

AI-Assisted Meaningful Learning: Developing Infographic Media to Enhance Students' Understanding of *Umayyad* Social Transformation

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Abstract : This study aims to examine the effectiveness of meaningful learning-based infographic media assisted by NotebookLM in enhancing students' understanding of social transformations during the Umayyad Caliphate era. A quantitative approach was employed using a quasi-experimental, non-equivalent control group design. The study population consisted of 146 seventh-grade students, while the sample comprised 21 students in the experimental group and 20 in the control group, selected purposively based on the equivalence of class characteristics. Data were collected via pre-tests and post-tests using an assessment instrument developed based on learning objectives TP 2.6 and TP 2.7. Data analysis involved the Shapiro-Wilk test, Levene's test, independent-samples t-test, and N-Gain analysis using IBM SPSS Statistics 26. The results revealed significant differences between the experimental and control groups for TP 2.6 ($t = -5.533$; $p < 0.001$) and TP 2.7 ($t = -5.237$; $p < 0.001$). The N-Gain scores for the experimental group reached 0.7217 (72.17%) for TP 2.6 and 0.7372 (73.72%) for TP 2.7, both falling into the high category. The study's contribution lies in providing empirical evidence that infographics can function not merely as visual aids but as learning representations that help activate prior knowledge, organize historical information, and connect past transformations to the students' own life contexts through source-assisted AI support. These findings expand the scope of historical media research by integrating meaningful learning, infographics, and source-assisted AI in the study of social transformations.

Keywords : Meaningful Learning; Infographic Media; Social Transformation; Artificial Intelligence, Umayyad Caliphate

Abstrak : Penelitian ini bertujuan menguji efektivitas media infografis berbasis pembelajaran bermakna berbantuan NotebookLM dalam meningkatkan pemahaman peserta didik mengenai transformasi sosial pada materi Daulah Umayyah. Penelitian menggunakan pendekatan kuantitatif dengan desain kuasi-eksperimen Nonequivalent Control Group Design. Populasi penelitian berjumlah 146 peserta didik kelas VII, sedangkan sampel terdiri atas 21 peserta didik pada kelompok eksperimen dan 20 peserta didik pada kelompok kontrol yang dipilih secara purposive berdasarkan kesetaraan karakteristik kelas. Data dikumpulkan melalui pretest dan posttest menggunakan instrumen pemahaman yang dikembangkan berdasarkan tujuan pembelajaran TP 2.6 dan TP 2.7. Analisis data meliputi uji Shapiro-Wilk, Levene, independent-samples t-test, dan N-Gain menggunakan IBM SPSS Statistics 26. Hasil menunjukkan perbedaan yang

signifikan antara kelompok eksperimen dan kontrol pada TP 2.6 ($t=-5,533$; $p<0,001$) dan TP 2.7 ($t=-5,237$; $p<0,001$). N-Gain kelompok eksperimen mencapai 0,7217 (72,17%) untuk TP 2.6 dan 0,7372 (73,72%) untuk TP 2.7, keduanya termasuk kategori tinggi. Kontribusi penelitian ini terletak pada bukti empiris bahwa infografis dapat berfungsi bukan hanya sebagai media visual, tetapi sebagai representasi pembelajaran yang membantu mengaktifkan pengetahuan awal, mengorganisasi informasi sejarah, dan menghubungkan transformasi masa lalu dengan konteks kehidupan peserta didik melalui dukungan AI berbasis sumber. Temuan ini memperluas kajian media sejarah dengan mengintegrasikan meaningful learning, infografis, dan source-assisted AI dalam pembelajaran transformasi sosial.

Kata kunci : Pembelajaran Bermakna; Media Infografis; Artificial Intelligence, Transformasi Sosial; Daulah Umayyah

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INTRODUCTION

Islamic Cultural History occupies an important position in Islamic education because it provides students with opportunities to understand how Muslim societies developed, responded to challenges, and produced forms of civilization that influenced subsequent generations. However, learning history becomes less meaningful when students encounter it primarily as a collection of names, dates, rulers, and events that must be memorized. Historical learning should instead encourage students to interpret change, identify values within historical experiences, and relate them to contemporary life (Rahayu et al., 2026). In this perspective, the Umayyad Caliphate offers rich learning material because its development involved transformations in social services, administration, communication, culture, agriculture, finance, governance, and military organization. The curriculum consequently requires students not only to understand the development of Islamic civilization but also to develop a dynamic attitude toward advancing Islamic civilization in present and future contexts. The TP 2.6 learning objective in the research specifically emphasizes students' ability to demonstrate such a dynamic attitude based on the experience of the Umayyad period. The accompanying assessment framework translates this objective into 25 affective indicators covering social, cultural, and political-military transformations.

Despite the richness of the material, historical learning does not automatically lead students toward meaningful interpretation. The initial classroom analysis at MTsN 3 Tanah Datar identified that instruction remained strongly dependent on textbooks, teacher explanations, and relatively simple presentation media. Students experienced difficulty processing lengthy historical narratives and tended to perceive the subject as material that needed to be remembered rather than knowledge that could be connected with their own experiences. The problem is pedagogically significant because social transformation is an abstract concept when it is presented only through historical description. Students may recognize that a particular ruler introduced a policy, but recognition does not necessarily mean that they understand why the change mattered or how its underlying values could be expressed in contemporary life (Damayanti & Abimayu, 2025). The need for learning media that can simplify complex historical information while simultaneously creating opportunities for interpretation, connection, and application (Nuriana & Hotimah, 2023).

The theoretical basis for addressing this problem is meaningful learning, particularly the perspective associated with David Ausubel. Meaningful learning occurs when new information is connected with relevant knowledge already possessed by learners, allowing

new concepts to become part of an organized cognitive structure rather than remaining isolated facts. In historical education, this principle is particularly important because students often encounter information about people and events that are distant from their immediate experiences (Popa, 2023). The challenge is therefore not merely to provide additional information but to create connections between historical knowledge and students' existing cognitive and social worlds. Previous research on meaningful learning in Islamic history learning has shown the relevance of Ausubel's perspective for helping students understand historical material more deeply (Hamida et al., 2022). Similarly, meaningful learning can encourage students to interpret historical events rather than simply reproduce information. Meaningful learning is operationalized through the transformation of historical information into prompts and learning situations that encourage students to connect Umayyad developments with contemporary social realities.

Infographics are particularly suitable for this purpose because they combine concise text, images, symbols, color, typography, and visual relationships to organize complex information (Setiawan, 2026). Cognitive Theory of Multimedia Learning argues that learners process information through verbal and visual channels with limited capacity; complementary words and visuals can therefore support selection, organization, and integration. Recent empirical studies support the use of infographics in history education. (Nasution & Diansyah, 2020) found that infographic media met the criteria for suitability in history education, (Oktiana et al., 2022) reported improved learning mastery through the use of QR-code-based infographics, while (Maslulah et al., 2022) established the effectiveness of infographic-based media on learning outcomes. (Amalia et al., 2024) identified a significant impact of infographic media on history learning achievement, whereas (Zulkifli et al., 2024) reported higher post-test scores in a group using statistical infographics compared to a control group. (Sudibyo et al., 2025) developed infographic-based history instruction to enhance understanding and motivation; (Jasanddes & Ofianto, 2025) utilized infographics to strengthen skills in analyzing historical change and continuity; (Seven et al., 2025) investigated Canva-based infographics; and (Susanto et al., 2025) found that digital infographic media contributed significantly to chronological thinking skills. The integration of artificial intelligence introduces another dimension to the development of learning media. AI refers to computational systems capable of performing tasks that typically require human cognitive abilities, such as processing information, generating content, and supporting decision-making (Holmes & Tuomi, 2022; Sugiono, 2024). In education, AI can function as an assistive technology to support teachers and learners in accessing, organizing, and processing learning resources (Suharyo et al., 2024; Widodo et al., 2024). In this study, NotebookLM is used as an assistive technology in the preparation of source-based infographic content. NotebookLM is described in the thesis as an artificial-intelligence tool designed to organize, analyze, and work with information supplied by the user (Andriyana et al., 2026).

The concept of social transformation constitutes the substantive bridge between the Umayyad historical material and meaningful learning. Transformation in this study is not understood merely as a chronological change in institutions but as a process through which social life, cultural practices, governance, and public services develop in response to particular needs. The Umayyad period provides numerous examples that can be examined from this perspective, including developments in information systems, health services, care for orphans, protection of persons with disabilities, social welfare, leadership, zakat

management, currency, administrative language, irrigation, agriculture, industrial activity, financial administration, judicial institutions, and military organization (Zein, 2022), (Jufri, 2025). The TP 2.6 framework transforms these historical developments into 25 affective indicators. Importantly, the indicators progress beyond factual recognition: students are asked to carry out, support, propose, connect, consider, adapt, and act upon values associated with historical transformation in contemporary situations. This makes social transformation an appropriate outcome for meaningful learning because students are required to move from knowing what happened in the past toward considering what historical values may mean for their present social environment.

The relationship among meaningful learning, infographic representation, NotebookLM, and social transformation can therefore be understood as a connected instructional system. Meaningful learning provides the pedagogical principle: new historical knowledge should be connected with students' prior knowledge and contemporary experience. Infographics provide the representational mechanism: complex historical information is reorganized into a concise and visually structured form. NotebookLM provides technological assistance in organizing source-based content and developing an initial visual learning product. Social transformation provides the substantive learning orientation: students are encouraged to interpret historical changes and consider their relevance to present social life. This integration is consistent with research suggesting that meaningful learning becomes stronger when students are given opportunities to connect historical knowledge with real-life contexts (Asmara, 2019; Tumarjio & Abdu, 2025). It also extends previous infographic research by incorporating an AI-assisted development process and by placing transformation-oriented indicators at the center of the learning outcome rather than focusing exclusively on factual achievement. Thus, the novelty of the present study lies not in the isolated use of any single technology or medium, but in the alignment of a meaningful-learning framework, infographic communication, source-assisted AI, and a transformation-oriented assessment model.

LITERATURE REVIEW

The concept of understanding social transformation is central to the learning outcomes of the Daulah Umayyah material, as it requires students not only to know that change occurred, but also to understand the conditions before the change, the forms and processes of change, the driving factors, and the impacts that resulted. Social transformation can be understood as a process of change occurring across all aspects of societal life including social structures, patterns of social relationships, values, culture, and other social systems (Ahmed, 2023) (Naito et al., 2022). Social transformation during the Umayyad period was reflected in the development of a more structured governance system, the expansion of scientific and educational activities, and cultural interactions due to the expansion of Islamic rule (Martiansyah et al., 2025; Wati & M, 2025). Understanding these changes allows students to realize that the advancement of a civilization does not arise instantly, but through a long and gradual process. Social transformation understanding also requires students to connect changes in the past with developments in modern society, so that history learning does not stop at the cognitive level alone (Raidifi & Emiyati, 2024).

Fostering such understanding requires instructional media that align with the characteristics of the subject matter and the needs of the learners. Instructional media serve as tools for conveying information, clarifying content, and helping learners grasp complex information (Miranda et al., 2022; Nurfadhillah, 2021). One such form is visual media, which presents information through elements that can be directly observed. Infographics are a type

of visual medium suitable for instruction; they combine text, images, icons, symbols, colors, typography, and layout to present information in a concise, systematic, and structured manner (Jaleniauskiene & Kasperuniene, 2023; Traboco et al., 2022). The components of infographics, such as color, typography, layout, images, icons, and graphics, play an important role in creating a logical reading flow and reducing the cognitive load on the reader (Hasyim et al., 2023). The use of infographics is particularly relevant to history education, as historical content encompasses not only facts and events but also chronological sequences, interconnections between concepts, and the relationships among social, political, economic, and cultural developments. Theoretically, the use of infographics can be explained by the Cognitive Theory of Multimedia Learning, which posits that learners process information through separate verbal and visual channels that have limited capacity. Consequently, learning is optimized when complementary verbal and visual information is presented coherently and without information overload (Mayer, 2021). Empirically, (Affandi et al., 2024) demonstrated that the use of Canva-based infographics helps learners organize instructional information and improves academic achievement. These findings indicate that infographics function not merely as an engaging medium for presenting material but also as visual representations that assist learners in selecting, organizing, and connecting information to form a more comprehensive understanding. This aligns with the view that active learner engagement and conceptual understanding are crucial components in establishing a meaningful learning process (Asy'ari et al., 2025).

Although visual representations can help organize historical information, the mere visual presentation of data does not automatically guarantee the development of meaningful understanding. Information presented via infographics must be linked to students' existing knowledge and experiences so that newly learned concepts can be integrated into their established cognitive structures. This principle aligns with the concept of "meaningful learning" rooted in Ausubel's theory which emphasizes that new knowledge becomes meaningful when it can be connected to relevant knowledge the learner already possesses. Thus, meaningful learning differs from rote memorization of isolated facts because it encourages students to build connections between new concepts and prior knowledge (Al-Am et al., n.d.). This principle is crucial for understanding social transformations, as students need to synthesize information regarding figures, policies, institutions, social changes, and their impacts into a coherent conceptual framework. (Nuriana & Hotimah, 2023) demonstrate the relevance of meaningful learning in history education by highlighting the connections between historical content, students' prior knowledge, and everyday life contexts. Research by (Poma Solier, 2025) further indicates that graphic organizers as visual structures can support meaningful learning by reinforcing conceptual connections and information processing, while (Prasetyo & Mulyani, 2025) show that applying meaningful learning principles fosters a learning process that promotes higher-order thinking skills. These findings reinforce the role of meaningful learning as the pedagogical foundation of this study. Consequently, meaningful learning is not treated merely as an additional feature of infographics but as a pedagogical principle guiding students to connect information about the social transformation of the Umayyad Caliphate with their prior knowledge, interrelated concepts, and examples of social change in contemporary life. In this way, the visual structure of infographics and the process of meaningful learning serve complementary functions: infographics help organize

information, while meaningful learning enables students to construct connections and derive meaning from that information.

The advancement of Artificial Intelligence (AI) opens up new opportunities for developing learning materials by assisting educators in managing and processing information from diverse sources. However, the use of AI in education requires a clear pedagogical approach to ensure the technology is utilized in alignment with learning objectives and the needs of learners (Shobichah, 2026). (Shulkhan & Nechad, 2026) demonstrate that integrating technology via the TPACK framework can enhance the learning process when technological knowledge is appropriately combined with pedagogical and content knowledge. In this study, NotebookLM is utilized as a source-grounded AI tool to help organize and synthesize information from selected sources for infographic development (Alisoy, 2025). The resulting output undergoes selection, verification, and alignment with learning objectives, ensuring that AI serves as a supporting technology rather than a substitute for the pedagogical judgment of teachers or researchers. Consequently, the use of NotebookLM becomes an integral part of a media development process that combines technological assistance with principles of meaningful learning and visual representation through infographics. While research on infographics, meaningful learning, and the use of technology in education has expanded, studies specifically integrating these elements with source-grounded AI to foster an understanding of social transformation during the Umayyad Caliphate era remain limited. This study aims to address this gap by developing a meaningful learning-based infographic assisted by NotebookLM to improve students' understanding of social transformation during the Umayyad Caliphate.

METHOD

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group design (Arib et al., 2024). The study involved an experimental group and a control group that had been formed prior to the study. The population consisted of 146 Grade VII students, with a sample of 41 students comprising 21 students in the experimental group and 20 students in the control group. The sample was selected using purposive sampling based on the consideration that both classes were at the same grade level, had relatively comparable academic characteristics, and were appropriate for the objectives of the study. Data were collected through a comprehension test consisting of a pretest and posttest. The pretest was administered to both groups before the treatment to determine students' initial understanding. Subsequently, the experimental group received instruction using infographic media based on meaningful learning assisted by NotebookLM, whereas the control group received instruction without the developed infographic media. After the treatment, both groups completed the posttest to determine changes in students' understanding.

Table 1. Nonequivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Experimental	O ₁	X	O ₂
Control	O ₃	-	O ₄

Note:

O₁ = experimental group pretest;

O₂ = experimental group posttest;

O₃ = control group pretest;

O₄ = control group posttest;

X = instruction using meaningful-learning infographic media assisted by NotebookLM.

The data were analyzed using IBM SPSS Statistics through descriptive and inferential statistical analyses. Descriptive analysis was used to determine the mean, standard deviation, minimum, and maximum scores of the pretest and posttest. Before hypothesis testing, the Shapiro–Wilk normality test and Levene’s test of homogeneity of variance were conducted as prerequisite tests. Subsequently, an independent-samples t-test was used to examine the difference in learning outcomes between the experimental and control groups at a significance level of 0.05 (Magdalena & Angela Krisanti, 2019; Nurwiani & Trisanti, 2024). The research hypotheses were formulated as follows: H_0 : there is no significant difference in students' understanding between the group using meaningful-learning infographic media assisted by NotebookLM and the group that did not use the media; H_1 : there is a significant difference in students' understanding between the two groups. In addition, students' learning gains were analyzed using the N-Gain Score with the following formula (Harianja et al., 2024):

$$N\text{-Gain score} = \frac{\text{Score Posttest} - \text{score pretest}}{\text{Score maksimum} - \text{score pretest}}$$

The N-Gain score was interpreted according to the criteria presented in Table 2.

Table 2. N-Gain Interpretation Criteria

N-Gain value	Interpretation
> 0.70	High
0.30-0.70	Medium
< 0.30	Low

Source: (Retnawati, 2016) in (Mukarromah et al., 2021)

RESULT AND DISCUSSION

Results

The experiment was conducted with two groups of seventh grade students from MTsN 3 Tanah Datar who had relatively equal academic characteristics: the experimental group consisted of 21 students, while the control group consisted of 20 students. The infographic media used in the experimental group had previously been declared highly valid by subject matter experts ($V = 0.828$) and media experts ($V = 0.8529$), and was considered very practical according to responses from teachers (95.00%) and students (90.14%) in earlier trials, making it suitable for use in the effectiveness testing phase. The experimental group received instruction using infographic media based on meaningful learning, while the control group received instruction using conventional media, such as textbooks and simple presentations without infographics. Both groups were taught by the same teacher during the same study period to maintain equality in learning conditions, aside from the media treatment given.

The description of the pretest and posttest results shows different improvement patterns between the two groups. In the experimental group, posttest scores increased more significantly compared to pretest scores after learning with infographic media, whereas the control group showed relatively limited improvement. A comparison of the average posttest scores between the two groups for TP 2.6 indicates that the experimental group scored an average of 11.143 points higher than the control group, with a 95% confidence interval ranging from -15.217 to -7.069. A similar pattern was found in TP 2.7, where the experimental group consistently showed higher posttest results than the control group. This

descriptive data forms the basis for prerequisite analysis testing before statistical hypothesis testing is conducted.

Table 3 Normality of Result in TP 2.6

Tests of Normality				
	Value	Shapiro-Wilk		
		Statistic	Df	Sig.
Result	Pretest A "Control"	.934	20	.181
	Posttest A "Control"	.928	20	.144
	Pretest B "Experimental"	.950	21	.343
	Posttest B "Experimental"	.938	21	.196

Table 4 Normality of Result in TP 2.7

Tests of Normality					
			Shapiro-Wilk		
	Value		Statistic	Df	Sig.
Result	Pretest A "Control"		.923	20	.115
	Posttest A "Control"		.934	20	.186
	Pretest	B	.924	21	.105
	"Experimental"				
	Posttest	B	.923	21	.100
	"Experimental"				

The results of the Shapiro-Wilk normality test for the pretest and posttest data of TP 2.6 and TP 2.7 are presented in Table 3. All data groups showed significance values above 0.05, ranging from 0.100 to 0.343. Referring to the criterion that data are considered normally distributed if the significance value is greater than 0.05, all data groups for both Learning Objectives have met the assumption of normality.

After the normality assumption was fulfilled, the homogeneity of variance was tested using Levene's test, as presented in the following table.

Table 5 Homogeneity of Result in TP 2.6

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	.211	1	39	.648
	Based on Median	.331	1	39	.568
	Based on Median and with adjusted df	.331	1	38.604	.568
	Based on trimmed mean	.222	1	39	.640

Table 6 Homogeneity of Result in TP 2.7

		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	.466	1	39	.499
	Based on Median	.550	1	39	.463
	Based on Median and with adjusted df	.550	1	38.916	.463
	Based on trimmed mean	.523	1	39	.474

All significance values for both Learning Objectives are above 0.05, whether based on the mean, median, median with adjusted degrees of freedom, or trimmed mean. Therefore, the data variance between the experimental and control groups is considered homogeneous. The fulfillment of the normality and homogeneity assumptions provides a methodological basis for hypothesis testing using the independent samples t-test. Hasil pengujian hipotesis menggunakan independent sample t-test disajikan pada Tabel 5 berikut.

Tabel 7. Results Independent Sample T-Test

TP	t	Df	Sig. (2-tailed)	information
2.6	-5,533	39	0,000	Significant (H0 rejected)
2.7	-5,237	39	0,000	Significant (H0 rejected)

For TP 2.6, a t-value of -5.533 was obtained with df = 39 and a significance value (2-tailed) of 0.000. For TP 2.7, a t-value of -5.237 was obtained with df = 39 and a significance value (2-tailed) of 0.000. Since the significance values for both Learning Objectives are less than 0.05, the results indicate that there is a significant difference between the average posttest scores of the experimental group and the control group for both measured indicators. Therefore, H0 is rejected and H1 is accepted.

Table 8 N-Gain Score Analysis Score Asesmen TP 2.6**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	21	.58	1.00	.7217	.13262
NGain_Persen	21	58.33	100.00	72.1724	13.26238
Valid N	21				

Table 9. N-Gain Score Analysis Score Asesmen TP 2.7**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	21	.50	1.00	.7372	.13559
NGain_Persen	21	50.00	100.00	73.7171	13.55918
Valid N	21				

For TP 2.6 (N = 21), the minimum score was 0.58, the maximum score was 1.00, the mean was 0.7217 or 72.17%, and the standard deviation was 0.13262. For TP 2.7 (N = 21), the minimum score was 0.50, the maximum was 1.00, the mean was 0.7372 or 73.72%, and the standard deviation was 0.13559. According to the interpretation criteria for N-Gain Score, a g value greater than 0.70 falls into the high category, so both Learning Objectives are classified as having a high level of improvement in understanding. A summary of the achievement of social transformation understanding indicators is presented in Table 7. For TP 2.6, out of 25 indicators, 21 indicators (84%) were in the high score category (80–100%), 1 indicator (4%) in the medium category, 1 indicator (4%) in the low category, and 2 indicators (8%) in the very low category. The weakest indicators were related to reasoning about judicial governance, military defense, and the secretariat of the attorney general and finance. For TP 2.7, out of 25 indicators, 21 indicators (84.0%) were in the high category and 4 indicators (16.0%) in the medium category, with none in the low or very low categories. The most developed indicators were related to the exemplary conduct of hadith, tafsir, and medical scholars, while indicators needing further strengthening were related to the rational reasoning of fiqh scholars and steadfast adherence to the principle of asceticism (zuhud).

Discussion

These effectiveness results align with predictions from the Cognitive Theory of Multimedia Learning, which explains that presenting information through a combination of complementary text and visuals can facilitate information processing compared to text presentation alone (Mayer, 2021). In the medium used in this experiment, the concise arrangement of text, icons, and visual structures in infographics enabled students to select important information without having to process lengthy textual explanations. This condition enabled students to allocate their cognitive capacity to organize the relationships between concepts of social transformation. The visual structure, arranged based on thematic flows in each developmental area, also helped students integrate various information previously scattered in textbooks into a more complete framework of understanding. Thus, the higher learning outcomes of the experimental group can be explained by cognitive mechanisms such as the process of selecting, organizing, and integrating information facilitated by the infographic design, not solely due to its visual appeal. The use of infographic media is also supported by previous research which shows that visual information presented in a concise and organized manner can help students understand learning materials and improve learning outcomes (Azizah & Susanti, 2023; Maslulah et al., 2022; Sudibyo et al., 2025).

The effectiveness of media can also be explained through the principle of meaningful learning, which emphasizes the importance of connecting new knowledge with students' existing cognitive structures (Ausubel, 1968). In the experimental group, learning was directed so that students connected their prior knowledge of contemporary social life with new information about social transformation during the Umayyad Dynasty through reflective questions inserted into the infographic-based learning process. This learning pattern aligns with the application of meaningful learning in history teaching, which helps students connect past events with the context of their present lives (Nuriana & Hotimah, 2023). Through the stages of prior knowledge, new information, understanding, and reflection, students in the experimental group were not only directed to memorize facts about the development of Islamic civilization but also encouraged to understand their relevance to their own lives. This kind of contextual learning is important in history education because meaningful understanding develops when students have the

opportunity to connect historical knowledge with experiences and situations close to their own lives (Ernawati et al., 2026). Therefore, the effectiveness of the media in this study is not only related to the form of infographics, but also to the learning process that encourages students to construct meaning from the historical information presented.

The effectiveness findings of this study also support previous research on the use of infographics in learning. Previous research has shown that infographic-based learning media can support student learning outcomes, motivation, and understanding through the presentation of more structured and easily accessible information (Masluhah et al., 2022; Seven et al., 2025; Sudibyo et al., 2025). In history learning, infographics can also provide opportunities for students to process and reorganize historical information, rather than simply receiving information from the teacher (Hanna & Santosa, 2024). The use of infographics is increasingly relevant to the material in this study because social transformation during the Umayyad era encompassed various interrelated dimensions, such as social, cultural, political, governmental, and scientific. Organizing these dimensions into a thematic visual structure helps students more easily recognize the relationships between historical information. Furthermore, the use of infographics can meet students' needs for learning materials that present historical information more systematically and visually (Wari & Yefferson, 2024). Research on the development of infographic-based history learning media also indicates that such media can be designed to present historical content in a systematic and accessible form, making it easier for students to engage with the material (Ikhsani, 2023). Unlike previous research, which generally examined the effectiveness of infographics on general cognitive learning outcomes, this study specifically focuses on understanding social transformation and integrates the principles of meaningful learning with the development of AI-assisted infographics in Islamic Cultural History.

The use of NotebookLM also provides support in the development of learning media, particularly in organizing and synthesizing information from various selected learning sources. In this process, NotebookLM is not positioned as a substitute for teachers or researchers, but rather as a technology that assists in the process of compiling learning materials. Source selection, information verification, and content alignment with learning objectives remain under the researcher's control. This position is important because the integration of artificial intelligence in education must remain guided by pedagogical considerations and student learning needs. The use of artificial intelligence in learning media development can help produce more interactive learning materials and support the media development process when integrated with appropriate learning planning (Estuhono & Safitri, 2025). At the same time, the application of AI in education requires attention to digital literacy, infrastructure, data privacy, and ethical aspects so that the use of technology does not replace the educator's pedagogical role (Bastomi et al., 2024). Recent developments in history education also indicate that artificial intelligence provides opportunities for developing more adaptive and innovative learning, while simultaneously requiring educators to understand how AI should be integrated into historical interpretation and analysis (Fatimah & Octaviani, 2023). Therefore, NotebookLM's contribution to this research is more appropriately understood as technological support in the development of meaningful learning media, while pedagogical decisions and validation of learning content remain the researcher's responsibility.

Overall, the effectiveness of the media does not mean that all indicators of understanding social transformation experienced the same improvement in the

experimental group. Based on the analysis of each indicator, students demonstrated a better understanding of social transformation in the social and cultural dimensions through interactions with various community groups, in the political and governmental dimensions through the structuring of the Islamic state administration system, and in the scientific dimension through the exemplary practices of Muslim scholars in the fields of hadith, tafsir, fiqh, Sufism, language, history, geography, and medicine. However, indicators related to reasoning regarding judicial governance, military defense, and the appointment of prosecutorial secretariats and finance in TP 2.6 showed relatively lower achievement. Similarly, in TP 2.7, indicators related to the rational thinking tendencies of fiqh scholars and steadfastness in applying the principle of asceticism still require strengthening. These differences indicate that students more easily understand aspects of social transformation that can be represented through concrete information and clear relationships, while indicators that require abstract reasoning and interpretation of values require deeper cognitive engagement. Therefore, these indicators need to be reinforced through contextual examples, discussions, reflective questions, and learning activities that encourage students to interpret historical information, not simply recognize it. This is in line with the view that social transformation is a complex process that requires in-depth reasoning, so abstract indicators require reinforcement through contextual support in Islamic Cultural History (Zulfikar, 2022)

CONCLUSION

The study demonstrates that NotebookLM assisted meaningful-learning infographic media are effective in improving students' understanding of social transformation in the Umayyad Caliphate material. Posttest differences between the experimental and control groups were significant for both TP 2.6 and TP 2.7, with $t = -5.533$ and $t = -5.237$, respectively, and $\text{Sig.} = 0.000$. Improvement in the experimental group was also high according to N-Gain, reaching 0.7217 (72.17%) for TP 2.6 and 0.7372 (73.72%) for TP 2.7. The principal contribution of the study is empirical evidence that infographics can function not merely as visual media but as representational tools that support meaningful learning by connecting historical knowledge, prior knowledge, and contemporary contexts. NotebookLM served as a source organization and initial content development aid, while human verification remained essential. The study is limited by its relatively small sample, intact-class design, focus on one historical topic, and implementation in a single school context. Future research should involve larger and more diverse samples, multiple schools, additional historical topics, and longitudinal designs to examine the sustainability of learning gains. Future studies may also combine infographics with scaffolding or inquiry-based activities to strengthen indicators requiring abstract reasoning.

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