UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

[1] R. M. Jacobsen, S. R. Cox, C. F. Griggio, and N. van Berkel, "Chatbots for data collection in surveys: A comparison of four theory-based interview probes," in *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems*, ser. CHI '25. New York, NY, USA: Association for Computing Machinery, 2025. [Online]. Available: https://doi.org/10.1145/3706598.3714128

[2] D. Yigci, M. Eryilmaz, A. K. Yetisen, S. Tasoglu, and A. Ozcan, "Large language model-based chatbots in higher education," *Advanced Intelligent Systems*, aug 2024. [Online]. Available: https://doi.org/10.1002/aisy.202400429

[3] T. Totlis, K. Natsis, D. Filos *et al.*, "The potential role of ChatGPT and artificial intelligence in anatomy education: a conversation with ChatGPT," *Surgical and Radiologic Anatomy*, vol. 45, no. 10, pp. 1321–1329, 2023. [Online]. Available: https://doi.org/10.1007/s00276-023-03229-1

[4] S. Lobentanzer *et al.* (2024, feb 17) A platform for the biomedical application of large language models. Accessed: May 1, 2026. [Online]. Available: https://biocypher.github.io/biochatter-paper/v/0cdd37790a8dda42978a9ad0e39a66b21daa9f83/

[5] M. C. Sáiz-Manzanares, R. Marticorena-Sánchez, L. J. Martín-Antón, I. González Díez, and L. Almeida, "Perceived satisfaction of university students with the use of chatbots as a tool for self-regulated learning," *Heliyon*, vol. 9, no. 1, p. e12843, jan 2023. [Online]. Available: https://doi.org/10.1016/j.heliyon.2023.e12843

[6] A. Abd-alrazaq *et al.*, "Large language models in medical education: Opportunities, challenges, and future directions," *JMIR Medical Education*, vol. 9, no. 1, p. e48291, jun 2023. [Online]. Available: https://doi.org/10.2196/48291

[7] G. Bolatli, S. Birisci, and Z. Bolatli, "An alternative approach in anatomy education: Design of a learning environment based on artificial intelligence-supported virtual manipulatives and investigation of its effectiveness," *Clinical Anatomy*, jul 2025. [Online]. Available: https://doi.org/10.1002/ca.70008

[8] I. S. H. Ng, A. Siu, C. Han, O. S. H. Ho, J. Sun, A. Markiv, S. Knight, and M. Sagoo, "Evaluating a custom chatbot in undergraduate medical education: Randomised crossover mixed-methods evaluation of performance, utility, and perceptions," *Behavioral Sciences*, vol. 15, no. 9, p. 1284, sep 2025. [Online]. Available: https://doi.org/10.3390/bs15091284

[9] D. Baur, J. Ansorg, C.-E. Heyde, and A. Voelker, "Development and evaluation of a retrieval-augmented generation chatbot for orthopedic and trauma surgery patient education: A mixed-methods study (Preprint)," *JMIR AI*, mar 2025. [Online]. Available: https://doi.org/10.2196/75262

[10] L. Zhang, L. Zhang, S. Shi, X. Chu, and B. Li, "LoRA-FA: Efficient and effective low rank representation fine-tuning," *arXiv preprint arXiv:2308.03303*, 2023. [Online]. Available: https://doi.org/10.48550/arXiv.2308.03303

UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

[11] B. Collins, E. W. Black, and K. Rarey, "Introducing AnatomyGPT: A customized artificial intelligence application for anatomical sciences education," *Clinical Anatomy*, vol. 37, no. 6, mar 2024. [Online]. Available: https://doi.org/10.1002/ca.24178

[12] H. Yu, J. Zhou, L. Li, S. Chen, J. Gallifant, A. Shi, X. Li, W. Hua, M. Jin, G. Chen, Y. Zhou, Z. Li, T. Gupte, M.-L. Chen, Z. Azizi, Y. Zhang, T. Assimes, X. Ma, D. Bitterman, and L. Fan, "Aipatient: Simulating patients with ehrs and llm powered agentic workflow," [Online], sep 27 2024, available: https://www.researchgate.net/publication/384447372_AIPatient_Simulating_Patients_with_EHRs_and_LLM_Powered_Agentic_Workflow.

[13] M. A. Kuhail, N. Alturki, S. Alramlawi, and K. Alhejori, "Interacting with educational chatbots: A systematic review," *Education and Information Technologies*, vol. 28, no. 1, pp. 973–1018, 2023. [Online]. Available: https://doi.org/10.1007/s10639-022-11177-3

[14] T. A. Baha, M. E. Hajji, Y. Es-Saady, and H. Fadili, "The impact of educational chatbot on student learning experience," *Education and Information Technologies*, vol. 29, no. 8, pp. 10 153–10 176, 2024. [Online]. Available: https://doi.org/10.1007/s10639-023-12166-w

[15] A. T. Neumann, Y. Yin, S. Sowe, S. Decker, and M. Jarke, "An LLM-driven chatbot in higher education for databases and information systems," *IEEE Transactions on Education*, vol. 68, no. 1, pp. 103–116, 2025, doi: 10.1109/TE.2024.3467912.

[16] B. Alsafari, E. Atwell, A. Walker, and M. Callaghan, "Towards effective teaching assistants: From intent-based chatbots to LLM-powered teaching assistants," *Natural Language Processing Journal*, vol. 8, p. 100101, 2024. [Online]. Available: https://doi.org/10.1016/j.nlp.2024.100101

[17] Y. Dan, Z. Lei, Y. Gu, Y. Li, J.-C. Yin, J. Lin, L. Ye, Z. Tie, Y. Zhou, Y. Wang, A. Zhou, Z. Zhou, Q. Chen, J. Zhou, L. He, and X. Qiu, "EduChat: A large-scale language model-based chatbot system for intelligent education," *arXiv preprint arXiv:2308.02773*, 2023. [Online]. Available: https://doi.org/10.48550/arXiv.2308.02773

[18] J. Odede and I. Frommholz, "JayBot: Aiding university students and admission with an LLM-based chatbot," in *Proceedings of the 2024 ACM Conference on Human Information Interaction and Retrieval*. ACM, 2024, pp. 427–431. [Online]. Available: https://doi.org/10.1145/3627508.3638293

[19] M. Hasbi, R. Imanda, and M. F. Fauzan, "Implementasi chatbot berbasis large language model untuk pencarian skripsi mahasiswa terintegrasi dengan WhatsApp," *Arcitech: Journal of Computer Science and Artificial Intelligence*, vol. 5, no. 1, 2025. [Online]. Available: https://doi.org/10.29240/arcitech.v5i1.13974

[20] V. Mavrych, P. Ganguly, and O. Bolgova, "Using large language models (ChatGPT, Copilot, PaLM, Bard, and Gemini) in Gross Anatomy course: Comparative analysis," *Clinical Anatomy*, vol. 38, no. 2, pp. 200–210, 2025, doi: 10.1002/ca.24244. [Online]. Available: https://doi.org/10.1002/ca.24244

UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

[21] M. Elzayyat, J. Naeim, and S. Zaqout, "Assessing LLM-generated vs. expert-created clinical anatomy MCQs: a student perception-based comparative study in medical education," *Medical Education Online*, vol. 30, no. 1, p. 2554678, aug 2025. [Online]. Available: https://doi.org/10.1080/10872981.2025.2554678

[22] G. Xiong, Q. Jin, Z. Lu, and A. Zhang, "Benchmarking retrieval-augmented generation for medicine," in *Proceedings of the 62nd Annual Meeting of the Association for Computational Linguistics (ACL)*, 2024, pp. 6233–6251. [Online]. Available: https://doi.org/10.48550/arXiv.2402.13178

[23] L. V. Comia, "Chatbot for student descipline handbook-related queries: A RAG-based LLM using Llama-3 approach," in *2025 11th International Conference on Web Research (ICWR)*. IEEE, 2025, pp. 306–312. [Online]. Available: https://doi.org/10.1109/icwr65219.2025.11006165

[24] L. S. T. Nguyen and T. Quan, "URAG: Implementing a unified hybrid RAG for precise answers in university admission chatbots - a case study at HCMUT," *arXiv preprint arXiv:2501.16276*, 2025. [Online]. Available: https://doi.org/10.48550/arXiv.2501.16276

[25] S. Xu, Z. Yan, C. Dai, and F. Wu, "MEGA-RAG: a retrieval-augmented generation framework with multi-evidence guided answer refinement for mitigating hallucinations of LLMs in public health," *Frontiers in Public Health*, vol. 13, p. 1635381, oct 2025. [Online]. Available: https://doi.org/10.3389/fpubh.2025.1635381

[26] X. Sun, Y. Ji, B. Ma, and X. Li, "A comparative study between full-parameter and LoRA-based fine-tuning on Chinese instruction data for instruction following large language model," *arXiv preprint arXiv:2304.08109*, 2023. [Online]. Available: https://doi.org/10.48550/arXiv.2304.08109

[27] E. Ross, Y. Kansal, J. Renzella, A. Vassar, and A. Taylor, "Supervised fine-tuning LLMs to behave as pedagogical agents in programming education," *arXiv preprint arXiv:2502.20527*, 2025. [Online]. Available: https://doi.org/10.48550/arXiv.2502.20527

[28] A. Faisal, M. A. M. Hayat, and D. Anggreani, "Implementation of fine-tuning LLM model on new student registration chatbot at Muhammadiyah University of Makassar," *Internet of Things and Artificial Intelligence Journal*, vol. 5, no. 3, 2025. [Online]. Available: https://doi.org/10.31763/iota.v5i3.1010

[29] A. Trigo, "Artefact-driven narrative literature review (ART-NLR): supporting evidence synthesis for design science research," *Journal of Documentation*, 2026. [Online]. Available: https://doi.org/10.1108/JD-01-2026-0013

[30] A. Tjahyanto, I. Hafidz, and F. J. Atletiko, "Design science research approach in developing Bulugh al-Maram chatbot," *Procedia Computer Science*, vol. 284, pp. 1341–1350, 2026. [Online]. Available: https://doi.org/10.1016/j.procs.2026.07.122

[31] S. Bonnet and F. Teuteberg, "Unfolding the potential of generative artificial intelligence: Design principles for chatbots in academic teaching and research,"

UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

International Journal of Knowledge Management, vol. 21, no. 1, pp. 1–25, 2025. [Online]. Available: https://doi.org/10.4018/IJKM.368223

[32] A. Siaril, H. Ipung, and T. D. Sofianti, "Integrating LLM chatbot in HR business process of small IT enterprise," *Eduvest - Journal of Universal Studies*, vol. 5, no. 12, 2025. [Online]. Available: https://doi.org/10.59188/eduvest.v5i12.51876

[33] J. Gregório, L. Reis, M. Peyroteo, M. Maia, M. Mira da Silva, and L. V. Lapão, "The role of Design Science Research Methodology in developing pharmacy eHealth services," *Research in Social and Administrative Pharmacy*, vol. 17, no. 12, pp. 2089–2096, 2021. [Online]. Available: https://doi.org/10.1016/j.sapharm.2021.05.016

[34] I. Ahmad and S. Samsugi, "PENERAPAN AUGMENTED REALITY PADA ANATOMI TUBUH MANUSIA UNTUK MENDUKUNG PEMBELAJARAN TITIK TITIK BEKAM PENGOBATAN ALTERNATIF," *Jurnal TEKNOINFO*, vol. 16, no. 1, pp. 46–53, 2022. [Online]. Available: https://doi.org/10.33365/jti.v16i1.1522

[35] L. Labadze, M. Grigolia, and L. Machaidze, "Role of AI chatbots in education: systematic literature review," *International Journal of Educational Technology in Higher Education*, vol. 20, no. 1, p. 56, 2023. [Online]. Available: https://doi.org/10.1186/s41239-023-00426-1

[36] O. M. Schei, A. Møgelvang, and K. Ludvigsen, "Perceptions and use of AI chatbots among students in higher education: A scoping review of empirical studies," *Education Sciences*, vol. 14, no. 8, p. 922, 2024. [Online]. Available: https://doi.org/10.3390/educsci14080922

[37] S. M. Mian, M. S. Khan, M. Shawez, and A. Kaur, "Artificial intelligence (AI), machine learning (ML) & deep learning (DL): A comprehensive overview on techniques, applications and research directions," in *2024 2nd International Conference on Sustainable Computing and Smart Systems (ICSCSS)*. IEEE, 2024, pp. 1404–1409. [Online]. Available: https://doi.org/10.1109/ICSCSS60660.2024.10625368

[38] B. Mahesh, "Machine learning algorithms - a review," *International Journal of Science and Research (IJSR)*, vol. 9, no. 1, pp. 381–386, 1 2020. [Online]. Available: https://doi.org/10.21275/ART20203995

[39] N. Sharma, R. Sharma, and N. Jindal, "Machine learning, deep learning applications- a vision," *Global Transitions Proceedings*, vol. 2, no. 1, pp. 24–28, 2021. [Online]. Available: https://doi.org/10.1016/j.gltp.2021.01.004

[40] C. Tana, C. Siniscalchi, N. Cerundolo, T. Meschi, P. Martelletti, M. Tana, L. Moffa, W. Wells-Gatnik, F. Cipollone, and M. A. Giamberardino, "Smart aging: integrating AI into elderly healthcare," *BMC Geriatrics*, vol. 25, no. 1, p. 1024, 2025. [Online]. Available: https://doi.org/10.1186/s12877-025-06723-w

[41] X. A. Yu, "Research status and trend of fault diagnosis based on deep learning," in *2020 3rd International Conference on Electron Device and Mechanical*

UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Engineering (ICEDME). IEEE, 2020, pp. 230–232. [Online]. Available: https://doi.org/10.1109/ICEDME50972.2020.00060

[42] A. Vaswani, N. Shazeer, N. Parmar, J. Uszkoreit, L. Jones, A. N. Gomez, Lukasz. Kaiser, and I. Polosukhin, "Attention is all you need," in *Advances in Neural Information Processing Systems (NeurIPS)*, vol. 30, 2017, pp. 5998–6008. [Online]. Available: https://arxiv.org/abs/1706.03762

[43] D. Khurana, A. Koli, K. Khatter, and S. Singh, "Natural language processing: state of the art, current trends and challenges," *Multimedia Tools and Applications*, vol. 82, no. 3, pp. 3713–3744, 2023. [Online]. Available: https://doi.org/10.1007/s11042-022-13428-4

[44] H. You, Y. Fu, Z. Wang, A. Yazdanbakhsh, and Y. Lin, "When linear attention meets autoregressive decoding: Towards more effective and efficient linearized large language models," *arXiv preprint arXiv:2406.07368*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2406.07368

[45] S. Minaee, T. Mikolov, N. Nikzad, M. Chenaghlu, R. Socher, X. Amatriain, and J. Gao, "Large language models: A survey," *arXiv preprint arXiv:2402.06196*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2402.06196

[46] H. Touvron, L. Martin, K. Stone, P. Albert, A. Almahairi, Y. Babaei, N. Bashlykov, S. Batra, P. Bhargava, S. Bhosale, D. Bikel, L. Blecher, C. C. Ferrer, M. Chen, G. Cucurull, D. Esiobu, J. Fernandes, J. Fu, W. Fu, B. Fuller, C. Gao, V. Goswami, N. Hartshorn, S. Hosseini, R. Hou, H. Inan, M. Kardas, V. Kerkez, M. Khabsa, I. Kloumann, A. Korenev, P. S. Koura, M.-A. Lachaux, T. Lavril, J. Lee, D. Liskovich, Y. Lu, Y. Mao, X. Martinet, T. Mihaylov, P. Mishra, I. Molybog, Y. Nie, A. Poulton, J. Reizenstein, R. Rungta, K. Saladi, A. Schelten, R. Silva, E. M. Smith, R. Subramanian, X. Tan, B. Tang, R. Taylor, A. Williams, J. X. Kuan, P. Xu, Z. Yan, I. Zarov, Y. Zhang, A. Fan, M. Kambadur, S. Narang, A. Rodriguez, R. Stojnic, S. Edunov, and T. Scialom, "Llama 2: Open foundation and fine-tuned chat models," *arXiv preprint arXiv:2307.09288*, 2023. [Online]. Available: https://doi.org/10.48550/arXiv.2307.09288

[47] S. S. Khairat, T. Niu, J. Geracitano, and Z. Zhou, "Performance evaluation of popular open-source large language models in healthcare," *Studies in Health Technology and Informatics*, vol. 328, pp. 215–219, 2025. [Online]. Available: https://doi.org/10.3233/shti250705

[48] B. Salam, C. Stüwe, S. Nowak, A. M. Sprinkart, M. Theis, D. Kravchenko, N. Mesropyan, T. Dell, C. Endler, C. C. Pieper, D. Kuetting, J. Luetkens, and A. Isaak, "Large language models for error detection in radiology reports: a comparative analysis between closed-source and privacy-compliant open-source models," *European Radiology*, vol. 35, pp. 4549–4557, 2025. [Online]. Available: https://doi.org/10.1007/s00330-025-11438-y

[49] G. Zhang, Q. Jin, Y. Zhou, S. Wang, B. Idnay, Y. Luo, E. Park, J. G. Nestor, M. E. Spotnitz, A. Soroush, T. R. Campion, Z. Lu, C. Weng, and Y. Peng, "Closing the gap between open source and commercial large language models for medical evidence summarization," *npj Digital Medicine*, vol. 7, no. 1, p. 239, 2024. [Online]. Available: https://doi.org/10.1038/s41746-024-01239-w

UNIVERSITAS
GADJAH MADA
Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented Generation dan Fine-Tuning Large Language Model
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

[50] X. Bi, D. Chen, G. Chen, S. Chen, D. Dai, C. Deng, H. Ding, K. Dong, Q. Du, Z. Fu, H. Gao, K. Gao, W. Gao, R. Ge, K. Guan, D. Guo, J. Guo, G. Hao, Z. Hao, Y. He, W.-H. Hu, P. Huang, E. Li, G. Li, J. Li, Y. Li, Y. K. Li, W. Liang, F. Lin, A. Liu, B. Liu, W. Liu, X. Liu, X. Liu, Y. Liu, H. Lu, S. Lu, F. Luo, S. Ma, X. Nie, T. Pei, Y. Piao, J. Qiu, H. Qu, T. Ren, Z. Ren, C. Ruan, Z. Sha, Z. Shao, J.-M. Song, X. Su, J. Sun, Y. Sun, M. Tang, B.-L. Wang, P. Wang, S. Wang, Y. Wang, Y. Wang, T. Wu, Y. Wu, X. Xie, Z. Xie, Z. Xie, Y. Xiong, H. Xu, R. X. Xu, Y. Xu, D. Yang, Y.-m. You, S. Yu, X.-y. Yu, B. Zhang, H. Zhang, L. Zhang, L. Zhang, M. Zhang, M. Zhang, W. Zhang, Y. Zhang, C. Zhao, Y. Zhao, S. Zhou, S. Zhou, Q. Zhu, and Y. Zou, "DeepSeek LLM: Scaling open-source language models with longtermism," *arXiv preprint arXiv:2401.02954*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2401.02954

[51] S. M. S. Sheikh, D. Kubal, and C. Thakre, "Comparative evaluation of open-source large language models: LLaMA2 vs Mistral," in *2025 2nd International Conference on Integration of Computational Intelligent System (ICICIS)*. IEEE, 2025, pp. 1–6. [Online]. Available: https://doi.org/10.1109/icicis65613.2025.11371086

[52] A. Dubey, A. Jauhri, A. Pandey *et al.*, "The Llama 3 herd of models," *arXiv preprint arXiv:2407.21783*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2407.21783

[53] P. Lewis, E. Perez, A. Piktus, F. Petroni, V. Karpukhin, N. Goyal, H. Küttler, M. Lewis, W.-t. Yih, T. Rocktäschel, S. Riedel, and D. Kiela, "Retrieval-augmented generation for knowledge-intensive NLP tasks," in *Advances in Neural Information Processing Systems (NeurIPS)*, H. Larochelle, M. Ranzato, R. Hadsell, M. F. Balcan, and H. Lin, Eds., vol. 33. Curran Associates, Inc., 2020, pp. 9459–9474. [Online]. Available: https://proceedings.neurips.cc/paper_files/paper/2020/file/6b493230205f780e1bc26945df7481e5-Paper.pdf

[54] Y. Gao, Y. Xiong, X. Gao, K. Jia, J. Pan, Y. Bi, Y. Dai, J. Sun, M. Wang, and H. Wang, "Retrieval-augmented generation for large language models: A survey," *arXiv preprint arXiv:2312.10997*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2312.10997

[55] D. Goyal and A. Gautam, "Introduction to LangChain framework," in *Introduction to LangChain Framework*. John Wiley & Sons, Ltd, 2025, ch. 11, pp. 253–285. [Online]. Available: https://doi.org/10.1002/9781394287499.ch11

[56] X. Zhang, Y. Song, Y. Wang, S. Tang, X. Li, Z. Zeng, Z. Wu, W. Ye, W. Xu, Y. Zhang, X. Dai, S. Zhang, and Q. Wen, "RAGLAB: A modular and research-oriented unified framework for retrieval-augmented generation," *arXiv preprint arXiv:2408.11381*, 2024. [Online]. Available: https://doi.org/10.48550/arXiv.2408.11381

[57] Y. Gao, Y. Xiong, M. Wang, and H. Wang, "Modular RAG: Transforming RAG systems into LEGO-like reconfigurable frameworks," *ACM Transactions on Information Systems*, 2024. [Online]. Available: https://doi.org/10.1145/3837856

[58] X. Xie, H. Liu, W. Hou, and H. Huang, "A brief survey of vector databases," in *2023 9th International Conference on Big Data and Information*

UNIVERSITAS
GADJAH MADA
**Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented
Generation dan Fine-Tuning Large Language Model**
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Analytics (BigDIA). IEEE, 2023, pp. 364–371. [Online]. Available: https://doi.org/10.1109/BigDIA60485.2023.10444558

[59] T. Dettmers, A. Pagnoni, A. Holtzman, and L. Zettlemoyer, "QLoRA: Efficient finetuning of quantized LLMs," *arXiv preprint arXiv:2305.14314*, 2023. [Online]. Available: https://doi.org/10.48550/arXiv.2305.14314

[60] R. Patil, P. Khot, and V. Gudivada, "Analyzing LLAMA3 performance on classification task using LoRA and QLoRA techniques," *Applied Sciences*, vol. 15, no. 6, p. 3087, 2025. [Online]. Available: https://doi.org/10.3390/app15063087

[61] B. Hanindhito, B. Patel, and L. K. John, "Large language model fine-tuning with low-rank adaptation: A performance exploration," in *Proceedings of the 16th ACM/SPEC International Conference on Performance Engineering*. New York, NY, USA: Association for Computing Machinery, 2025. [Online]. Available: https://doi.org/10.1145/3676151.3719377

[62] P. Shakya, A. Khaneja, and K. Wagholikar, "For clinical data extraction, QLoRA attains accuracy close to LoRA while requiring lower compute resources," *medRxiv*, 2025. [Online]. Available: https://doi.org/10.1101/2025.10.21.25338506

[63] S. S. Alahmari, L. O. Hall, P. R. Mouton, and D. B. Goldgof, "Repeatability of fine-tuning large language models illustrated using QLoRA," *IEEE Access*, vol. 12, pp. 153 221–153 231, 2024. [Online]. Available: https://doi.org/10.1109/access.2024.3470850

[64] A. Shen, Z. Lai, Q. Wang, X.-l. Li, L. Zhang, D. Li, and J. Li, "Accurate and efficient fine-tuning of quantized large language models through optimal balance in adaptation," *Transactions of the Association for Computational Linguistics*, vol. 13, pp. 861–877, 2025. [Online]. Available: https://doi.org/10.1162/tacl.a.23

[65] T. Zhang, V. Kishore, F. Wu, K. Q. Weinberger, and Y. Artzi, "BERTScore: Evaluating text generation with BERT," in *8th International Conference on Learning Representations (ICLR)*. OpenReview.net, 2020. [Online]. Available: https://openreview.net/forum?id=SkeHuCVFDr

[66] J. Risch, T. Möller, J. Gutsch, and M. Pietsch, "Semantic answer similarity for evaluating question answering models," in *Proceedings of the 3rd Workshop on Machine Reading for Question Answering*. Association for Computational Linguistics, nov 2021, pp. 149–157. [Online]. Available: https://doi.org/10.18653/v1/2021.mrqa-1.15

[67] N. R. Sudianjaya and S. Rochimah, "Goal-oriented functional suitability measurement on loan origination system based on ISO/IEC 25010," in *2023 International Conference on Computer, Control, Informatics and its Applications (IC3INA)*. IEEE, 2023, pp. 161–166. [Online]. Available: https://doi.org/10.1109/IC3INA60834.2023.10285765

[68] International Organization for Standardization, *ISO/IEC 25010:2023 Systems and Software Engineering — Systems and Software Quality Requirements and Evaluation (SQARE) — Product Quality Model*, International Organization for

UNIVERSITAS
GADJAH MADA
Pengembangan dan Evaluasi Platform Pembelajaran Anatomi Otak Berbasis Web dengan Retrieval-Augmented Generation dan Fine-Tuning Large Language Model
Galuh Ayu Niken Adi Untari, Ir. Adhistya Erna Permanasari, S.T., M.T., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Standardization Std., 2023. [Online]. Available: https://www.iso.org/standard/78176.html