

**PENGARUH *VIRTUAL REALITY* (VR) BERBASIS MODEL 3D
TERHADAP KECERDASAN VISUAL-SPASIAL PADA MATA
PELAJARAN GAMBAR TEKNIK DI SMK N 5 BANDUNG**



SKRIPSI

diajukan untuk memenuhi sebagian dari syarat memperoleh gelar Sarjana
Pendidikan Teknik Arsitektur di Program Studi Pendidikan Teknik Arsitektur

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Juli 2025

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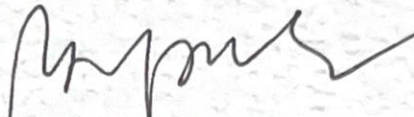
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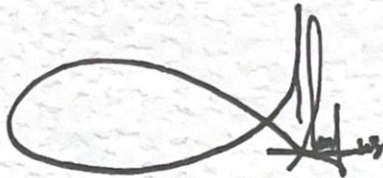
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“Pengaruh *Virtual Reality* (VR) berbasis Model terhadap Kecerdasan Visual-Spasial 3D pada Mata Pelajaran Gambar Teknik di SMK N 5 Bandung”

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh penggunaan media *Virtual Reality* (VR) berbasis model 3D terhadap kecerdasan visual-spasial peserta didik pada mata pelajaran gambar teknik di SMK Negeri 5 Bandung. Lebih dari 75% peserta didik diketahui mengalami kesulitan dalam memproyeksikan gambar 2D menjadi bentuk 3D saat mengerjakan tugas gambar teknik, sehingga dibutuhkan media pembelajaran yang dapat membantu pemahaman visual spasial mereka. Metode yang digunakan adalah pendekatan kuantitatif dengan desain *quasi experimental model non-equivalent control group design*. Sampel terdiri dari dua kelas, yaitu kelas eksperimen yang memperoleh perlakuan menggunakan media VR berbasis model 3D dan kelas kontrol yang mengikuti pembelajaran konvensional. Instrumen penilaian berupa tugas menggambar *block plan* dari 2D ke 3D yang dinilai menggunakan rubrik kecerdasan visual-spasial. Data dianalisis menggunakan uji *paired t-test*, *independent t-test*, dan perhitungan *n-gain score*. Hasil penelitian menunjukkan bahwa terdapat perbedaan signifikan antara hasil *post-test* kelas eksperimen dan kelas kontrol ($p < 0,05$). Hasil *paired t-test* menunjukkan peningkatan signifikan pada kelas eksperimen, dengan nilai *n-gain* sebesar 0,41 (kategori sedang), sedangkan kelas kontrol hanya mencapai 0,13 (kategori rendah). Kesimpulan dari penelitian ini adalah bahwa penggunaan VR berbasis model 3D berpengaruh signifikan terhadap peningkatan kecerdasan visual-spasial peserta didik. Temuan ini mengindikasikan bahwa VR dapat menjadi media pembelajaran alternatif yang efektif dalam pembelajaran gambar teknik di SMK.

Kata Kunci: *Virtual Reality* (VR), kecerdasan visual-spasial, gambar teknik

“The Effect of Model-based Virtual Reality (VR) on 3D Visual-Spatial Intelligence in Technical Drawing Subjects at SMK N 5 Bandung”

ABSTRACT

This study aims to determine the effect of using 3D model-based Virtual Reality (VR) media on the visual-spatial intelligence of students in technical drawing classes at SMK Negeri 5 Bandung. More than 75% of students were found to have difficulty projecting 2D images into 3D forms when completing technical drawing assignments, necessitating the use of educational media that can enhance their visual-spatial understanding. The method employed was a quantitative approach using a quasi-experimental design with a non-equivalent control group design. The sample consisted of two classes: an experimental class that received treatment using VR-based 3D model media and a control class that followed conventional learning. The assessment instrument was a task of drawing a block plan from 2D to 3D, evaluated using a visual-spatial intelligence rubric. Data were analyzed using paired t-tests, independent t-tests, and n-gain score calculations. The results showed a significant difference between the post-test scores of the experimental and control groups ($p < 0.05$). The paired t-test revealed a significant improvement in the experimental group, with an n-gain score of 0.41 (moderate category), while the control group achieved only 0.13 (low category). The conclusion of this study is that the use of VR based on 3D models has a significant effect on improving students' visual-spatial intelligence. These findings indicate that VR can be an effective alternative learning medium in technical drawing education at vocational high schools.

Keywords: *Virtual Reality (VR), visual-spatial intelligence, 3D model, technical drawing*

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DAFTAR PUSTAKA

- Aini, N. N., Azizah, M., Becti, R. S., & Thohir, M. A. (2023). Efektivitas Penggunaan Media Pembelajaran *Virtual Reality* (VR) terhadap Hasil Belajar Peserta didik pada Pembelajaran IPA di SD. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, 6(2), 267. <https://doi.org/10.33603/caruban.v6i2.8611>
- Alamsyah, S. I., Subani, F. M., Febrianto, A., Ghizanda, R. D., & Wardoyo, D. A. D. (2023). *Virtual Reality* (VR) Sebagai Media Pembelajaran Jaringan Komputer. *Jurnal Teknologi Informasi Dan Komunikasi*, 14(2), 248–254. <https://doi.org/10.51903/jtikp.v14i2.586>
- Alhalabi, W. (2016). *Virtual Reality* (VR) systems enhance students' achievements in engineering education. *Behaviour & Information Technology*. <https://doi.org/http://dx.doi.org/10.1080/0144929X.2016.1212931>
- Antoni Musril, H., & Hurrahman, M. (2020). *IMPLEMENTASI TEKNOLOGI VIRTUAL REALITY (VR) PADA MEDIA PEMBELAJARAN PERAKITAN KOMPUTER* (Vol. 9, Issue 1).
- Arini & Sesrita. (2024). *Penggunaan Virtual Reality (VR) dalam Meningkatkan Kemampuan Visual-Spasial Peserta Didik SMK*.
- Armstrong, T. (2013). *Multiple intelligences in the classroom*.
- Arsyad, A. (2020). *Media Pembelajaran*. Jakarta: PT. Raja Grafindo Persada.
- Bilgin, Cigdem., Anteneh, Melat., Thompson, M. (2021). What's So Special About Spatial?: A Review Study Joining Virtual Reality and Spatial Ability. In *Implementing Augmented Reality Into Immersive Virtual Learning Environments*. <https://doi.org/http://dx.doi.org/10.4018/978-1-7998-4222-4.ch003>
- Bodner, G. M., & Guy, R. B. (1997). The Purdue Visualization of Rotations Test. *The Chemical Educator*, 2(4), 1–17. <https://doi.org/10.1007/s00897970138a>
- Bower, M., & Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers and Education*, 88(July), 343–353. <https://doi.org/10.1016/j.compedu.2015.07.013>
- Brunyé, T. T. (2018). Modulating spatial processes and navigation via transcranial electrical stimulation: A mini review. *Frontiers in Human Neuroscience*, 11(January), 1–8. <https://doi.org/10.3389/fnhum.2017.00649>
- Carlisle, D., Tyson, J., & Nieswandt, M. (2015). Fostering spatial skill acquisition by general chemistry students. *Chemistry Education Research and Practice*, 25, 16–33.
- Chao, J., Chiu, J. L., DeJaegher, C. J., & Pan, E. A. (2016). Sensor-Augmented Virtual Labs: Using Physical Interactions with Science Simulations to Promote Understanding of Gas Behavior. *Journal of Science Education and Technology*, 25(1), 16–33. <https://doi.org/10.1007/s10956-015-9574-4>

- Chao, K.-J., Chiang, C.-H., & Hung, W.-H. (2023). An immersive *Virtual Reality* (VR) learning system for improving spatial ability in architectural drawing. *Interactive Learning Environments*, 31(1), 20–40.
- Cheng, K.-H., & Tsai, C.-C. (2020). Students' motivational beliefs and strategies, perceived immersion and attitudes towards science learning with immersive *Virtual Reality* (VR): A partial least squares analysis. *British Journal of Educational Technology*, 51. <https://doi.org/10.1111/bjet.12956>
- Cohen, L., Manion, L., & Morrison, K. (2007). Book Reviews Research Methods in Education. *The Austr Alian Educational Researcher*, 2, 147–156.
- Contreras, M. J., Escrig, R., Prieto, G., & Elosúa, M. R. (2018). Spatial Visualization ability improves with and without studying Technical Drawing. *Cognitive Processing*, 19(3), 387–397. <https://doi.org/10.1007/s10339-018-0859-4>
- Darmawan, D. (2009). Google SketchUp mudah dan cepat menggambar 3 dimensi. In *Jogjakarta. CV Andi Offset*.
- Di, X., & Zheng, X. (2022). A meta-analysis of the impact of virtual technologies on students' spatial ability. *Educational Technology Research and Development*, 70(1), 73–98. <https://doi.org/10.1007/s11423-022-10082-3>
- Fernanda, A., Retta, A. M., Isroqmi, A., Palembang, U. P., & Selatan, S. (2024). *Pengembangan Media Pembelajaran Virtual Reality* (VR) Berbasis Android pada Pembelajaran Matematika SMP. 9(3), 1612–1618.
- Freina, L., & Ott, M. (2015). a Literature Review on Immersive *Virtual Reality* (VR) in Education: State of the Art and Perspectives. *11th International Conference ELearning and Software for Education*, 1(April), 133–141. <https://doi.org/10.12753/2066-026x-15-020>
- Gardner, H. (1993). *Multiple intelligences: The theory in practice* (10th anniversary ed.). Basic Books. Diakses dari Infed: <https://infed.org/mobi/howard-gardner-multiple-intelligences-and-education/>
- Gunawan, Ali., Wiranto, Nivendy., Wu, D. (2023). Application of *Virtual Reality* (VR) in diverse fields of study in education sector: a systematic literature review. *Procedia Computer Science*, 227(1), 948–957. <https://doi.org/http://dx.doi.org/10.1016/j.procs.2023.10.602>
- Guzsvinecz, T., Orbán-Mihálykó, É., Perge, E., & Sik-Lányi, C. (2020). Analyzing the spatial skills of university students with a *Virtual Reality* (VR) application using a desktop display and the gear VR. *Acta Polytechnica Hungarica*, 17(2), 35–56. <https://doi.org/10.12700/APH.17.2.2020.2.3>
- Hajhashemi, K., Caltabiano, N., Anderson, N., & Tabibzadeh, S. A. (2018). Multiple intelligences, motivations and learning experience regarding video-assisted subjects in a rural university. *International Journal of Instruction*, 11(1), 167–182. <https://doi.org/10.12973/iji.2018.11112a>

- Harle, M., & Towns, M. (2011). A review of spatial ability literature, its connection to chemistry, and implications for instruction. *Journal of Chemical Education*, 88(3), 351. <https://doi.org/https://doi.org/10.1021/ed900003n>
- Jerald, J. (2015). *The VR Book: Human-Centered Design for Virtual Reality* (VR). <https://doi.org/http://dx.doi.org/10.1145/2792790.2792833>
- Kemdikbud. (2018). Peraturan Menteri Pendidikan Dan Kebudayaan Republik Indonesia Nomor 37 Tahun 2018. *Jakarta*, 37, 527.
- Koç, A., & Kanadlı, S. (2025). Effect of Interactive Learning Environments on Learning Outcomes in Science Education: A Network Meta-Analysis. *Journal of Science Education and Technology*, 0123456789. <https://doi.org/10.1007/s10956-025-10202-7>
- Konradsen, F. (n.d.). A review of the use of *Virtual Reality* (VR) head-mounted displays in education and training. *Education and Information Technologies*. <https://doi.org/https://link.springer.com/article/10.1007/s10639-017-9676-0>
- Kozhevnikov, M. (2007). *Spatial Visualization in Physics Problem Solving*.
- Kustandi, C., Situmorang, R., & Lestari, I. (2019). *Virtual Reality* (VR) Use in Online Learning. *Article in International Journal of Engineering and Technology*, 8(3), 308–314. <https://doi.org/10.14419/ijet.v8i3.29166>
- Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, 28(4), 563. <https://doi.org/https://doi.org/10.1111/j.1744-6570.1975.tb01393.x>
- LeBow, V., Bernhardt-Barry, M. L., & Datta, J. (2018). Improving spatial visualization abilities using 3D printed blocks. *ASEE Annual Conference & Exposition*.
- Maier, P. H. (1996). Spatial geometry and spatial ability—How to make solid geometry solid? In *International Journal of Mathematics Education in Science and Technology: Vol. 27(4)*.
- Makransky, G., & Petersen, G. B. (2021). The Cognitive Affective Model of Immersive Learning (CAMIL): a Theoretical Research-Based Model of Learning in Immersive *Virtual Reality* (VR). *Educational Psychology Review*, 33(3), 937–958. <https://doi.org/10.1007/s10648-020-09586-2>
- Masykur, M. (2007). Mathematical Intelligence. *AarRuzz Media*.
- Merchant, Z., Goetz, E. T., Keeney-Kennicutt, W., Cifuentes, L., Kwok, O., & Davis, T. J. (2013). Exploring 3-D *Virtual Reality* (VR) technology for spatial ability and chemistry achievement. *Journal of Computer Assisted Learning*, <https://doi.org/https://doi.org/10.1111/jcal.12018>
- Merchant, Z., Goetz, E. T., Keeney-Kennicutt, W., Kwok, O., Cifuentes, L., & Davis, T. J. (2012). The learner characteristics, features of desktop 3D *Virtual Reality* (VR) environments, and college chemistry instruction: A structural equation modeling analysis. *Computers & Education*. <https://doi.org/https://doi.org/10.1016/j.compedu.2012.02.004>

- Miralbes, R., Ranz, D., Gomez, J. A., & Diago, L. (2023). Implementation of *Virtual Reality* (VR) for Teaching in Technical Drawing. *Lecture Notes in Mechanical Engineering*, 831–838. https://doi.org/10.1007/978-3-031-20325-1_63
- Mohler, J. L., & Miller, C. L. (2008). Improving spatial ability with mentored sketching. *Engineering Design Graphics Journal*, 72(1), 19–27.
- Molina-Carmona, R., Pertegal-Felices, M. L., Jimeno-Morenilla, A., & Mora-Mora, H. (2018). *Virtual Reality* (VR) learning activities for multimedia students to enhance spatial ability. *Sustainability (Switzerland)*, 10(4), 1–13. <https://doi.org/10.3390/su10041074>
- Mütterlein, J. (2018). The three pillars of *Virtual Reality* (VR)? Investigating the roles of immersion, presence, and interactivity. *Proceedings of the Annual Hawaii International Conference on System Sciences, 2018-Janua* (January), 1407–1415. <https://doi.org/10.24251/hicss.2018.174>
- Naufal Azmi, M., Mansur, H., & Hadi Utama, A. (2024). Vol 12 Special Issue No 1 2024 JDPP Potensi Pemanfaatan *Virtual Reality* (VR) Sebagai Media Pembelajaran Di Era Digital. *Pendidikan, Jurnal Dimensi Pembelajaran*. <http://journal.umpo.ac.id/index.php/dimensi/index>
- Newton, P., & Bristoll, H. (2009). Spatial ability practice test 1. In *Psychometric Success* (p. 4).
- Nichla Choirin Attalina, S., Efendi, A., Niswah, N., Almayra Nugroho, V., Guru Sekolah Dasar, P., & Unisnu Jepara, F. (2024). EFEKTIVITAS MEDIA PEMBELAJARAN BERBASIS *Virtual Reality* (VR) UNTUK MENINGKATKAN KEMAMPUAN PEMAHAMAN MATERI PADA PESERTA DIDIK SEKOLAH DASAR. *Journal Tunas Bangsa*, 11(1), 31–43. <https://ejournal.bbg.ac.id/tunasbangsa>
- Nikman, Y. (2019). Penerapan Aplikasi SketchUp Untuk meningkatkan Aktivitas Dan Hasil Belajar Aplikasi Perangkat Lunak Dan Perancangan Interior Gedung Pada Peserta didik Kelas XI Program Keahlian Desain Pemodelan Informasi Bangunan Smk Negeri 2 Binjai. *Jurnal Pendidikan Teknik Bangunan Dan Sipil*, 5(2), 1–6.
- Novita Nur Aini, Milatul Azizah, R. S. B., & Thohir, M. A. (2024). *Efektivitas Penggunaan Media Pembelajaran Virtual Reality* (VR) terhadap Hasil Efektivitas Penggunaan Media Pembelajaran *Virtual Reality* (VR) terhadap Hasil Belajar Peserta didik pada Pembelajaran IPA di SD. May. <https://doi.org/10.33603/caruban.v6i2.8611>
- Pantelidis, V. S. (2010). Reasons to Use *Virtual Reality* (VR) in Education and Training Courses and a Model to Determine When to Use *Virtual Reality* (VR). *Themes in Science and Technology Education*, 2(1–2), 59–70.
- Parong, Jocelyn., Mayer, R. (2020). Cognitive and affective processes for learning science in immersive *Virtual Reality* (VR). *Journal of Computer Assisted Learning*, 37(1), 226–241. <https://doi.org/http://dx.doi.org/10.1111/jcal.12482>

- Pellas, N., Mystakidis, S., & Kazanidis, I. (2021). Immersive *Virtual Reality* (VR) in K-12 and Higher Education: A systematic review of the last decade scientific literature. In *Virtual Reality* (VR) (Vol. 25, Issue 3). <https://doi.org/10.1007/s10055-020-00489-9>
- Pramesti, A. A., Sitompul, R. P., Sopiya, N., & Fitroh. (2022). Systematic Literature Review: Pemanfaatan *Virtual Reality* (VR) Sebagai Alternatif Media Pembelajaran. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 19(2), 105–117. <https://doi.org/10.23887/jptkuniksha.v19i2.48027>
- Pratiti, N. T., & Putri, E. D. M. (2018). Hubungan Antara Kemampuan Visual-Spasial dengan Kreativitas pada Mahapeserta didik Prodi Arsitektur. *Persona: Jurnal Psikologi Indonesia*, 7(2), 215–223. <https://doi.org/10.30996/persona.v7i2.1911>
- Pribyl, J. R., & Bodner, G. M. (1987). Spatial ability and its role in organic chemistry: A study of four organic courses. *Journal of Research in Science Teaching*. <https://doi.org/https://doi.org/10.1002/tea.3660240304>
- Putra, D. 2013. *Rahasia Membuat Otak Super*. Jogjakarta: Laksana
- Radianti, J., Majchrzak, T. A., Fromm, J., & Isabell Wohlgenannt. (2020). A systematic review of immersive *Virtual Reality* (VR) applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*.
- Rahmawati, Y. P., Handayani, A., & Rakhmawati, D. (2024). *Efektivitas Penggunaan Media Virtual Reality* (VR) *Dalam Pembelajaran Sains*. 13(2), 325–333. <https://doi.org/10.26877/paudia.v13i2.766>
- Rodríguez, S., Núñez, J. C., Valle, A., Freire, C., Ferradás, M. del M., & Rodríguez-Llorente, C. (2019). Relationship between students' prior academic achievement and homework behavioral engagement: The mediating/moderating role of learning motivation. *Frontiers in Psychology*, 10(MAY), 1–10. <https://doi.org/10.3389/fpsyg.2019.01047>
- Sarin, A., Mamoh, O., & Suddin, S. (2021). Penggunaan Bahan Ajar Berbasis Audio Visual Dalam Mengatasi Kesulitan Belajar Online Peserta didik SMA. *MATH-EDU: Jurnal Ilmu Pendidikan Matematika*, 6(2), 50–57. <https://doi.org/10.32938/jipm.6.2.2021.50-57>
- Setiawan, S. I. A. (2011). Google SketchUp Perangkat Alternatif dalam Pemodelan 3D. *Jurnal ULTIMATICS*, 3(2), 6–10. <https://doi.org/10.31937/ti.v3i2.298>
- Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive *Virtual Reality* (VR). *Frontiers Robotics AI*, 3(DEC), 1–47. <https://doi.org/10.3389/frobt.2016.00074>
- Sorby, S. A., Drummer, T., Hungwe, K., & Charlesworth, P. (2005). Developing 3-D spatial visualization skills for non-engineering students. *ASEE Annual Conference and Exposition, Conference Proceedings, February 2021*, 4047–4057. <https://doi.org/10.18260/1-2--15370>
- Sudjana., Rivai., A. (2009). *Media Pengajaran*. Bandung: Sinar Baru Algensindo.

- Terlecki, M. S., & Newcombe, N. S. (2005). How important is the digital divide? the relation of computer and videogame usage to gender differences in mental rotation ability. *Sex Roles*, 53(5–6), 433–441. <https://doi.org/10.1007/s11199-005-6765-0>
- Sugiyono. (2024). *Metode Penelitian Kuantitatif: Dilengkapi dengan R&D, dan Mix Methods*. CV Alfabeta.
- Thahirah, N. F. (2024). *PENGARUH VIRTUAL REALITY (VR) TERHADAP KEMAMPUAN VISUAL SPASIAL PESERTA DIDIK*.
- Trimble Inc. (2024). *SketchUp Help Center*. <https://help.sketchup.com/en/sketchup/system-requirements>.
<https://help.sketchup.com/en/sketchup/system-requirements>
- Tuker, C. (2024). Encyclopedia of Computer Graphics and Games. *Encyclopedia of Computer Graphics and Games*, January. <https://doi.org/10.1007/978-3-031-23161-2>
- Wai, J., Lubinski, D., & Benbow, C. P. (2009). Spatial Ability for STEM Domains: Aligning Over 50 Years of Cumulative Psychological Knowledge Solidifies Its Importance. *Journal of Educational Psychology*, 101(4), 817–835. <https://doi.org/10.1037/a0016127>
- Wu, Bian., Yu, Xiaoxue., Gu, X. (2020). Effectiveness of immersive *Virtual Reality* (VR) using head-mounted displays on learning performance: A meta-analysis. *British Journal of Educational Technology*, 51(6). <https://doi.org/http://dx.doi.org/10.1111/bjet.13023>
- Yang, C., Zhang, J., Hu, Y., Yang, X., Chen, M., Shan, M., & Li, L. (2024). The impact of *Virtual Reality* (VR) on practical skills for students in science and engineering education: a meta-analysis. *International Journal of STEM Education*, 11(1). <https://doi.org/10.1186/s40594-024-00487-2>