digital Rights and Digital Security were characterized by a bit lower achievement of 83.8%. These lower results may be explained by the fact that copyright compliance and privacy protection require more technically specific decisions (Fitri & Laela, 2025). Still,

the results show that students were able to apply the principles of digital ethics learned during STS to their digital products. This fact confirms the relevance of the concept of

digital citizenship education in terms of responsible participation in the online world (Ribble, 2015).

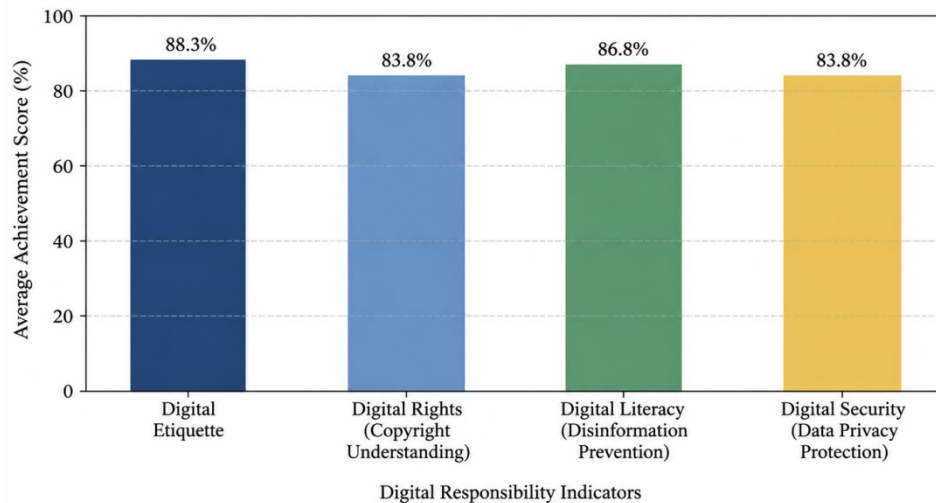


Figure 2. Overall Achievement of Students' Digital Responsibility Across Four Indicators

Figure 2 shows the results in terms of differences between indicators. There is a small gap between the highest and lowest results, i.e., the difference of 4.5 points. It means that there is no great inconsistency in terms of the levels of digital responsibility with regard to the indicators. In particular, Digital Etiquette showed the highest result, which can be explained by the direct and visible aspect of communication practices during collaborative production. Students needed to negotiate words, tone, and wording when communicating with others and preparing content for the audience (Komalasari et al., 2023). However, somewhat lower scores for Digital Rights and Digital Security may be explained by the fact that these competencies involve more procedural aspects of knowledge. Students

need to identify permissible media assets, provide attribution, blur information about identifiable people, etc (Subakti & Rahayu, 2023). This interpretation aligns with the general concept of digital literacy in terms of not only technical but also critical, ethical and social aspects (Eshet-Alkalai, 2004; Buckingham, 2007).

The qualitative evidence is helpful in explaining the results as well. At the Concept Application stage, students were seen talking about appropriate language, checking sources, selecting media assets, and taking care of privacy issues when adding some material to their posters and videos (Castek et al., 2017). It means that the scores in Table 1 were justified by real learning behaviors rather than students' self-assessments.

Table 2. Observed Digital Responsibility Practices During the STS Project

Digital Responsibility Indicator	Observed Practice	Evidence Context	Interpretation
Digital Etiquette	Discussing respectful language and avoiding aggressive or provocative expressions	Scriptwriting and group discussion	Students considered the social consequences of digital communication
Digital Rights	Searching for royalty-free or Creative Commons media and adding attribution	Poster and video production	Students applied copyright principles during authentic media selection
Digital Literacy	Cross-checking information and conducting reverse-image searches	Investigation and content development	Students evaluated the credibility and accuracy of digital information
Digital Security	Blurring faces and anonymizing personal information or chat screenshots	Video editing and visual preparation	Students recognized privacy risks associated with digital publication

As can be seen from Table 2, each numerical indicator corresponds to certain practices observed during the learning process. In particular, regarding Digital Etiquette, students reported negotiating language choices in order to avoid hostile or provocative expressions. Regarding Digital Literacy, students applied such practices as information cross-checking, reverse image search when incorporating certain claims into their content (Supriatna, 2019). Digital Rights were demonstrated through selecting royalty-free or Creative Commons materials and attributing. As for Digital Security, the indicator appeared in such privacy protection practices as blurring faces and anonymizing personal information. This evidence is important as it allows to complement the product scores with some behavioral evidence. It reduces the reliance on self-report assessments (Mossberger et al., 2008).

The overall pattern can be also interpreted through the STS framework. In terms of the object of investigation (digital transformation and its social consequences), the learning process involved the connection between technological practices and social and ethical aspects of the latter (Ohiarah, 2026). It means that, instead of teaching digital ethics as an isolated topic, students faced ethical decisions related to information search, media asset selection, message construction, and content preparation for publication (Selwyn, 2016). This approach aligns with the STS conception of connecting technological developments with the societal needs and consequences (Acut & Antonio, 2023). Also, it shows the relevance of Social Studies as the context for the development of students' ability to interpret social changes (Sihotang & Wijaya, 2022; Supriatna, 2019).

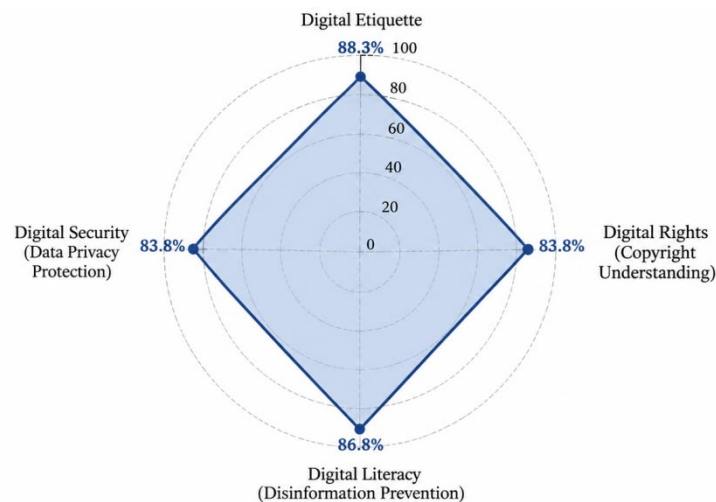


Figure 3. Profile of Students' Digital Responsibility Across Four Indicators

The profile presented in Figure 3 shows that the four indicators form a relatively balanced pattern, even though Digital Etiquette and Digital Literacy go a little bit further compared to Digital Rights and Digital Security. It means that students demonstrate better competence in the communication and information evaluation than in copyright and privacy protection, which involves more procedural knowledge. From the pedagogical perspective, such a distinction is important as the responsible participation in the online world requires the integration of different types of competencies (communicative, critical, legal, and security-related ones) (Asem & Claro, 2025). Consequently, the results show that STS-based multimodal learning can provide the contextual environment for practicing these dimensions. They are also consistent with the conception that meaningful digital literacy requires students to engage critically with information, media and their consequences (Hobbs, 2010).

Overall, the results show that there is a relatively high level of digital responsibility among students in terms of the four indicators. Specifically, the highest achievements in Digital Etiquette and Digital Literacy confirm that students were able to

communicate appropriately and critically evaluate digital information. At the same time, the high level in Digital Rights and Digital Security demonstrates that copyright and privacy protection practices were also incorporated into digital production (Gleason & Von Gillern, 2018). Importantly, these results should be interpreted as the evidence of students' achievement in the context observed rather than as the evidence of causality of the STS model (Beghi et al., 2026). However, the integration of the artifact evaluation, observation, and interview evidence helps to provide a more comprehensive representation of students' digital responsibility than self-report measures.

b. Comparison of Digital Responsibility Across Poster and Video Formats

Comparison of students' digital responsibility indicators across different artifact formats (poster and video) revealed the same pattern according to which the video campaigns received significantly higher achievement scores than the infographics on posters for all four indicators. This is crucial since both artifact types entailed the same demonstration of students' digital responsibility values but

through different multimodal constructions (Pratiwi et al., 2025). Posters required mainly the static combination of text, images, typography, and design. Videos, in turn, had to incorporate narration, moving images, sound, captions, sequence, and editing

(Mehdiyev & Fataliyev, 2026). The comparison is thus an evidence of how the particularities of different artifact formats affected the observable patterns of students' enacted digital responsibility.

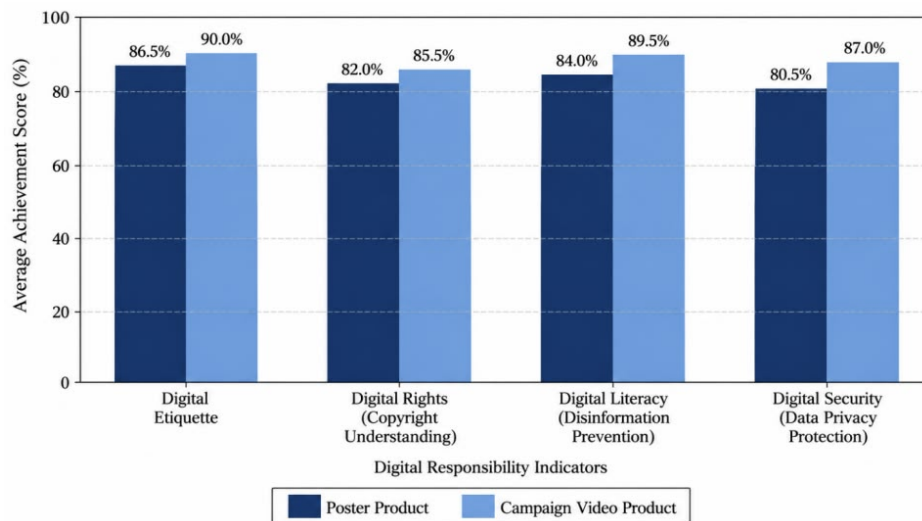


Figure 1. Comparison of Students' Digital Responsibility Indicator Scores Across Poster and Video Media Formats

According to Figure 1 above, video products scored higher for all indicators in comparison with poster products. Digital Etiquette increased from 86.5% in posters to 90.0% in videos; Digital Rights from 82.0% to 85.5%; Digital Literacy from 84.0% to 89.5%, and Digital Security from 80.5% to 87.0%. The consistency in the direction of the differences shows that students provided more evidence of digital responsibility when working with video artifacts (Ran et al., 2023). The greatest difference was in the case of Digital Security, followed by Digital

Literacy, while Digital Etiquette and Digital Rights demonstrated a lower but equal difference. Importantly, these differences should be interpreted as descriptive rather than the result of statistical causality (Alobaid, 2025). Specifically, it is evident that the characteristics of video production gave students more chances to demonstrate certain practices.

The comparison becomes even more clear when considering the differences between artifact types quantitatively.

Table 3. Comparative Achievement of Digital Responsibility Across Poster and Video Products

Digital Responsibility Indicator	Poster Score (%)	Video Score (%)	Video–Poster Difference (percentage points)	Achievement Pattern
Digital Etiquette	86.5	90.0	+3.5	Higher in video
Digital Rights	82.0	85.5	+3.5	Higher in video
Digital Literacy	84.0	89.5	+5.5	Higher in video
Digital Security	80.5	87.0	+6.5	Higher in video

According to Table 3, the magnitude of difference varied between the four indicators. Digital Security showed the greatest difference, which reached 6.5 percentage points, followed by Digital Literacy, which was 5.5 percentage points. Digital Etiquette and Digital Rights, in turn, were different by 3.5 percentage points each. The relatively large gap in Digital Security may be explained by the technical features of video production. Video editing often requires the use of recognizable faces, recordings of conversations, background scenes, screenshots, etc., which gives students more chances to make decisions about anonymization and protection of privacy (Egamberdiyeva, 2025). Similarly, the relatively greater difference in Digital

Literacy may have been caused by the need to coordinate more information, narrations, visual evidences, and time sequences in order to produce a video campaign.

Figure 4 below visualizes the difference between scores of video and poster for all four digital responsibility indicators. The positive differences in all four dimensions show the consistent descriptive pattern rather than an increase in only one indicator (Chang et al., 2023). The gap in Digital Security suggests that the privacy-related decisions become particularly observable during video production, while the difference in Digital Literacy indicates the relevance of information verification during the combination of various media elements and claims.

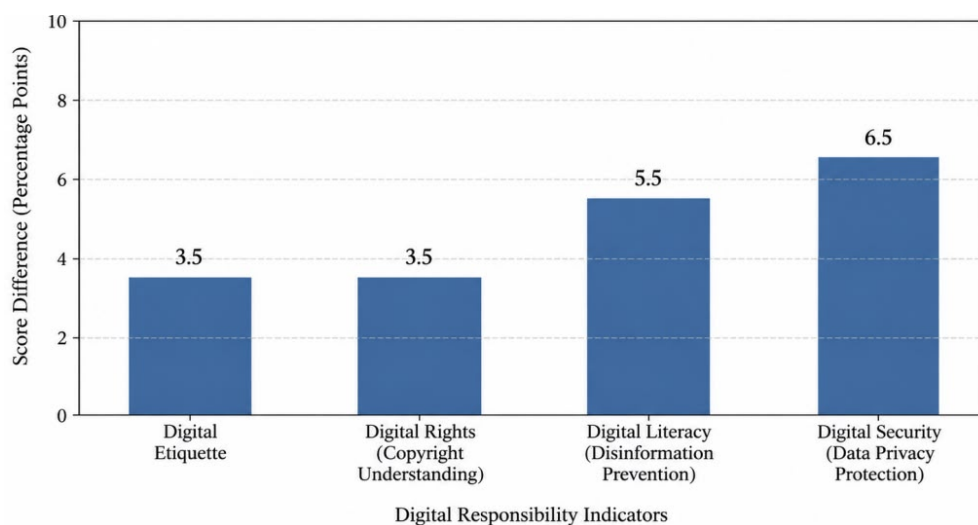


Figure 4. Achievement Differences Between Poster and Video Formats

The findings in Figure 4 align with observations that students search for royalty-free audio, check sources, add attribution, blur faces, and anonymize personal information during video editing. The aforementioned comparisons are supported by qualitative evidence from the learning process (Liu, 2026).

The difference between the two formats can be also explained by the concept of multimodal production as formulated by Kress (2010). According to this scholar, multimodal communication is the coordinated combination of several semiotic modes for meaning construction. In the current study, the video production entailed the integration of language, visual

representation, writing, sound, sequence, and movement. As a result, it gave students more points at which they should consider the accuracy, appropriateness, and ethics of their communicative decisions. The static nature of posters, in turn, restricted the communication to relatively fixed visual and textual elements (Hidayah et al., 2025). It does not mean that posters were less valuable for the learning process; both formats only provided different conditions for students to exhibit digital responsibility.

This pattern is also consistent with the perspective of New Literacies as proposed by Lankshear & Knobel (2011). In this theory, digital literacy implies participation, production, and meaning-making in the contemporary digital environment. In the current study, students were not only consumers of information but producers of communicative artifacts targeted at certain audiences. Video production entailed more continuous decisions about sequencing, source integration, sound selection, visual representation, and delivery of messages (Adeshina, 2024). This production process therefore provided more opportunities for students to apply ethical considerations throughout the entire production cycle, demonstrating how the design of multimodal learning tasks can shape the opportunities available for students to enact digital responsibility. This interpretation is consistent with the role of digital media production in fostering students' critical and responsible engagement with information and media.

The findings also imply that multimodal production can complement the process of STS learning as it makes sociotechnological dilemmas more concrete. When students were developing campaign videos related to such issues as cyberbullying, misinformation, online scams, etc. Social Change, they were required to transform their

conceptual understanding into messages intended for real audiences (Miriam et al., 2025). The transformation entailed such decisions as what information to include, what sources to use, what language to employ, and how to represent visual or audio materials. The process of making these decisions connects the technological dimension of STS with its social and ethical dimensions (Shin et al., 2026).

Overall, the comparison shows the consistent descriptive pattern according to which video artifacts have higher digital responsibility scores than posters across all four indicators. The differences were especially noticeable in Digital Security and Digital Literacy. The qualitative observations provide the plausible explanation of the differences by showing that video production exposes students to more complex decisions related to information verification, copyright, privacy, and communication (Nadoleanu et al., 2022). The findings thus imply that the multimodal artifact production, in particular through video, creates more comprehensive context for the observable enactment of digital responsibility, while posters provide another means of representing the same principles in a concise and visually appealing way.

c. Qualitative Evidence of Ethical Decision-Making and Digital Responsibility

Qualitative examination of students' achievements was performed by means of classroom observations and interviews after the completion of the STS project. The qualitative data show that students' success was expressed by practices related to communication, information verification, copyright compliance, and privacy protection. Instead of studying digital responsibility as an abstract attitudinal

construct, the focus of this analysis was on ethical decisions made by students during their search for information, assessment of digital resources, negotiations on content with peers, and production of multimodal

artifacts. Triangulation of product evaluation, observation, and interview results helped to interpret the patterns identified in the previous section (Huot et al., 2025).

Table 4. Observations of Digital Responsibility Practices During the STS Project

Digital Responsibility Indicator	Observed Practice	Learning Context	Interpretation
Digital Etiquette	Negotiating respectful language and avoiding aggressive or provocative expressions	Scriptwriting and group discussion	Students considered the social consequences of digital communication
Digital Rights	Searching for royalty-free or Creative Commons media and adding attribution	Poster and video production	Students applied copyright principles during authentic media selection
Digital Literacy	Cross-checking information and conducting reverse-image searches	Investigation and content development	Students evaluated the credibility and accuracy of digital information
Digital Security	Blurring faces and anonymizing personal information or chat screenshots	Video editing and visual preparation	Students recognized privacy risks associated with digital publication

According to Table 4, every indicator of digital responsibility was linked to the observed practices of students during the STS project. Digital Etiquette was demonstrated by discussion of language choices and attempts to avoid phrases and words that could cause offense or hostilities. Digital Literacy was shown by source verification and reverse image search before incorporation of information in the product (Salehi Gahrizsangi et al., 2026). Digital Rights became relevant for searching for media resources that could be used and including proper attribution, while Digital Security was expressed by anonymization of personal data and blurring of identifiable

people. These observations are especially valuable in terms of the fact that the students' digital responsibility was proven by concrete production practice (Fraenkel et al., 2019).

Further interview data indicated that ethical decisions made by students were linked to their knowledge of social consequences of digital communication. At the Concept Application stage of the STS project, students had to consider not only the suitability of content but also its appropriateness for public communication (Torres-Rivera et al., 2025). This was especially true for development of campaign content on cyberbullying and misinformation.

Table 5. Representative Interview Evidence About Digital Responsibility of Students

Digital Responsibility Dimension	Context of Interview	Representative Evidence	Interpretation
Digital Etiquette	Campaign video on cyberbullying	Students reported avoiding aggressive slang and accusatory expressions to prevent further online hostility	Students linked language choices with social consequences
Digital Literacy	Poster on digital scams	Students replaced an unverified social-media graphic with verified information from an official government portal	Students applied source verification before publication
Digital Rights	Video background music	Students avoided popular copyrighted songs and searched for Creative Commons audio with attribution requirements	Students recognized copyright as part of responsible media production
Digital Security	Video and visual editing	Students blurred faces of bystanders and anonymized personal chat screenshots	Students considered privacy risks before digital publication

Table 5 provides examples of students' thinking behind the observed practices. Thus, one of students from Group 3 said that the group intentionally avoided the use of aggressive slang and accusations in the course of development of campaign video on cyberbullying because the aim of the video was to educate peers, not provoke hostilities online. Likewise, one of students from Group 5 explained that the group rejected the use of unverified graphic obtained from social media and replaced it with verified information from the government website (Castek et al., 2017). These statements show that students began to understand connections between production decisions and effects on audience and credibility of information. These practices are consistent with the principles of digital citizenship defined by Ribble (2015) and critical dimensions of digital literacy defined by Buckingham (2007).

Moreover, the qualitative evidence shows that ethical decision-making was not confined to the content of students' messages but included the resources for construction of the products. Students faced dilemmas of

copyright particularly during video production. One of the interviewed students said that the group initially had difficulties with choice of the background music since popular songs could not simply be downloaded and used (Ohiarah, 2026). However, the group finally looked for Creative Commons audio and put appropriate attribution in the video. This example shows how an abstract notion like copyright becomes a concrete decision in the course of authentic media production. Instead of learning copyright only as a rule, students faced the consequences of copyright compliance while creating the product for audience (Asem & Claro, 2025).

A similar process took place in relation to privacy protection. When editing video, students faced visual content with faces of bystanders and personal information in screenshots. Anonymization of this information shows that privacy became a factor of the production process. This finding is especially valuable since Digital Security obtained the lowest score among four indicators (83.8%) and thus privacy protection was still an issue despite the

awareness of the problem. Qualitative evidence can help to understand why the numerical score did not merely indicate the lack of awareness but also the technical

complexity of privacy protection during digital production (Gleason & Von Gillern, 2018).

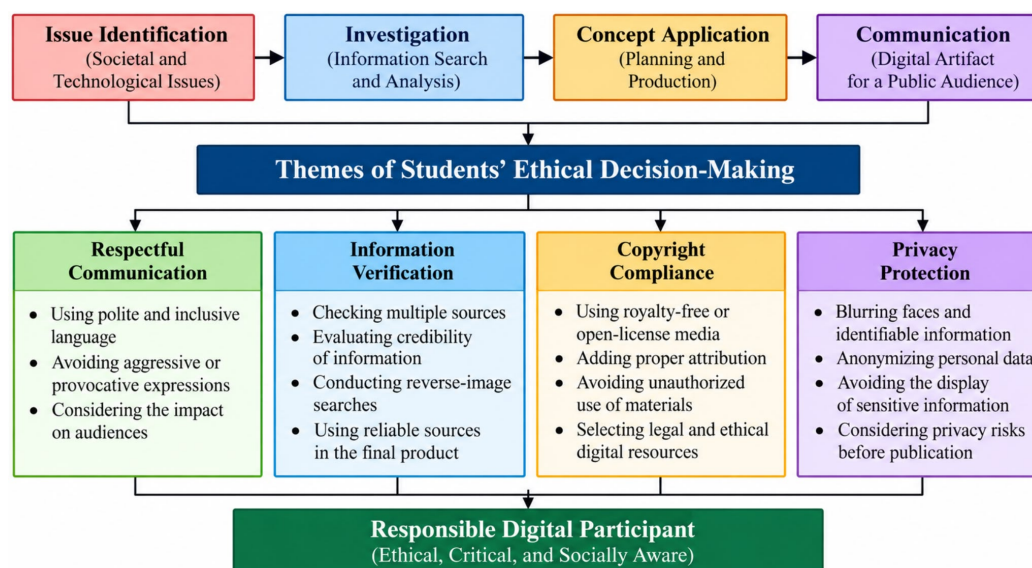


Figure 5. Forms of Ethical Decision-Making by Students During the STS Project

Figure 5 summarizes the findings on ethical decision-making in four interconnected forms. The first theme was respectful communication as shown by students' negotiations on language and framing of messages. Information verification as the second theme was shown by checking of sources and rejection of unverified materials (Beghi et al., 2026). The third theme was copyright compliance as shown by the decisions on usage and attribution of digital assets. Finally, privacy protection as the fourth theme was shown by anonymization of personal information and modification of identifiable visual content. Overall, these forms of ethical decision-making indicate that digital responsibility was realized as the series of practical decisions and not the result of any one instructional activity (Pratiwi et al., 2025). This finding is consistent with the STS approach that links technology to its social implications.

Furthermore, the qualitative findings highlight the role of collaborative interaction in the development of ethical judgment, supporting a progressive learning environment in which peer discussion, feedback, negotiation, and shared decision-making contribute to students' construction of responsible digital practices. Not all decisions were made individually by the students but the ethical choices were often made in the course of group discussions, peer feedback, and negotiation during script writing, source verification, and media editing (Mehdiyev & Fataliyev, 2026). This collaborative process is consistent with the social constructivist perspective of Vygotsky (1978), where learning occurs through social interaction and creation of meaning. In the current study, peers become sources of feedback and scaffolding when students have doubts regarding language, credibility of the sources, copyright, and privacy.

These findings also confirm the reason for using of authentic digital artifacts along with observations and interviews. Product scores indicated the level of achievement, while observations showed what students actually did during production and interviews revealed reasons for making certain decisions (Ran et al., 2023). The convergence of these methods improves the interpretation of students' digital responsibility and decreases the reliance on self-reported attitudes only.

Thus, the qualitative evidence indicates that students' digital responsibility was shown through the practices of ethical decision-making during authentic multimodal production. Students learned to regulate their communication, verify information, respect digital rights, and protect personal data in the process of solving contemporary sociotechnological problems. These findings supplement the quantitative results and prove the processes by which the students realized digital responsibility. Thus, the STS project did not operate only as the model of content delivery but provided a context for translation of Social Studies concepts into concrete ethical practices during digital content production.

d. STS, Multimodal Production, and the Transformation of Social Studies Learning

Accordingly, the implementation of the Science, Technology, and Society (STS) learning model integrated with multimodal digital production led to the formation of a learning environment where the studied concepts of Social Studies were linked to the students' experience of using technology and their social responsibilities (Abidin et al., 2024). Contrary to the common learning paradigm that perceives learners merely as recipients of knowledge, the process of learning involved students in identifying current digital problems, investigating information, using Social Studies concepts, creating digital content, and analyzing the social and ethical aspects of communication (Alobaid, 2025). Such a pattern is consistent with the core orientation of the STS learning paradigm since it implies the connection of conceptual knowledge with technological practices and societal issues. In the case of the current study, such a connection was particularly prominent since the participants were expected to convert their knowledge of social change into communicative digital products.

The alignment of the STS stages, learning activities, student artifacts, and digital responsibility indicators is illustrated in Table 6.

Table 6. Alignment of STS Stages, Learning Activities, Artifacts, and Digital Responsibility

STS Stage	Main Learning Activities	Student Artifacts/ Outputs	Digital Responsibility Emphasis
Initiation	Identifying cyberbullying, misinformation, online scams, copyright infringement, and privacy issues	Issue statements and guiding questions	Digital etiquette and awareness of social consequences
Concept Formation	Discussing social change, technology society relationships, source credibility, and civic responsibility	Concept maps, discussion notes, verified information sources	Digital literacy and critical information evaluation

STS Stage	Main Learning Activities	Student Artifacts/ Outputs	Digital Responsibility Emphasis
Concept Application	Designing infographic posters and producing short campaign videos	30 posters and 30 campaign videos	Digital rights, digital literacy, etiquette, and security
Consolidatio n and Reflection	Presenting products, receiving peer feedback, and reflecting on ethical decisions	Revised digital artifacts and reflection responses	Integrated digital responsibility and ethical awareness

It can be seen from Table 6 that digital responsibility was not considered as an isolated issue that could be learned using only direct instruction techniques. Instead, the four dimensions were distributed along the entire learning process and gained prominence as the students moved from problem identification to creation and communication of digital content (Egamberdiyeva, 2025). As part of the initiation stage, the students encountered the problems existing in their digital environments, including cyberbullying, misinformation, scams, and the misuse of digital content. At the stage of concept formation, these problems were connected to the Social Studies concepts related to social change, social interaction, civic responsibility, and technology-society relationships (Chang et al., 2023). Such contextualization is consistent with the approach of Yager (1996), which considers real-world problems as meaningful contexts of learning. Furthermore, the learning process corresponds with the ideas of Acut & Antonio (2023) on the relevance of the STS paradigm to connect learning with relevant contexts and applications.

The concept application stage was the key stage at which the conceptual knowledge turned into observable digital practices. While developing their posters and videos, the students had to decide about language, information sources, visual materials, music, personal information, and ways of presenting their content (Liu, 2026). Therefore, the artifacts of digital learning were not only learning products but also the evidence of the way in which the students applied ethical considerations to their digital practices. Such a feature is particularly relevant to the multimodal nature of the research since the meaning is constructed in the process of interaction of written language, visual elements, sound effects, sequences, typographic features, and other semiotic resources (Kress, 2010). Thus, the production process positioned students as active creators who were responsible for both the content and the implications of their communicative messages, reflecting a progressive learning orientation in which students actively construct, communicate, evaluate, and refine knowledge through meaningful digital practices.

The interconnection of STS stages and digital responsibility is depicted in Figure 6.

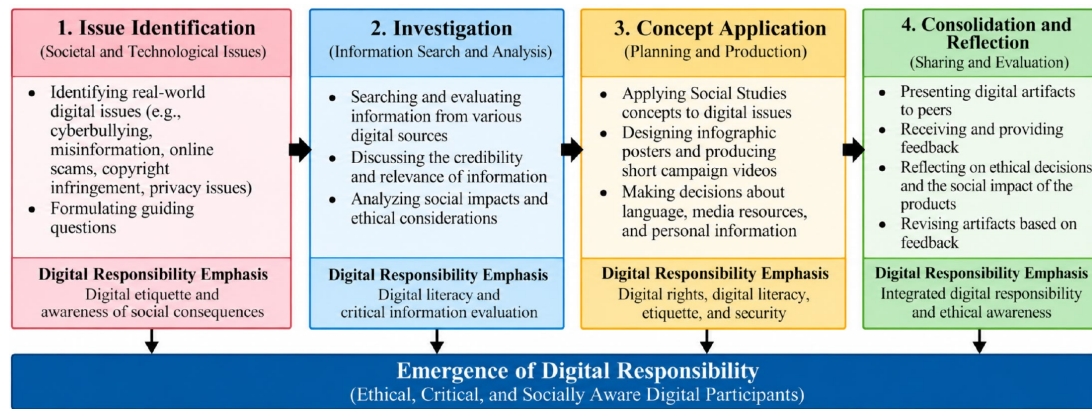


Figure 6. STS Learning Process and Emergence of Digital Responsibility

As can be seen from Figure 6, digital responsibility emerged progressively through the learning process and not as the result of single instructional activity. First, the identification of authentic digital problems created the social context, while investigation required students to evaluate the credibility and relevance of the information. At the production stage, these considerations became a part of decisions about language, sources, media assets, and personal information. Reflection provided an opportunity for the students to reconsider the social and ethical appropriateness of their

products (Fatihatussa'adah et al., 2024). Such a sequence is significant because it demonstrates how the learning process can connect abstract concepts of Social Studies with observable digital practices (Adeshina, 2024). Moreover, the sequence corresponds with the social constructivism proposed by Vygotsky (1978), according to which the learning is achieved through interactions, dialogues, and mediated activities and not merely through the information reception.

The combination of STS, multimodal production, and digital responsibility can be explained using Figure 7.

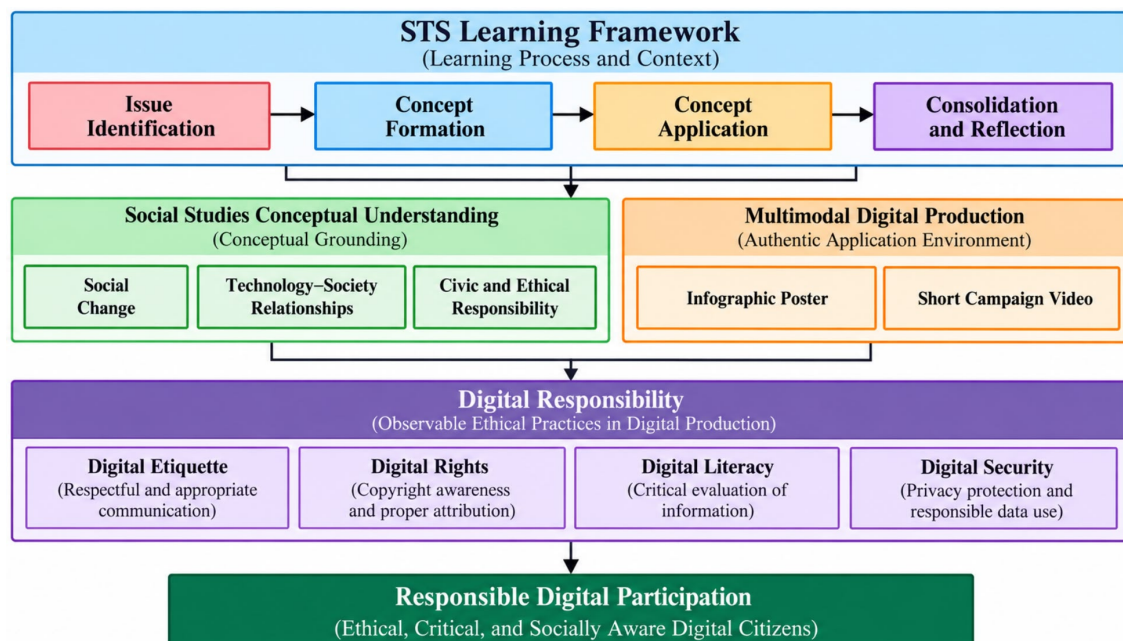


Figure 7. Integrated STS–Multimodal Digital Responsibility Framework

Figure 7 shows that the three elements of the learning design functioned as the interrelated components and not independent instructional strategies. STS provided the contextual and inquiry-oriented structure, Social Studies provided the conceptual framework to interpret social change and technology-society relationships, and multimodal production provided the authentic environment to demonstrate the acquired knowledge (Shin et al., 2026; Anggriyani et al., 2025). Digital responsibility was implemented through these components since the students were expected to make ethical decisions during information searching, content development, media selection, editing, and communication. Such an interpretation is consistent with the ideas of Kress (2010), who positioned the multimodality as the process of meaning-making with multiple semiotic resources, and with the ideas of Buckingham (2007) on the necessity to develop the critical engagement with digital

media rather than just access it. Similarly, Lankshear & Knobel (2011) emphasized the idea that the digital literacy involves the situated practices where users actively create, interpret, and communicate the meaning.

Another important observation from the integrated STS, multimodal production, and digital responsibility learning process is the transition of students from digital consumers to responsible digital producers, reflecting an advanced form of learning in which students critically evaluate information, construct knowledge, make ethical decisions, and consider the social implications of their creations and distribution (Miriam et al., 2025). At the early stage of the learning process, the students experienced the digital information only as the users and recipients. With the help of the STS project, however, they were expected to select information, evaluate sources, create messages, choose media resources, protect personal information, and communicate with an intended audience. The transition is illustrated in Figure 8.

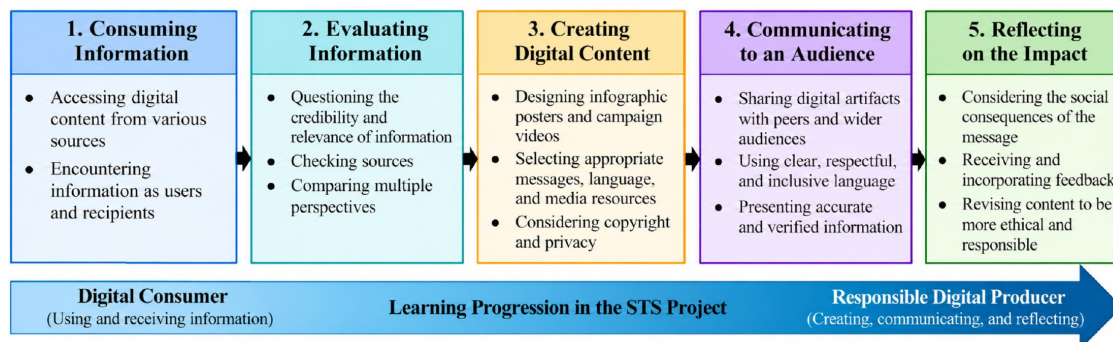


Figure 8. From Digital Consumer to Responsible Digital Producer

Figure 8 provides the conceptual interpretation of the observed learning process, according to which the responsible digital participation requires more skills than just access or operation of digital technologies. The students went through several interrelated practices including information consumption, its credibility

evaluation, selection of relevant evidence, content production, communication, and reflection of its ethical implications (Nadoleanu et al., 2022). The transition became particularly evident in the decisions made during observations and interviews that included replacement of the unverified information with credible sources, usage of

open-license materials, attribution of media resources, modification of language to avoid offensive expressions, and anonymization of identifiable information (Salehi Gahrizsangi et al., 2026). The practice demonstrates that the digital responsibility was expressed not only in students' attitudes but also in their decisions during the production process.

Collaboration was also evident through all the four STS stages since the students discussed which information to include, negotiated the wording, evaluated alternatives, selected visual materials, and reviewed whether their products would potentially lead to misunderstandings or harm. Such interaction allowed the students to get in touch with different interpretations and to justify their decisions in front of their peers. This finding is consistent with the social constructivism of Vygotsky (1978) that suggests that learning happens through interactions and not individual information reception. The collaborative nature of the multimodal production means that the responsibility was shared among the group where different members found information, designed visual compositions, edited the videos, and evaluated the accuracy or ethical appropriateness of the product.

The research results also demonstrate the significance of Social Studies as the context of digital responsibility since social change does not happen only in terms of institutional, cultural, or social interaction changes; it also includes changes in communication, information acquisition, social participation, and construction of social meaning using digital technologies (Sihotang & Wijaya, 2022). Consequently, digital responsibility may be considered as an extension of the Social Studies learning since the students were expected to think about the impact of technological practices on interpersonal relationships, information

circulation, public communication, and social participation. This interpretation underlines the significance of Social Studies in preparing students for contemporary social transformations (Supriatna, 2019).

Thus, the results of the research obtained from the four interconnected themes prove that the STS-based multimodal project provided the learning context where conceptual learning, digital production, collaboration, and ethical decision-making were interrelated. The evidence from observations, artifact analysis, and interviews allows interpreting that the students showed digital responsibility through the observable practices of communication etiquette, information verification, copyright awareness, and privacy protection (Miriam et al., 2025). The high scores of achievement that are reported in previous sections are more meaningful if combined with these qualitative practices since digital responsibility was not limited to students' attitudes but included their decisions during information searching, evaluation, production, editing, communication, and reflection of the digital content (Nadoleanu et al., 2022). Overall, the integrated process reinforces the potential of Social Studies learning to solve contemporary technological and societal problems.

Overall, the fourth finding is related to the STS–multimodal integration as the pedagogical framework for connecting Social Studies concepts with authentic digital practices, while the evidence is descriptive and context-specific. Since the study did not involve experimental comparison or pre–post measurement, these findings are to be interpreted as the evidence of the observed learning processes and digital responsibility patterns in the participating class and not the proof of the instructional model effect.

4. Conclusion

The findings indicate that the integration of the Science, Technology, and Society (STS) learning approach with multimodal digital production created a contextual and progressive learning environment for developing students' digital responsibility in Social Studies learning on social change. Across the STS stages, students engaged in identifying authentic digital problems, investigating and evaluating information, applying Social Studies concepts, creating multimodal digital artifacts, and reflecting on the ethical and social implications of digital communication, demonstrating an advanced learning process that integrated critical, creative, technological, and ethical competencies. According to the findings, there are four distinct observable dimensions of digital responsibility: digital etiquette, digital rights, digital literacy, and digital security, and the level of achievement of students varied between the categories of high and very high. Video products had higher levels of description in terms of the four criteria, than infographic posters did, especially regarding digital security and digital literacy, due to the fact that the former required a larger number of decisions about the way the message was delivered. Qualitatively, students' responsible behaviors are evident in their respectful communication, information verification, copyrighting, and the protection of personal data. Thus, the research demonstrates the potential of STS-based Social Studies learning to connect conceptual understanding of social change with authentic digital practices, enabling students to move beyond consuming information toward becoming critical, creative, collaborative, and ethically responsible digital producers. However, the context-specific findings should be interpreted as descriptive evidence of learning processes and observed patterns rather than causal effects. Future learning designs can build on these findings

by providing continuous opportunities for authentic digital inquiry, multimodal production, reflection, feedback, and ethical decision-making to support sustainable digital learning and responsible participation in society.

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