INNOVATION IN OPEN-DISTANCE LEARNING: GEOSPATIAL TECHNOLOGY OF QUANTUM GIS (QGIS)

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Abstract

This article aims to explore the use of Geographic Information System-based applications namely Quantum GIS (QGIS), an open-source geospatial technology, in supporting new research and innovation in Open and Distance learning / ODL. ODL faces challenges in the accurate and efficient distribution and analysis of geospatial data. Geospatial technologies such as QGIS offer solutions that can optimize the process of data collection, analysis, and visualization for educational purposes, especially in diverse geographical and demographic contexts. This study uses the literature review method to review various studies that have used QGIS in geospatial data analysis. The main focus is on QGIS's ability to analyze vector, raster, and attribute data to support decision-making in distance education. The results of the literature review show that QGIS allows for a clearer and more structured visualization of the geographical distribution and accessibility of education. QGIS is capable of performing vector data analysis through conversion, data management, 3D analysis, and network analysis with the help of plugins such as QuickOSM, qgis2threejs, and MMQGIS. QGIS supports remote sensing analysis, data management, and interpolation using plugins such as Dzetsaka and Free-hand Raster Geo-referencer. Meanwhile, attribute data analysis is facilitated by table conversion and editing with plugins such as Profile Tool and Travel Time. Plugins such as qgis2web and Quickmapservices also play an important role in interactive data visualization and access to base maps. Using QGIS as an open-source geospatial technology in open-distance education research provides significant benefits in terms of efficiency, accuracy, and ease of data analysis. The implementation of QGIS is expected to improve the quality and equality of education in various regions by utilizing geospatial data effectively.

Keywords: QGIS, geospatial technology, open-source, plugin, open and distace learning (ODL)

1 INTRODUCTION

Open and Distance Learning (ODL) has great potential to improve access to education for people in various geographical locations (Fozdar, 2015). Under ideal conditions, ODL can provide equal learning opportunities for all regardless of geographical and socio-economic boundaries (Devkota, 2021). The technology that supports the teaching and learning process in ODL must be able to overcome geographical challenges, ensuring that all students have equal access to educational resources (de Klerk & Palmer, 2022).

Real conditions show that ODL often faces challenges in the accurate and efficient distribution and analysis of geospatial data (Ball et al., 2017; Krawczyk, 2016). Many educational institutions have not fully utilized geospatial technology to manage and analyze data related to student location, resource distribution, and educational accessibility (Fargher, 2018). This leads to gaps in the quality of education received by students in different regions, especially in remote or underdeveloped areas.

Geospatial technologies such as Quantum GIS (QGIS) offer solutions that can optimize the process of data collection, analysis, and visualization for educational purposes (Imran et al., 2020). QGIS, as an open-source software, provides flexibility and robust geospatial analysis capabilities without high licensing fees (Duarte & Teodoro, 2021). By using QGIS, geospatial data can be analyzed more effectively, supporting better decision-making in ODL management, and ensuring a more equitable distribution of educational resources (Petras et al., 2015).

The urgency to adopt geospatial technology in ODL is increasing along with the development of technology and the need to provide quality and equal education for all students. The implementation of technologies such as QGIS not only improves operational efficiency but also helps in identifying and addressing gaps in educational accessibility (Meena et al., 2023). Therefore, research on the use of QGIS in ODL is essential to provide guidance for educational institutions in adopting this technology effectively.

QGIS has been recognized as one of the most popular and widely used open-source geospatial software in various fields, including education, environment, urban planning, and disaster management. QGIS has the ability to handle different types of geospatial data, both vector and raster, and comes with a variety of plugins that extend its functionality (Graser & Olaya, 2015). Plugins such as QuickOSM, Qgis2threejs, Qgis2web, MMQGIS, Profile Tool, Dzetsaka, Quickmapservices, and freehand raster georeferencer provide ease in data analysis and in-depth visualization. However, the use of QGIS in the context of ODL is still not widely explored in depth, so this study aims to bridge the gap and explore the full potential of QGIS in supporting distance education.

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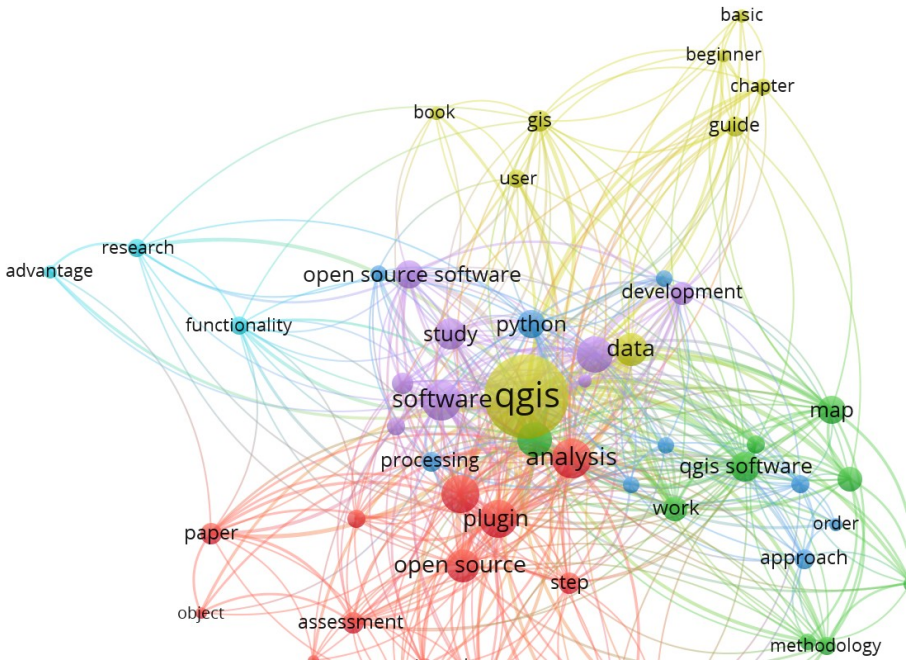

Figure 1. Network Visualization of QGIS on ODL with Vos Viewer

Based on the representation from Figure 1. This article aims to explore the use of Quantum GIS (QGIS), especially the use of the QGIS plugin, an open-source geospatial technology, in supporting new research and innovation in Open-Distance Learning (ODL). This study uses the literature review method to review various studies that have used the QGIS plugin in geospatial data analysis. The main focus is on QGIS's ability to analyze vector, raster, and attribute data to support decision-making in distance education.

2 METHODOLOGY

2.1 Method

This study uses the literature review method to examine various studies that have used Quantum GIS (QGIS), especially in the 3.28.10 series in the analysis of geospatial data shown in Figure 2. The data used in this study include scientific publications, research reports, and relevant technical documents (Rosas-Chavoya et al., 2022). The selected literature is evaluated based on its relevance to the research topic, the quality of the methodology, and the findings produced.

Figure 2. Initial View of QGIS 3.28.10 (Firence)

5. Data Analysis

Data analysis was carried out by categorizing the findings from the reviewed literature into three main groups: vector data analysis, raster data analysis, and attribute data analysis. Each group was further analyzed to evaluate QGIS's capabilities in data conversion, data management, visualization, as well as the use of relevant plugins such as QuickOSM, qgist2threejs, qgis2web, MMQGIS, Profile Tool, Dzetsaka, Quickmapservices, and freehand raster georeferencer. This can be seen in Figure 3.

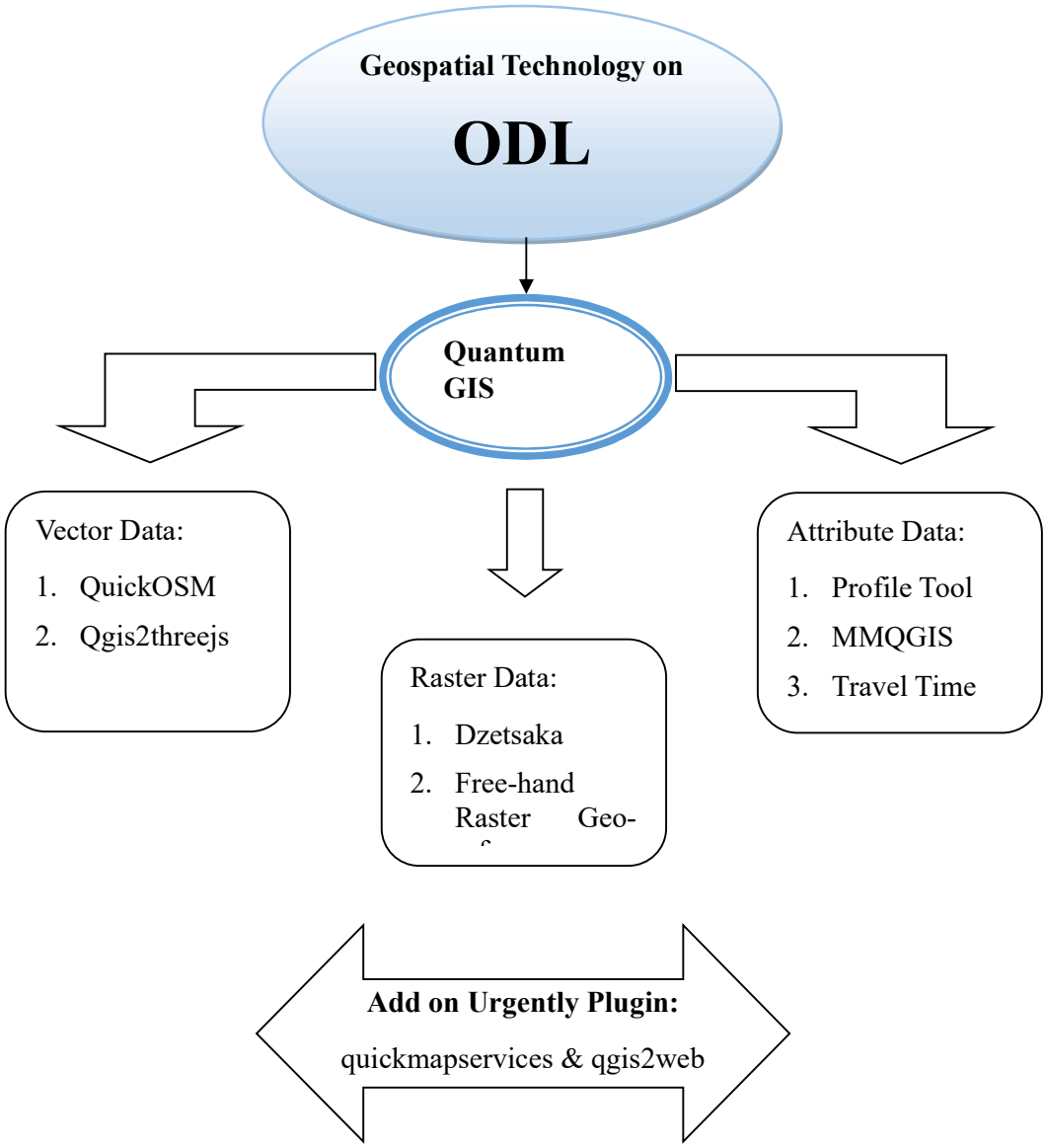

Figure 3. Framework of QGIS Plugin for Analysis with Geospatial Data on ODL.

3 FINDINGS AND DISCUSSION

3.1 Vector Data Analysis

In Table 1, the first findings show that QGIS is very effective in vector data analysis. With the help of plugins such as QuickOSM and qgis2threejs, QGIS is capable of performing data conversion, data management, 3D analysis, and network analysis. This allows for more detailed visualization and aids in better planning and decision-making in the context of ODL.

Table 1. List of Review Literature on the Use of Plugins for Vector Data Analysis based on journal articles.

Plugin	Author	Title
A. QuickOSM	Anna Charly, Nikita Jayan Thomas, Aoife Foley, and Brian Caulfield	Identifying optimal locations for community electric vehicle charging
	Firman Afrianto	Fractal Dimensions Analysis of Urban Agglomeration at Road Intersections in Metropolitan Malang Raya
	Martina Fazio, Nadia Giuffrida, Michela Le Pira, Giuseppe Inturri, and Matteo Ignaccolo	Planning Suitable Transport Networks for E-Scooters to Foster Micromobility Spreading
B. qgis2threejs	Sushil Chandra, Udai Raj, Rajeev Sonkar, Ujjwal Yadav, Pragati Srivastava, Sanghmitra, and Atma Prakash Maurya	Visualization Raster Based 3D Digital Elevation Model on WEB using QGIS
	E. G. V. de Jesus, A. L. de Amorim, N. J. Groetelaars, and V. O. Fernandes	Modeling Cities For 3D GIS Purposes
	Maulana Malik Nashrulloh, Nia Kurniawan, and Brian Rahardi	PHYLOGEOrec: A QGIS Plugin for Spatial Phylogeographic Reconstruction from Phylogenetic Tree and Geographical Information Data

3.2 Raster Data Analysis

Through Table 2, the second finding shows that QGIS is also very useful in raster data analysis. Plugins like Dzetsaka and Free-hand Raster Geo-referencer facilitate remote sensing analysis, data management, and interpolation. This capability is critical to identifying areas that need more attention in the distribution of educational resources and accessibility.

Table 2. List of Review Literature on the Use of Plugins for Raster Data Analysis based on journal articles.

Plugin	Author	Title
A. Dzetsaka	Oto Barbosa de Andrade, Abelardo Antônio de Assunção Montenegro, Moisés Alves da Silva Neto, Lizandra de Barros de Sousa, Thayná Alice Brito Almeida, João Luis Mendes Pedroso de Lima, Ailton Alves de Carvalho, Marcos Vinícius da Silva, Victor Wanderley Costa de Medeiros, Rodrigo Gabriel Ferreira Soares, Thieres George Freire da Silva, and Bárbara Pinto Vilar	UAV-Based Classification of Intercropped Forage Cactus: A Comparison of RGB and Multispectral Sample Spaces Using Machine Learning in an Irrigated Area
	Abdalrahman Ahmed, Brian Rotich, and Kornel Czimber	Assessment of the environmental impacts of conflict-driven Internally Displaced Persons: A sentinel-2 satellite based analysis of land use/ cover changes in the Kas locality, Darfur, Sudan
	Iram M. Iqbal, Heiko Balzter, Firdaus-e-Bareen, and Asad Shabbir	Mapping Lantana camara and Leucaena leucocephala in Protected Areas of Pakistan: A Geo-Spatial Approach
B. Free-hand Raster Geo-referencer	Raffaele Persico and Giuseppe Muci	Ground penetrating radar investigation and

		georeferencing without global satellite navigation systems: The case history of the amphitheatre of Lecce, Italy
	Domizia D'Erasmo	Georeferencing Napoleonic Cartography to reconstruct Ancient Egypt landscapes: methods in comparison and the case of the island of iw-rd in the 16th nomos of Upper Egypt
	Lucas Silva Costa, Edson Eyji Sano, Manuel Eduardo Ferreira, Cássia Beatriz Rodrigues Munhoz, João Vítor Silva Costa, Leomar Rufino Alves Júnior, Thiago Roure Bandeira de Mello, and Mercedes Maria da Cunha Bustamante	Woody Plant Encroachment in a Seasonal Tropical Savanna: Lessons about Classifiers and Accuracy from UAV Images

3.3 Attribute Data Analysis

In Table 3, the third finding shows that QGIS has a strong ability in attribute data analysis. With plugins like Profile Tool, MMQGIS, and Travel Time, QGIS makes it easy to convert and edit attribute tables. Plugins such as qgis2web and Quickmapservices also play an important role in the interactive visualization of data and access to base maps, which helps in the effective dissemination of information.

Table 3. List of Literature Review of the Use of Plugins for Attribute and Other Supporting Data Analysis based on journal articles.

Plugin	Author	Title
A. Profile Tool	Pierre Guillemot, St´ephane Jaillet, M. Gema Chacon´, V´eronique Pois, and MarieH´el`ene Moncel	Spatial patterning of Middle Palaeolithic lithic assemblages at the Abri du Maras, Southeast France: Combining GIS analysis and

		3D palaeotopographic reconstructions
	M. Di Stefano, G. Gonzalez Mirelis, and L. Mayer	Groundtruther: A QGIS plug-in for seafloor characterization
	Priyanka Singh, Debaroti Sammanit, and S K Singh	An Intelligent Approach to Elevation Profiling for LADAKH using QGIS techniques
B. MMQGIS	Shuping Kuan, Nyuk Ling Chin, Tuan Poy Tee, Noor Zafira binti Noor Hasnan, and Mahamad Sukor bin Senapi	QGIS Application for Spatial and Temporal Visualisation of Data for Food Safety Audits in Malaysia
	Khaoula Ajbal, Samy Housbane, and Bennani Othmani Mohammed	Administrative Division Data of Grand Casablanca: Creation of a District Repository Using QGIS
	Anita Graser and Victor Olaya	Processing: A Python Framework for the Seamless Integration of Geoprocessing Tools in QGIS
C. Travel Time	A. Hidayata, S. Terabea, and H. Yaginuma	Time Travel Estimations Using Mac Addresses Of Bus, Passengers: A Point To Path-QGIS Analysis
	Gianmarco Naro, Carlo Andrea Biraghi, and Emilia Lenzi	City Transport Analyzer: A Powerful QGIS Plugin For Public Transport Accessibility And Intermodality Analysis
	Tamim M Alnasser	Travel Time Reliability Estimation using GPS and GIS Integration
D. Qgis2web	N A Azmi, H Z M Shafri, F A Z Abidin, N S N Shaharum, and M M A AlHabshi	Development of WebGIS using open source geospatial technologies for Krau Wildlife Reserve

	Lia Duarte, and Ana Cláudia Teodoro	GIS Open-Source Plugins Development: A 10-Year Bibliometric Analysis on Scientific Literature
	H. Ostadabbas, H. Weippert, and F.-J. Behr	Database Transformation, Cadastre Automatic Data Processing In QGIS And Implementation In Web GIS
E. Quickmapservices	Joel Martin Geda, László Zentai, and Andrea Pődör	Open Data and machine learning in the service of complementing municipal GIS inventory
	Rasa Zalakeviciute, KatiuskaAlexandrino, Yves Rybarczyk, Alexis Debut, KarlaVizuete, and Maria Diaz	Seasonal variations in PM_{10} inorganic composition in theAndean city
	David García-Álvarez, María Teresa Camacho Olmedo, Martin Paegelow, and Jean François Mas	Land Use Cover Datasets and Validation Tools: Validation Practices with QGIS (Book)

4 CONCLUSION

The use of QGIS as an open-source geospatial technology in Open-Distance education research provides significant benefits in terms of efficiency, accuracy, and ease of data analysis. QGIS allows for a clearer and more structured visualization of the geographical distribution and accessibility of education. The implementation of QGIS is expected to improve the quality and equality of education in various regions by utilizing geospatial data effectively.

In conclusion, the adoption of QGIS technology in ODL is an important step to overcome geographical challenges in education distribution. With QGIS's vector, raster, and attribute data analysis capabilities, educational institutions can improve the management and planning of distance education, ensuring that all students have equal access to educational resources.

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