

ABSTRACT

The digitalization of education continues to be developed to reach various regions, including remote areas with limited infrastructure such as access to electricity and internet connectivity. Online learning using Learning Management Systems (LMS) like Moodle requires an efficient, portable server system capable of operating without internet access. However, most LMS infrastructures currently rely on devices with high power consumption and stable internet connections, making deployment in resource-constrained environments challenging.

This research proposes a microclustering server architecture consisting of five Raspberry Pi 4 units integrated into a unified system. The system is designed to run the Moodle platform locally. Supported by additional networking components such as a router, Mikrotik, and switch hub, this setup enables multi-client access independently within a local network.

Testing results show that the system weighs 1,314 kg, slightly heavier than a Mini-PC Intel NUC, yet still supports portability. It requires a maximum power of approximately 27.58 W, with a daily energy demand of around 220 Wh to support 8 hours of operation. This can be fulfilled using two 35 Ah (3.7V) power banks or four 20 Ah units. Alternatively, the system can be powered by a 70 Wp solar panel combined with a 12V, 75–120 Ah battery and a 100V/50A MPPT controller. Performance testing indicates that the system can handle up to 20 virtual users simultaneously without degradation, maintaining stable latency, throughput, and zero error rates. Therefore, the Raspberry Pi-based microclustering server architecture proves to be a viable and effective solution to support digital learning in areas with limited infrastructure.

Keywords: *microclustering, Raspberry Pi, LMS, remote areas, portability*