Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 11, No. 3 : September 2025
E-ISSN: 2442-7667
pp. 1259-1270
Email: jklppm@undikma.ac.id

Development of a Thematic Mapping Learning Module for Social Studies Based on Geographic Information Systems

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Abstract: This study aims to develop a GIS-based thematic mapping learning module at the West Java Provincial Social Service. This study employed a Research and Development (R&D) method with the Dick and Carey model, which consists of 10 stages of processing and five categories, namely very good, good, moderate, less, and poor. The research variables used include usability aspects such as self-contained, stand-alone, adaptive, and user-friendly, as well as effectiveness, efficiency, learning appeal, and module quality elements like module format or framework. The software used in developing the module is the Quantum Geographic Information System (QGIS). The data analysis technique used to determine the feasibility of the module is a quantitative descriptive analysis technique. The data analyzed includes feasibility data with individual trials, small group trials, and field trials. Based on the results, it was found that the thematic mapping module on the social aspect based on GIS is included in the good to very good category, with a percentage value of 76% to 94%. The results of module development are very suitable for learning thematic mapping on the social aspect by utilizing GIS technology. Social data is usually very suitable to be presented in the form of choropleth maps or diagrams. Other thematic maps can be used, but they must be adjusted to the characteristics of the social data to be visualized.

Article History
Received: 14-06-2025
Revised: 16-07-2025
Accepted: 29-08-2025
Published: 25-09-2025

Key Words:
Thematic Mapping; Social Studies; Geographic Information Systems.

How to Cite: Somantri, L., & Ihsan, H. M. (2025). Development of a Thematic Mapping Learning Module for Social Studies Based on Geographic Information Systems. *Jurnal Kependidikan*, *11*(3), 1259-1270. https://doi.org/10.33394/jk.v11i3.12542

https://doi.org/10.33394/jk.v11i3.12542

Introduction

Mapping learning is a process that involves creating and using maps to understand and analyze geographic data. Mapping learning plays an important role in understanding and managing various aspects of the environment and human life (Sejati, 2021). The ability to map geographic data, individuals and organizations can identify and analyze distribution patterns and changes that occur in the environment (Suwito, et al, 2016). Mapping learning also supports responses to social conditions in society, which can be visualized according to the available data (Jumardi, et al, 2021). Mapping learning is able to interpret the results of the analysis to make decisions or develop strategies, such as city or village planning. Mapping can include various types of thematic maps that are created digitally. Mapping learning is a comprehensive process that involves collecting, processing, analyzing, and interpreting geographic data to produce visual representations in the form of maps (Dewi, et al, 2021). Analysis of the resulting map allows users to interpret various geographic phenomena both physically and socially (Lasaiba, 2023). Mapping learning not only enriches individual knowledge but also provides a visualization tool for the sustainability and well-being of society as a whole (Oktavianto, 2017).

Social conditions refer to situations or circumstances related to interactions between individuals in society. This includes various factors such as social structure, norms, values, social roles, and dynamics between groups (Sumartono, 2019). Social conditions reflect how individuals interact, adapt, and influence each other in a given social context (Prayogi, 2024). Social conditions can include education levels, economic disparities, unemployment rates, public health levels, and social justice (Goa, 2017). These factors collectively form a social environment that affects the lives of individuals and groups in society (Nariastini, et al, 2023).

Geographic Information Systems (GIS) for social mapping is a very effective tool in collecting, analyzing, and visualizing data related to social aspects in various regions (Ballas, et al, 2017). Demographic data such as population distribution, education level, income, and public health can be mapped accurately and in detail (Parker, et al, 2009). This allows governments, non-profit organizations, and researchers to identify social needs, allocate resources more efficiently, and design targeted intervention programs. For example, GIS can be used to map areas with high poverty rates, so that social assistance programs can be focused on these areas (Kwan, 2012). GIS for social mapping also allows for in-depth spatial analysis of various social phenomena (Sianko, 2017). For example, the relationship between access to health facilities and public health levels can be analyzed to determine areas that require additional facilities. GIS also allows for the visualization of social changes over time, such as population migration, urbanization, and changes in employment patterns (Steinberg, 2005). With the ability to visualize social data in a geographic context, GIS becomes a powerful tool in public policy planning, social research, and sustainable development initiatives (Kong, et al. 2017). Social mapping using GIS not only enriches the understanding of social dynamics, but also supports data-based decision-making to improve the quality of life of the community (Robiglio, et al, 2003). Training in Geographic Information Systems (GIS) has a very important relevance for social studies anywhere by utilizing appropriate and certain information. GIS greatly enables the mapping of social data into an easily understood visual form (Janelle, et al, 2011). This allows social researchers to analyze and understand the geographic distribution of various social phenomena, such as population density, education level, poverty, and land use patterns (Goodchild, et al, 2010). GIS technology can visualize social data to assist in the formulation of more effective development policies and planning. GIS technology can also identify areas that require social assistance or infrastructure development more accurately (Da Cruz, 1999). GIS can be used to identify disaster-prone areas and evaluate social risks in an area (Teixeira, 2018). This helps in disaster management and emergency response more efficiently.

This gap creates a limited understanding of how GIS-based thematic mapping can effectively visualize and analyze social data such as poverty, education, health, and social inequality, which are crucial for evidence-based decision-making in social policy. Consequently, the specific problem addressed in this study is the lack of practical learning models and modules that integrate GIS technology into social studies, particularly in institutional contexts such as the West Java Provincial Social Service, where thematic mapping is essential to support social development programs and the allocation of resources..

This research introduces a novel contribution by integrating GIS-based thematic mapping into social studies learning, an area that has been overshadowed by applications in physical geography. By developing a practical learning module for the West Java Provincial Social Service, the study advances mapping learning practices while demonstrating the potential of GIS to address complex social issues through spatial visualization. Utilization of Geographic Information Systems for Thematic Mapping Learning Social Studies is important to provide geospatial information and support government development programs. This study aims to implement a GIS-based thematic mapping learning module at the West Java

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Provincial Social Service. In general, GIS is usually used for studies that are of a measurement nature, disasters, planning, which are of a physical geography nature. In GIS thematic learning is directed at social studies to identify how to visualize data in the form of social data.

Research Method

This research was conducted at the West Java Provincial Social Service with a Geographic Information System training scheme for thematic mapping of social studies. This study uses a Research and Development (R&D) method with the Dick and Carey (2015) model in developing learning module products, the model is quite good for use in developing learning modules (Almazyad, et al, 2020). This model has 10 stages, where each stage has a responsive and implementative nature in its implementation (MF Fauziayah, et al. 2023). Participants will work on the module that has been created by the developer, and later there will be a response from the participants for the development of the module. The suitability of the module in the implementation of thematic mapping of social studies is adjusted to the learning outcomes that have been designed in the module. An illustration of the stages can be seen in figure 1.

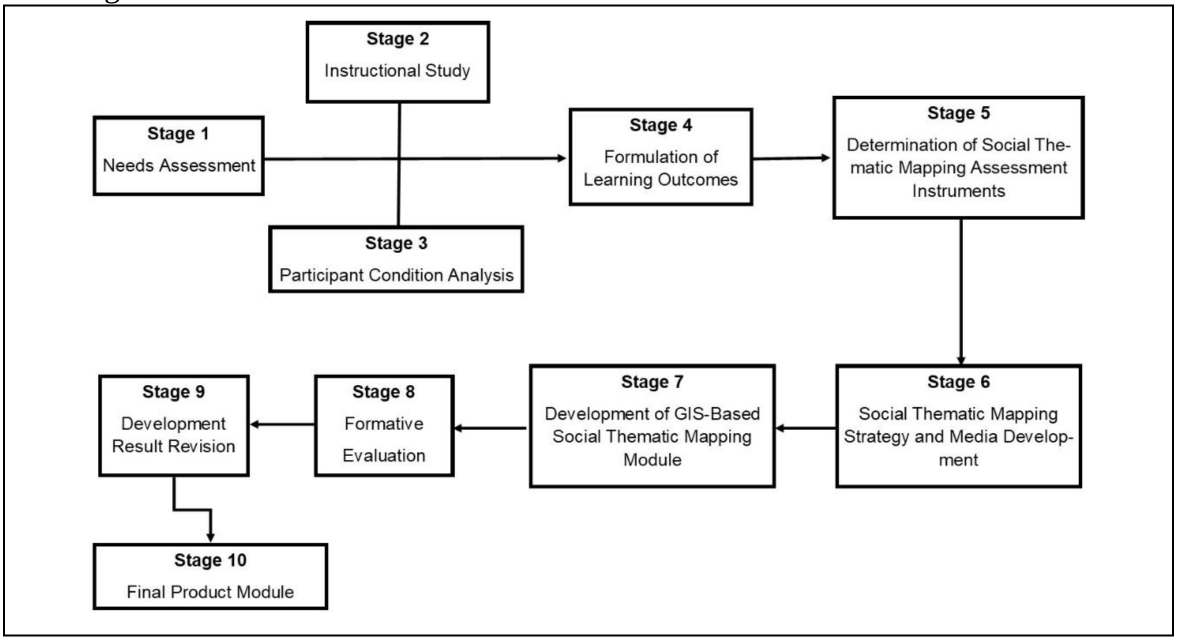

Figure 1. Mind Mapping Research

The module begins with a needs assessment then processed with the work of thematic mapping modules and finally will be reviewed using qualitative descriptive analysis tools. This analysis refers to the presentation of data and verification of conclusions in five classifications, namely very good, good, moderate, lacking and very lacking (Sugiyono, 2010). The classification can be adjusted through table 1. The product will be tested on several experts such as geospatial experts, social experts, geographers, education experts and training participants. All data results will be adjusted to the module so as to produce a module that is good enough for thematic mapping.

Table 1. Category

Average Score Range	Interval score	Category
$\bar{x}>M_i + 1,8\ SB_i$	$X > 81$	Very Good
$M_i + 0,6\ SB_i$	$61 < X \leq 80$	Good
$M_i - 0,6\ SB_i$	$41 < X \leq 60$	Moderate

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M_i - 1,8 SB_i	$21 < X \leq 40$	Less
$\overline{x} \leq M_i$ - 1,8 SB_i	$X \leq 20$	Poor

Description:
X : empirical score
X : ideal mean
sbi : ideal standard deviation

The data analysis technique used to determine the feasibility of the module is a quantitative descriptive analysis technique. The data analyzed includes feasibility data with individual trials, small group trials and field trials. The module consists of several materials, namely software installation, georeferencing, attribute data input, making thematic choropleth maps, making thematic diagram maps and map layout. The data visualized is social data such as population data. The software used is GIS software which is commonly used by map making learning. The variables used in the study for this module assessment are self-contained, stand alone, adaptive, user friendly, effectiveness, efficiency, learning appeal and module quality elements such as module format or framework.

Results and Discussion

Development of thematic mapping modules

The GIS-based thematic mapping module consists of three chapters, namely introduction, theoretical basis and activity stages. The module uses open-source software, namely QGIS (Quantum Geographic Information System). The introduction consists of an introduction to GIS and the interface and benefits of QGIS software in general. QGIS offers a variety of tools for creating, editing, visualizing, and analyzing spatial data. QGIS has the support of a large and active developer community, QGIS continues to grow with various plugins and updates that allow users to customize the application's functionality according to their specific needs. This makes it a popular choice for professionals in the fields of geography, urban planning, and scientific research.

In the context of social mapping, QGIS provides a very useful tool for collecting, analyzing, and visualizing social data. QGIS is used to map demographic distribution, education levels, economic status, and various other social indicators in an area. With powerful spatial analysis features, users can identify patterns and trends that may not be visible in non-spatial data. In addition, integration with various external data sources such as OpenStreetMap and government census data allows users to enrich their analysis with relevant information.

QGIS supports community collaboration and participation in social mapping processes. Tools such as map-based data collection and field surveys enable local communities to directly contribute to data collection. This not only improves the accuracy and relevance of the data, but also empowers communities by giving them the tools to understand and manage their own social environment. QGIS thus plays a vital role in sustainable development projects and inclusive social planning.

The module also develops a georeferencing method which links map images or aerial photographs to actual geographic coordinates on the Earth's surface. This involves adjusting and transforming images to fit a known coordinate system, allowing the map to be used in spatial analysis together with other geographic data. This process is usually done by setting control points on the image that have known geographic coordinates, then using these points to transform and adjust the image to fit the reference map or a particular coordinate system.

The georeferencing process is very important in GIS (Geographic Information Systems) because it allows the integration of data from various sources. The use of georeferencing, spatial data that was previously separate can be combined and analyzed comprehensively, providing deeper and more accurate insights into geographic conditions and changes that occur. Georeferencing is an important part of using GIS software, because the difference between maps and plans lies in the existence of spatial references that are transformed in the form of longitude and latitude. Georeferencing consists of inputting map data or images that are rectified so that they have coordinate values.

Other developments in the module provide related to map digitization and hoin attribute tables with social data. Social map digitization is the process of converting map information from a physical or analog format into a digital format using GIS software. This process involves marking or redrawing social features such as administrative boundaries, public facility locations, road networks, and other demographic data on a digital map. In digitization, a physical map is scanned or photographed, and then the user uses digitizing tools in GIS software to trace or redraw these features. The digitized results can then be stored as vector data, allowing users to analyze and visualize social information more dynamically and interactively.

The process of digitizing social maps is essential for more accurate and detailed spatial analysis in social studies and planning. For example, digitized social data can be used to create thematic maps that show population distribution, poverty levels, or access to health services. With digital maps, researchers and planners can conduct more in-depth analysis, such as identifying areas in need of policy intervention or planning for new infrastructure development. In addition, digitizing social maps also allows for the integration of data from multiple sources and time periods, providing a more comprehensive and historical picture of social and demographic change in an area.

Inputting attribute data into a GIS with social data involves adding descriptive information related to the geographic features on the map. This attribute data is usually stored in a table format that links each spatial feature to additional relevant information. For example, for a map showing the location of schools in an area, the attribute data might include the name of the school, the number of students, the level of education, the facilities available, and other socio-economic indicators. This process allows users to more effectively manage and analyze social information in a geographic context.

The process of inputting attribute data begins with identifying relevant sources of social data, such as censuses, field surveys, or government administrative data. This data is then integrated into a GIS by linking it to spatial features through unique identifiers, such as IDs or geographic coordinates. With structured and linked attribute data, users can perform a variety of analyses, such as identifying relationships between geographic locations and specific social indicators, mapping the distribution of social services, or evaluating the impact of policies on communities. In addition, visualizing attribute data in maps allows researchers and policymakers to see patterns and trends more clearly, so they can make more informed and data-driven decisions. The visualization modules used are diagram maps and choropleth maps. In social maps that use diagram techniques, diagram elements such as circles, bars, or other icons are used to represent data at specific geographic locations. The first step in layouting this map is to ensure that the diagram symbols are clearly placed in the right places on the map. The size and shape of the diagram must be carefully selected so that it is not too large or too small, avoiding overlapping that can interfere with the reading of the map. For example, if the map shows the population of different cities, circles of different sizes can be used, with additional colors or patterns to indicate other data categories, such as age or income.

In a choropleth social map, color or color gradients are used to indicate the intensity or value of data within a given geographic boundary. The layout process begins with choosing an intuitive and easily distinguishable color scheme, such as a light to dark color scale to indicate low to high values. It is important to ensure that the map is not too crowded with color, making it easy for users to understand the distribution patterns of social data. The map title should be clear and describe the data represented, while the legend should indicate the range of values that correspond to the color gradient used. The location of the legend should be easily accessible but not distracting from other map elements. The map scale and north arrow help users understand distance and orientation. Metadata, including data source and data collection date, should be included to provide context and credibility to the data presented. With good layout, a choropleth map can provide a powerful visualization of the spatial distribution of social data, aiding in analysis and decision-making.

The findings of this research are strengthened by the fact that the integration of QGIS-based thematic mapping into social studies learning aligns with recent scholarship highlighting the value of open-source GIS platforms for education, participatory mapping, and sustainable development planning. Scholars such as Graser and Olaya (2015) emphasize that QGIS's extensibility and active community support make it highly adaptable for diverse applications, including social mapping. Similarly, Goodchild and Li (2012) argue that the inclusion of volunteered geographic information and collaborative mapping practices enhances both the accuracy and relevance of social datasets, which supports the module's focus on community participation.

Furthermore, the digitization and georeferencing methods developed in this module resonate with Longley et al. (2021), who underline their importance in integrating heterogeneous data sources for comprehensive spatial analysis. The use of choropleth and diagrammatic mapping is also consistent with Slocum et al. (2009), who note that these visualization techniques are crucial in making complex social indicators accessible and interpretable for policymakers. Thus, by embedding georeferencing, digitization, attribute integration, and advanced visualization techniques within a GIS-based learning framework, this study not only contributes to mapping pedagogy but also provides a practical model for applying spatial analysis in social development contexts.

The feasibility assessment of the GIS-based thematic mapping module, which scored between 76% and 94% across variables such as self-contained, stand-alone, adaptive, user-friendly, effectiveness, efficiency, learning attraction, and module quality, demonstrates that the module is highly functional and pedagogically sound. These results are consistent with previous studies emphasizing that effective learning modules must be self-contained and capable of independent operation to ensure accessibility and user autonomy (Sadiman et al., 2011). The module's high adaptability (94%) aligns with research showing that flexible GIS-based tools are essential for accommodating diverse data sources and user needs in social and educational contexts (Goodchild & Li, 2012).

The strong user-friendly score (83%) resonates with findings by Nielsen (2012), who highlights usability as a key factor in reducing learning barriers and improving technology adoption. Similarly, the high effectiveness (86%) and efficiency (84%) scores reinforce the importance of GIS-based tools in producing accurate results while optimizing time and resources, as supported by Longley et al. (2021). Meanwhile, the attraction of learning variable (76%) reflects the growing recognition that interactive and visually engaging learning environments foster user motivation and engagement, a factor noted by Mayer (2009) in multimedia learning theory. Lastly, the outstanding rating for module quality elements (94%) indicates that the framework aligns with established standards of

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instructional design, as suggested by Dick, Carey, and Carey (2015). Taken together, these findings affirm that the module is not only feasible but also represents a valuable contribution to GIS-based social mapping education by integrating technical robustness with strong pedagogical principles.

Feasibility of thematic mapping module

The module's feasibility is assessed using several variables, namely Self-Contained, Stand Alone, Adaptive, User Friendly, Effectiveness, Efficiency, Learning Attraction, Module Quality Elements Such as Module Format or Framework. The survey results show that the module is included in the good to very good category. This study is assessed based on a percentage range of 76% to 94%. The percentage description can be seen in graph 2 and table 2.

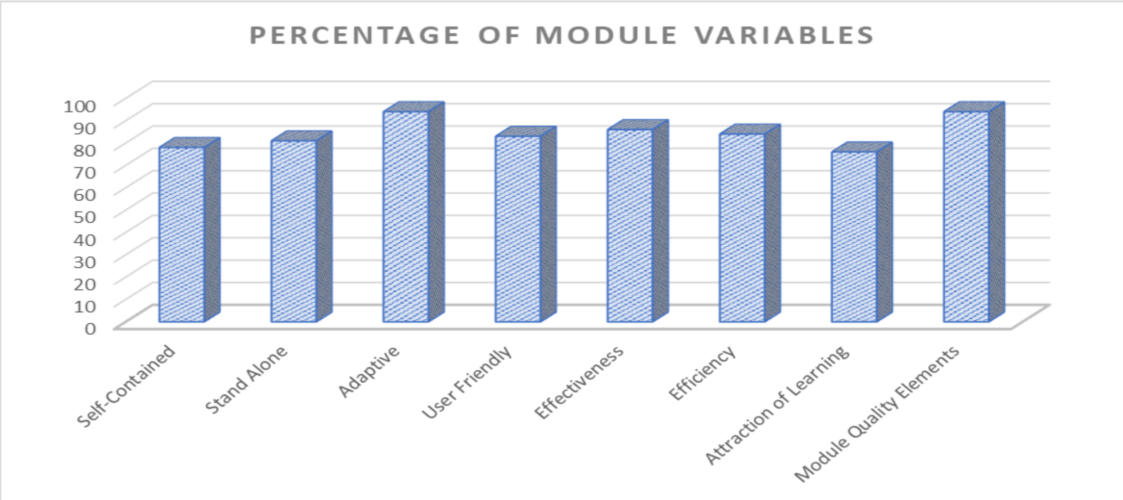

Figure 2. Percentage of Module Variables

Table 2. Percentage Module

Variables	Percentage	Category
Self-Contained	78%	Good
Stand Alone	81%	Very Good
Adaptive	94%	Very Good
User Friendly	83%	Very Good
Effectiveness	86%	Very Good
Efficiency	84%	Very Good
Attraction of Learning	76%	Good
Module Quality Elements	94%	Very Good

Self-contained in social mapping modules refers to the design of a module that is self-contained and complete, containing all the components needed to perform social mapping without the need for external add-ons. This module includes data collection, analysis, visualization, and reporting tools in one organized package. The advantage of a self-contained module is its ability to operate independently, which minimizes the need for integration with additional software or resources. This makes it easier for users to complete social mapping tasks with high efficiency and accuracy. The self-contained section has a good category with a value of 78%.

Stand-alone in social mapping modules refers to systems or software that can function independently without requiring connection or integration with other systems. Stand-alone modules are designed to contain all the features and tools needed to perform complete social

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mapping tasks. This includes the ability to collect, store, analyze, and visualize data independently. The main advantage of stand-alone modules is their ability to be used in environments with limited internet access or network resources, because all functions are available in one package that does not depend on external services. Stand Alone has a very good value of 81%.

Adaptiveness in social mapping modules refers to the module's ability to adapt to different conditions, needs, and scenarios. Adaptive modules are designed to be flexible in dealing with different types of data, formats, and analysis methods. This means that the module can be configured or changed according to the specific needs of the project or user, allowing for customization in terms of the data processed, the type of visualization used, or the processing methods applied. For example, the adaptive social mapping module can accommodate various data sources, from field surveys to census data, and provides various options for visualizing the results such as choropleth maps, diagrams, or graphs. The adaptive section has a percentage value of 94%, which is very good. User-friendly in social mapping modules refers to the design and interface that makes it easy for users to operate and utilize the module easily and efficiently. User-friendly modules usually have an intuitive interface, with clear navigation and easy-to-access tools. Features such as well-structured menus, easily recognizable icons, and informative user guides contribute to ease of use. This design helps reduce the learning curve for new users and allows them to focus on analyzing social data without having to struggle with the technical aspects of the software. The user-friendly section has a percentage value of 83%, which is very good.

Effectiveness in the social mapping module refers to the extent to which the module achieves the desired goals and outcomes in the process of mapping and analyzing social data. An effective module must be able to collect, manage, analyze, and visualize social data in an accurate and efficient manner, providing relevant and in-depth insights according to user needs. For example, if a module is designed to identify population distribution patterns or policy impact analysis, its effectiveness is measured by how well the module can provide accurate and useful results in that context. The effectiveness section has a value of 86% with a very good category.

Efficiency in the social mapping module refers to the extent to which the module can complete social data mapping and analysis tasks quickly and without wasting resources. An efficient module is designed to process data quickly, reduce the time required for analysis and map creation, and minimize the use of resources such as memory and CPU. For example, the features in the module must be able to process large and complex data without experiencing delays or interruptions, and produce relevant output with a fast response time. The efficiency section has a value of 84% or very good.

Attraction of Learning in the social mapping module refers to the attraction and motivation that the module provides to users in the process of learning and exploring social data. Modules that have elements of attraction of learning are designed to make the learning experience interesting, interactive, and fun. This includes features such as attractive visual interfaces, gamification, and interactive elements that encourage user engagement. For example, modules that include dynamic data visualizations, interactive maps, and intuitive analysis tools can make the learning process more interesting and motivate users to explore social data further. The attraction of learning section has a percentage value of 76% with a good category. Module Quality Elements in the social mapping module provides information related to the format or framework of the module. Module Quality Elements in the social mapping module include key aspects that determine how well the module meets performance,

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accuracy, and ease of use standards. This aspect provides information related to all variables that are formal and non-formal. In this section, the percentage reaches 94% or very good.

The feasibility assessment of the GIS-based thematic mapping module, which scored between 76% and 94% across variables such as self-contained, stand-alone, adaptive, user-friendly, effectiveness, efficiency, learning attraction, and module quality, demonstrates that the module is highly functional and pedagogically sound. These results are consistent with previous studies emphasizing that effective learning modules must be self-contained and capable of independent operation to ensure accessibility and user autonomy (Sadiman et al., 2011). The module's high adaptability (94%) aligns with research showing that flexible GIS-based tools are essential for accommodating diverse data sources and user needs in social and educational contexts (Goodchild & Li, 2012).

The strong user-friendly score (83%) resonates with findings by Nielsen (2012), who highlights usability as a key factor in reducing learning barriers and improving technology adoption. Similarly, the high effectiveness (86%) and efficiency (84%) scores reinforce the importance of GIS-based tools in producing accurate results while optimizing time and resources, as supported by Longley et al. (2021). Meanwhile, the attraction of learning variable (76%) reflects the growing recognition that interactive and visually engaging learning environments foster user motivation and engagement, a factor noted by Mayer (2009) in multimedia learning theory. Lastly, the outstanding rating for module quality elements (94%) indicates that the framework aligns with established standards of instructional design, as suggested by Dick, Carey, and Carey (2015). Taken together, these findings affirm that the module is not only feasible but also represents a valuable contribution to GIS-based social mapping education by integrating technical robustness with strong pedagogical principles.

Social mapping products

A diagram map (also known as a cartogram map) uses symbols or diagrams to represent social data at a specific geographic location. These symbols can be circles, squares, or other shapes that vary in size according to the data values they represent. For example, on a diagram map showing population numbers in different cities, circles of different sizes are placed for each city, with larger circles indicating larger populations. Diagram maps are particularly useful for directly and visually comparing social data across locations, helping users quickly identify patterns and anomalies (Figure 3).

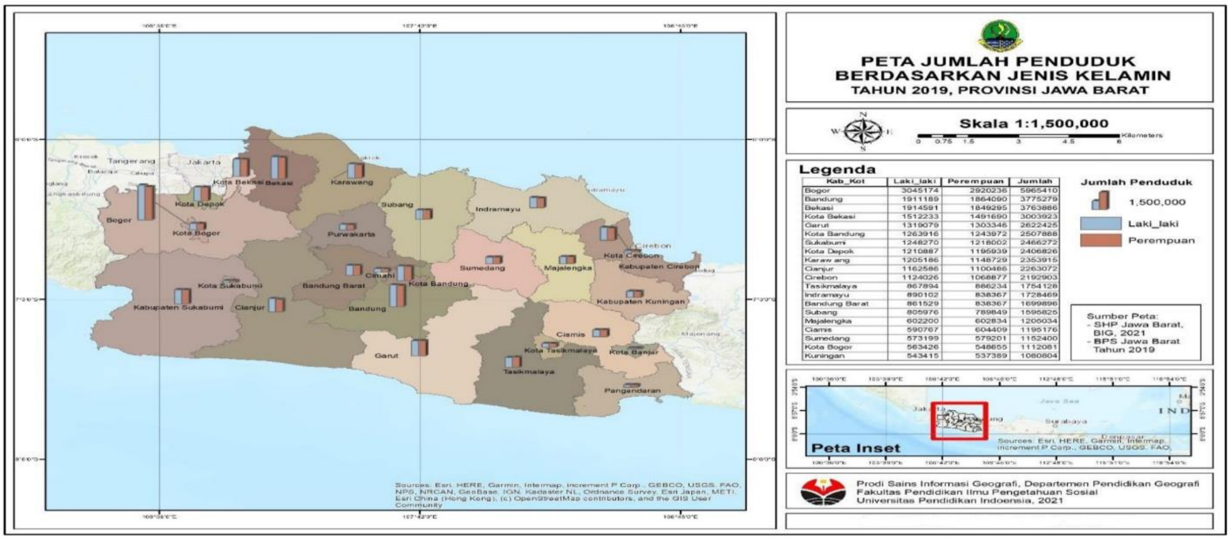

Figure 3. One of the products of the social mapping module

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Choropleth maps display social data using color gradients or patterns within different geographical boundaries, such as countries, states, or districts. Each region is colored according to the data value it contains, with darker or lighter colors indicating different levels or intensities. For example, a choropleth map showing poverty levels in a country might use darker colors for areas with higher poverty levels and lighter colors for areas with lower poverty levels. Choropleth maps are particularly effective for displaying aggregated data at the regional level, helping to understand the spatial distribution of social phenomena and identify regional trends (Figure 3). Both types of maps provide a clear and intuitive way to present social data, enabling visual analysis that helps policymakers, researchers, and the public understand social conditions and make better decisions.

The use of diagram maps and choropleth maps in the social mapping module significantly enhances the effectiveness of visualizing and interpreting social data, as both methods provide intuitive and comparative insights into spatial distributions. Diagram maps, by varying symbol size to represent data values, enable users to directly compare the magnitude of social indicators across locations, a technique supported by Slocum et al. (2009), who highlight proportional symbol mapping as one of the most effective tools for detecting spatial variation. Similarly, choropleth maps employ graduated colors to represent aggregated data, making them particularly useful for identifying regional trends and disparities; this aligns with Dent, Torguson, and Hodler (2009), who emphasize that choropleth techniques are fundamental in thematic cartography for communicating statistical data spatially. Moreover, Brewer (2016) stresses the importance of well-designed color schemes in choropleth maps to avoid misinterpretation, supporting the module's emphasis on careful layout and design principles. Together, the integration of diagram and choropleth mapping within the GIS-based learning module not only strengthens students' ability to interpret complex social phenomena but also supports policymakers and researchers in making data-driven decisions based on clear spatial evidence.

Conclusion

The thematic mapping module on social aspects based on GIS is included in the good to very good category. This condition is described by a percentage value of 76% to 94%. The variables in this study have quite good percentage values, namely Self-contained 78%, Stand Alone 81%, adaptive 94%, user-friendly 83%, effectiveness 86%, efficiency 84%, attraction of learning 76%, and module quality elements 94%. The development of the thematic mapping module involves several mapping components, namely QGIS software installation, georeferencing, data rectification, input of social data attributes, social data analysis, making diagram maps, making choropleth maps and map lay outing. The results of the module development are very suitable for learning thematic mapping on social aspects by utilizing GIS technology. Social data is usually very suitable to be presented in the form of choropleth maps or diagrams. Other thematic maps can be used, but they must be adjusted to the characteristics of the social data to be visualized

Recommendation

The follow-up recommendations from this study highlight the need for teachers to integrate the GIS-based thematic mapping module into classroom practices by designing project-based learning activities that encourage students to apply geospatial analysis in exploring social issues, thereby enhancing critical thinking and problem-solving skills. Teachers are also advised to continuously adapt the module to local contexts and update datasets to ensure relevance and accuracy in addressing current social dynamics. For future researchers, it is recommended to conduct longitudinal studies to evaluate the long-term impact of the module on students' spatial literacy and decision-making abilities, as well as to expand research by incorporating advanced GIS tools, mobile data collection, and participatory mapping approaches. Further exploration could also focus on comparing the effectiveness of GIS-based learning modules across different educational levels and disciplines, thereby strengthening the body of knowledge on geospatial education in social studies.

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Vol. 11, No. 3 : September 2025
E-ISSN: 2442-7667
pp. 1259-1270
Email: jklppm@undikma.ac.id

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