Vol 14(2) (2025): 127-136
DOI: http://dx.doi.org/10.24235/sc.educatia.v14i2.24346

SCIENTIAE EDUCATIA: JURNAL PENDIDIKAN SAINS

http://www.syekhnurjati.ac.id/jurnal/index.php/sceducatia

Effects of Real-World Problem Worksheets Integrated with Higher Order Thinking Skills on Physics Learning Outcomes: A Study of Industrial Engineering Students

Muhammad Syahrul Kahar[a*], Muh Mawardi[b], Rahmatullah Bin Arsyad[c], Muhammad Fathurrahman[d], Sulkifli[e], Santi Rachman[f]

[a,d,f] Department of Pedagogy, Universitas Muhammadiyah Sorong, Sorong, Indonesia.
[b] Department of Physical Education, Universitas Muhammadiyah Sorong, Sorong, Indonesia.
[c] Department of Mathematics Education, Universitas Muhammadiyah Sorong, Sorong, Indonesia.
[e] Department of Primary Teacher Education, Universitas Muhammadiyah Sorong, Sorong, Indonesia

[*]Corresponding author: Barat Daya, Jl. Pendidikan No.27, Kelurahan Klabulu, Malaimsimsa, Sorong City, Southwest Papua 98416. E-mail addresses: syahrulkahar@um-sorong.ac.id

a r t i c l e i n f o

Article history:
Received: 07 September 2025
Received in revised form: 27 October 2025
Accepted: 10 December 2025
Available online: 31 December 2025

Keywords:
Worksheet
HOTS
Real-world problem
Physics learning

a b s t r a c t

This study aims to examine the effects of Real-World Problem Worksheets integrated with Higher Order Thinking Skills (HOTS) on students' physics learning outcomes in higher education. A pre-experimental research design with a one-group posttest-only configuration was employed as the methodological framework. Data were collected through a validated physics achievement test instrument specifically designed to assess student learning outcomes following the instructional intervention. The sampling procedure employed was cluster random sampling, with a total sample of 30 industrial engineering students from Universitas Muhammadiyah Sorong. The findings reveal that the mean student score reached 7.67, indicating a notable improvement in physics learning outcomes following the implementation of the Real-World Problem Worksheets. Statistical analysis using the t-test further demonstrated that the calculated t-value significantly exceeded the critical t-table value ($t = 17.95 > t\text{-table} = 2.05$), confirming that the implementation of Real-World Problem Worksheets integrated with HOTS produced a statistically significant improvement in students' physics learning outcomes. Furthermore, student response data indicated that the instructional intervention was received with highly favorable evaluations, reflecting strong learner acceptance and engagement with the worksheet-based approach. These findings collectively suggest that the integration of real-world contextual problems with HOTS-oriented worksheets constitutes a promising and empirically supported pedagogical strategy for enhancing physics learning outcomes in undergraduate science and engineering education.

1. Introduction

Learning is an important activity to achieve a learning goal. Learning is a fundamental process that determines students' cognitive development and learning outcomes (Parrales et al., 2020; Samputri, 2020), the learning objectives of success or not depend on how the learner in learning experiences the process (Deak & Santoso, 2021). In principle, every student has the right to achieve the desired results because results are a benchmark for changes experienced by students during the learning process, both in terms of value and thinking ability (Fitriani, 2022). One of the thinking abilities that students must have is the ability to think higher (higher-order thinking) (Kosasih et al., 2022). The ability to consider is a process carried out by a person in recalling the knowledge stored in his memory for one moment to be used in receiving information, processing, and concluding something (Muzayyanah et al., 2020). The ability to think at a higher level involves connecting, manipulating, and transforming existing knowledge and experiences to think critically and creatively, enabling individuals to make decisions and solve problems in new situations (Widyastuti, 2015) (Turan et al., 2019). The ability to think at a high level can make an individual capable of interpreting, analyzing, or manipulating the information obtained. The ability to think at a high level can be determined by learners' knowledge at the level of analysis, evaluation, and creation. In addition, the ability to think at a high level requires the ability to remember and, in practice, the ability to think critically and creatively (Saregar et al., 2016). Higher Order Thinking Skills (HOTS) involve analysis, evaluation, and creation as described in the revised Bloom’s taxonomy (Chawla et al., 2026; Xiao et al., 2025).

Based on observations made in the even semester of students of the industrial engineering study program, it was found that there was a lack of motivation to learn physics in students, resulting in low learning outcomes; the teaching materials used were quite interesting, and the learning resources used were still dominated by indicators of remembering, understanding, and application only. The questions used were ordinary (routine) questions and low-level questions. When students are given questions slightly different from the example, students will tend to have difficulty doing these questions (Gog et al., 2020; Olivier, 2020). The factor causing the low ability to think at the high level of students is the lack of availability of test questions specifically designed to train the use of high-level thinking in solving contextual questions, demanding reasoning, argumentation, and creativity in solving them (Lestasi, 2016). In addition, students are more likely to do common questions; therefore, to achieve physics learning goals, quality questions are needed, questions that not only include indicators of remembering, understanding, and application but also include analysis, evaluation, and creation so that there is a need for questions specifically designed to train HOTS, or students' high-level thinking skills. This result reinforces the importance of developing worksheet physics based on High Order Thinking Skills (HOTS) to teach students to develop their thinking skills (Kahar et al., 2021; Kusumaningtyas et al., 2024). Learner Worksheets are a learning aid made by the lecturer in activities that are arranged and designed according to the conditions and situations in the classroom, which contain instructions for the implementation of practice in the classroom, as well as experiments that can be carried out. In class and at home, as well as containing discussion materials and practice questions with instructions, students are more active in the learning process and create a pleasant environment that can help students succeed in learning (Fitriani, 2022).

For this reason, as a critical and creative educational subject, I get used to solving problems that fall into analyzing, evaluating, and creating. Indirectly, learners can face future challenges in the global competition for the decision-making process and problem solving (Kohn, 2024; Hadi et al., 2024). Based on the above issues, it is necessary to apply the worksheets of students integrated with HOTS in introductory physics courses in the lecture process (Astra et al., 2021; Sarina et al., 2025). Because the application of student worksheets can improve student learning outcomes, this is commensurate with the research conducted by Sartono B. (2019) that the application of the Discovery Learning learning model assisted by student worksheets can improve student physics learning outcomes.

The development of the learning paradigm in higher education demands a transformation from teacher-centered learning to student-centered learning (Cao et al., 2026; Feng et al., 2025). This transformation not only emphasizes the mastery of concepts but also the students' ability to construct knowledge independently through activities of analysis, evaluation, and creation. In the context of introductory physics learning, these abilities become very important because physics not only involves formulas and mathematical procedures but also requires deep conceptual understanding and the ability to relate concepts to real phenomena. However, in practice, the learning process often still focuses on solving routine problems, so the opportunity for students to develop higher-order thinking skills has not been fully facilitated. However, the implementation of real-world problem worksheets integrated with HOTS in physics learning remains underexplored (Kahar et al., 2021).

Several previous studies have reported that the use of worksheets can improve learning outcomes and student engagement (Kong & Wang, 2024; Powell et al., 2024). However, most of these studies emphasize the general improvement of learning outcomes without specifically integrating HOTS indicators into each component of activities in the worksheet. Additionally, research examining the implementation of a HOTS-oriented worksheet for students in non-educational study programs, such as industrial engineering, is still relatively limited. This condition indicates a research gap that needs to be filled, particularly in examining how the integration of HOTS in worksheets can make a tangible contribution to the improvement of physics learning outcomes at the university level. Previous studies have shown that the integration of real-world contexts in physics learning can significantly enhance students' conceptual understanding and engagement (Rizki et al., 2025; Wu et al., 2026).

Based on the description, an empirical study is needed that not only tests the effectiveness of using the worksheet but also examines the role of HOTS integration within it as a strategy to improve the quality of learning (Li et al., 2023; Retno et al., 2025). This research aims to provide a more comprehensive overview of the implementation of HOTS-integrated worksheets in introductory physics courses, while also strengthening the theoretical and practical foundations related to the development of learning tools oriented towards higher-order thinking skills. Thus, this research is expected to contribute to the development of more adaptive physics learning models in response to the demands of 21st-century education. This approach is also supported by problem-based learning theory, which emphasizes the importance of real-world problem solving in improving students' higher-order thinking skills (Ayanwale & Omeh, 2026; Chang et al., 2026).

2. Method

This study employed a pre-experimental design using a one-group post-test design (Hyeon & Oh, 2025; Wang et al., 2025). The population and samples are students of the industrial engineering study program at Universitas Muhammadiyah Sorong, totaling 30 students. The sampling technique was carried out considering the classes that are the research samples. As with the selection process of all categories, some types have heterogeneous learning outcomes ranging from high, medium, and low. The research instrument in this study is a test of physics learning outcomes. The data collection technique used in this study was student learning outcomes data. The data analysis technique used in this study is in the form of descriptive analysis. Descriptive analysis was used to describe student learning outcomes obtained after the application of student worksheets. The flowchart in this study is presented as shown in Figure 1.

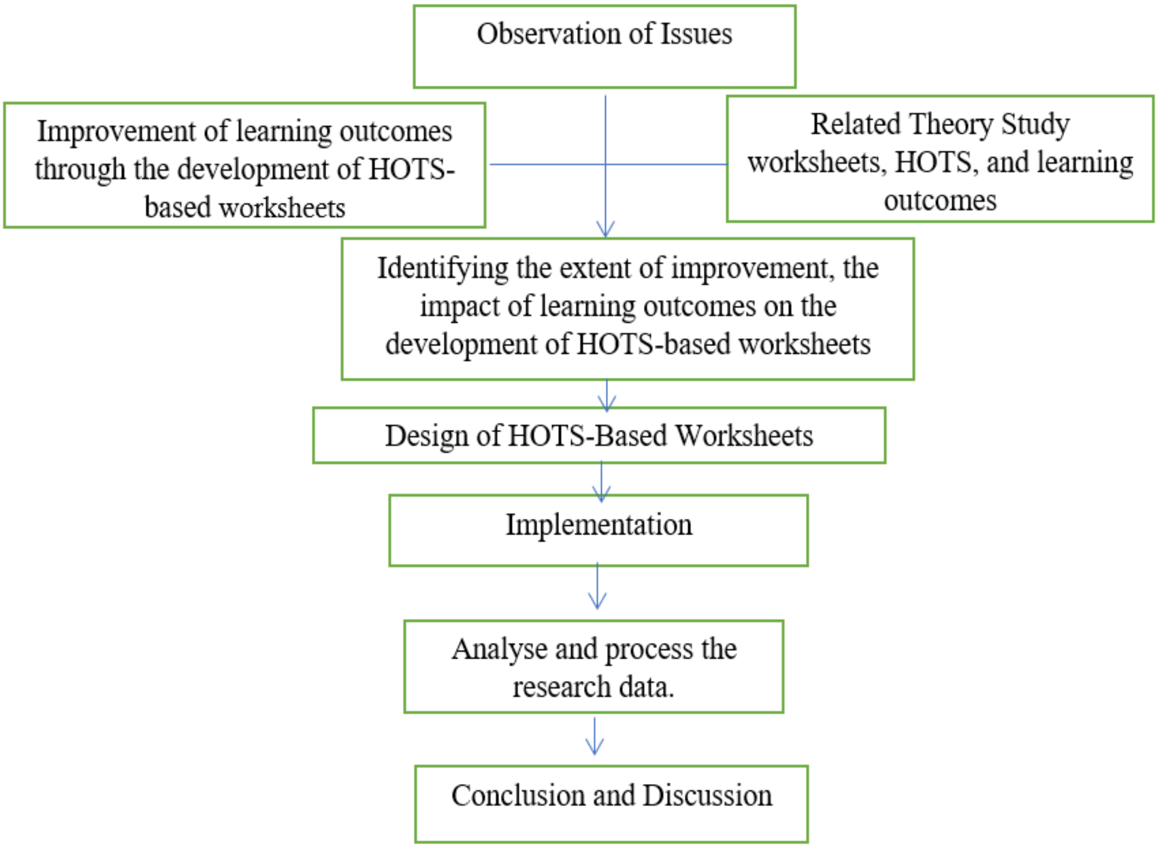

Figure 1. Research procedure

3. Result and Discussion

Following the implementation of the instructional intervention, descriptive statistical analysis was conducted to provide an initial overview of students' physics learning outcomes. The results of the descriptive statistical analysis are systematically presented in Table 1, encompassing key statistical parameters including the minimum score, maximum score, mean, and standard deviation of students' posttest scores. These descriptive statistics serve as the foundational basis for interpreting the overall distribution and central tendency of student learning outcomes following the implementation of Real-World Problem Worksheets integrated with Higher Order Thinking Skills (HOTS).

Table 1. Statistical descriptive test

	N	Min.	Max.	SD	Variance	Kurtos
Learning outcame	30	2.00	11.00	7.67	2.34	5.48

Note. SD = Standard Deviation; Min. = Minimum; Max. = Maximum; N = 30 (listwise)

As presented in Table 1, the mean student score of 7.67, equivalent to 76.7 on a 100-point scale, reflects a notable level of physics learning achievement following the implementation of the Real-World Problem Worksheets integrated with Higher Order Thinking Skills (HOTS). This finding indicates that the utilization of HOTS-integrated worksheets as an instructional tool effectively supports and encourages students' conceptual understanding of physics content. This result is consistent with the findings of Sulfemi and Mayasari (2019), who demonstrated that the systematic application of worksheets in instructional settings yields significant benefits for students by meaningfully improving their learning outcomes. The observed improvement in learning outcomes further aligns with empirical evidence establishing that the integration of real-world problem contexts into instructional materials substantially enhances students' depth of understanding and capacity for knowledge application (Wang et al., 2025). The extent to which students demonstrated higher-order thinking abilities as a result of the instructional intervention is further examined through the analysis of student learning outcomes presented in Table 2.

Table 2. One-sample test

Variable	t	df	p-value	Mean	95% CI Lower	95% CI Upper
Learning outcame	17.95	29	<0.001	7.68	6.80	8.54

As presented in Table 2, the results of the one-sample t-test reveal that the calculated t-value of 17.95 substantially exceeded the critical t-table value of 2.05 (t = 17.95 > t-table = 2.05), leading to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_a). This finding confirms that the implementation of Real-World Problem Worksheets integrated with Higher Order Thinking Skills (HOTS) produced a statistically significant improvement in students' physics learning outcomes in the introductory physics course. The mean posttest score further demonstrates that students' learning outcomes met and satisfied the established minimum completion criteria following the instructional intervention.

These findings are consistent with those of previous empirical studies demonstrating that HOTS-oriented learning activities significantly enhance conceptual understanding, critical thinking skills, and overall academic achievement in science education (Kim, 2025; Yee et al., 2015). Furthermore, the results corroborate the assertion of Hasbiyalloh et al. (2017), who established that the systematic application of student worksheets exerts a significant and positive impact on student learning outcomes. Collectively, these findings affirm that the integration of HOTS-oriented Real-World Problem Worksheets into introductory physics instruction constitutes an empirically supported and pedagogically effective strategy for enhancing students' conceptual understanding, higher-order thinking development, and overall physics learning achievement at the undergraduate level.

The improvement in learning outcomes obtained indicates that the integration of HOTS in Worksheet contributes to the thinking process of students during the learning process. Worksheet designed with an orientation towards analysis, evaluation, and creation encourages students not only to understand concepts procedurally but also to relate them to more contextual problem situations. This process allows students to build a deeper understanding of basic physics material, so that the learning outcomes achieved are not merely rote memorisation, but rather based on reasoning processes. This finding is consistent with the concept of higher-order thinking proposed in Taxonomy of Educational Objectives, particularly in the cognitive domains of analysing, evaluating, and creating. In addition, learning activities that emphasise reasoning and contextual problem-solving are considered effective in improving conceptual understanding and students' critical thinking abilities (Díaz-Simón & Ansari, 2025; Liu et al., 2026).

Theoretically, the improvement can be explained through a constructivist approach that emphasises that knowledge is actively constructed by learners through interaction with the learning environment. HOTS-oriented Worksheet facilitates students to explore concepts, discuss findings, and reflect on their thought processes. These activities indirectly train critical and creative thinking skills, which are the core of higher-order thinking abilities. Thus, learning is no longer centred on the lecturer, but provides a greater space for students to develop their intellectual potential. This is in line with the constructivist theory proposed by (Choi, 2025), which emphasises that learners actively construct knowledge through experience and social interaction. In addition, HOTS-oriented learning activities support the development of analytical and evaluative thinking skills that contribute to improving student learning outcomes (Affandy et al., 2024).

In addition, the active involvement of students in working on Worksheet also plays a role in increasing their learning motivation. in accordance with (AlBannai, 2025) When students are faced with questions that require analysis and problem-solving, they are encouraged to be more focused and engaged in the learning process. This engagement creates a more meaningful learning experience compared to the mechanical completion of routine problems. Therefore, the improvement in learning outcomes achieved not only reflects academic success but also indicates a change in the quality of the learning process experienced by the students.

The results of this study also reinforce previous findings that state that (Dwivedi et al., 2024; Gonzalez et al., 2024) learning devices designed systematically and orientated towards higher-order thinking skills can improve students' learning achievements. The implementation of HOTS-integrated Worksheet in this study shows that the approach is relevant to be applied in basic physics learning at universities, particularly for industrial engineering students. Thus, the use of HOTS-oriented Worksheet can be considered as one of the effective learning strategies to improve the quality of learning sustainably.

When compared to previous studies, the findings in this research show consistency that the use of Worksheet designed in a structured manner can have a positive impact on learning outcomes. However, the main difference in this study lies in the explicit integration of HOTS indicators in every component of the activities in the Worksheet (Astra et al., 2021; Sarina et al., 2025). This integration not only places questions at the levels of analysis, evaluation, and creation but also directs students to go through systematic thinking stages before arriving at the final answer. Thus, the improvement in learning outcomes that occurred is not solely due to the use of media, but rather by the deliberate design of cognitive activities aimed at training higher-order thinking skills.

Furthermore, the statistical test results showing that the t-value is greater than the t-table indicate that the observed improvement is not coincidental, but rather statistically significant. This reinforces the assumption that HOTS-based learning has a significant impact on students' academic achievements. Pedagogically, this condition shows that students need stimuli in the form of challenging problems to be able to develop their thinking potential optimally. When students are accustomed to facing problems with a higher level of complexity, their analysis and evaluation skills will develop in line with the intensity of the training provided (Fitriani, 2022).

On the other hand, the implementation of HOTS-integrated Worksheet also illustrates that basic physics learning can be packaged in a more contextual and applicative manner. Students do not only focus on solving calculations, but also on understanding the conceptual meaning behind each step of the solution. This is important because physics education at the university level should not stop at procedural aspects, but rather encourage students to connect concepts with broader engineering problems. Therefore, the findings of this research imply that the integration of HOTS in learning devices is a relevant strategy to simultaneously improve the quality of the learning process and outcomes (Kahar et al., 2021; Kusumaningtyas et al., 2024).

Theoretically, the results of this study reinforce the concept that the development of HOTS-oriented learning tools can be an effective means to enhance the quality of students' cognitive processes (Abidin, 2026; Hao et al., 2026). The integration of analysis, evaluation, and creation activities in the Worksheet shows that systematically designed learning can encourage students to achieve higher levels of thinking. These findings are in line with the revised cognitive taxonomy theory, which places the abilities to analyse, evaluate, and create as indicators of advanced cognitive achievement. Thus, this research contributes to strengthening the theoretical foundation regarding the importance of HOTS-based learning design in the context of higher education, particularly in basic physics education.

Practically, the implementation of HOTS-integrated Worksheet provides an alternative learning strategy that can be implemented by lecturers in lectures. The integrated HOTS Worksheet not only serves as a practice sheet but also as an activity guide that directs students to think systematically and reflectively. Lecturers can develop Worksheet by incorporating contextual problems relevant to the field of industrial engineering, making it easier for students to relate physics concepts to real-world applications in the field. This approach has the potential to increase student engagement and create a more interactive and meaningful learning environment. In addition, the use of contextual and HOTS-oriented learning materials can improve students' problem-solving abilities, analytical thinking, and active participation in the learning process (Annajmi et al., 2026).

In addition, the implications of this research also indicate that the development of learning tools should not only be orientated towards achieving final grades but also towards the process of shaping students' mindsets. The integration of HOTS in Worksheet can be an initial step towards building an academic culture that encourages students to think critically and creatively in a sustainable manner (Peterson, 2010; Solinska-Nowak et al., 2018). Therefore, the development of HOTS-oriented Worksheet can be considered as part of the strategy to improve the quality of learning in higher education, especially in foundational courses that serve as the basis for advanced courses.

4. Conclusion

The conclusion of this study explains that the application of HOTS-integrated student worksheets in introductory physics courses has an impact on improving student learning outcomes; therefore, based on the data obtained, it illustrates that the average results of student learning outcomes have increased after applying worksheets oriented to HOTS. It is recommended that lecturers apply real world problem worksheets integrated with HOTS in physics learning to enhance students' critical thinking and problem-solving skills. However, this study has several limitations, particularly the use of a one-group post-test design without a control group, which may limit the generalizability of the findings. Therefore, future research is suggested to involve more rigorous experimental designs with control groups, larger sample sizes, and different subject areas to further validate the effectiveness of this approach.

Acknowledgments

Heartfelt gratitude to the Ministry of Education, Culture, Research, and Technology, Directorate General of Higher Education, for the research funding assistance provided in 2022.

References

Abidin, Z. Z. (2026). Learning by brewing tea: Student experiences of a kolb-aligned, constructivist, learning-oriented assessment in chemical engineering. *Education for Chemical Engineers*, *54*, 100495. https://doi.org/https://doi.org/10.1016/j.ece.2025.100495

Affandy, H., Sunarno, W., Suryana, R., & Harjana. (2024). Integrating creative pedagogy into problem-based learning: The effects on higher order thinking skills in science education. *Thinking Skills and Creativity,* *53*, 101575. https://doi.org/https://doi.org/10.1016/j.tsc.2024.101575

AlBannai, N. A. (2025). From classroom to Boardroom: Ethical and cognitive challenges of ChatGPT use among DBA students in business problem-solving. *The International Journal of Management Education*, *23*(3), 101254. https://doi.org/https://doi.org/10.1016/j.ijme.2025.101254

Annajmi, A., Kuswandi, D., Setyosari, P., & Praherdhiono, H. (2026). Integrating multiple representations and local cultural contexts into problem-based learning within a flipped classroom: A new framework for mathematics education. *Social Sciences & Humanities Open*, *13*, 102797. https://doi.org/https://doi.org/10.1016/j.ssaho.2026.102797

Astra, I. M., Nurjannah, I., & Bakri, F. (2021). Hots and the 21st century learning skills: Formed with practicum-based physics learning worksheets. *AIP Conference Proceedings*, *2320*(1), 20012.

Ayanwale, M. A., & Omeh, C. B. (2026). AI-supported problem-based learning for enhancing computational thinking skills in STEM education. *Computers in Human Behavior: Artificial Humans*, *7*, 100263. https://doi.org/https://doi.org/10.1016/j.chbah.2026.100263

Cao, X., Huang, Z., Li, M., & He, T. (2026). Teachers' AI-TPACK as a tangible outcome in the digital transformation of education: A machine learning-based multilevel approach. *Teaching and Teacher Education*, *169*, 105270. https://doi.org/https://doi.org/10.1016/j.tate.2025.105270

Chang, S.-J., Lin, C.-T., & Chen, Y.-H. (2026). Cultivating thinking skills and computational thinking in higher education: A case-based decision-support model from Taiwan. *Thinking Skills and Creativity*, *61*, 102143. https://doi.org/https://doi.org/10.1016/j.tsc.2026.102143

Chawla, K., Uday Phatak, J., & Chawla, R. (2026). Comparison of high school textbooks analyzing higher order thinking skills development in India and Singapore. *Thinking Skills and Creativity*, *60*, 102058. https://doi.org/https://doi.org/10.1016/j.tsc.2025.102058

Choi, W. (2025). The role of changes in pronunciation ability and anxiety through Gen-AI on EFL learners' self-directed speaking motivation and social interaction confidence - A CHAT perspective. *System*, *133*, 103788. https://doi.org/https://doi.org/10.1016/j.system.2025.103788

Deak, V., & Santoso, R. (2021). Learning strategies and applications in learning achievements. *International Journal of Social and Management Studies*, *2*(4), 159–167. https://doi.org/10.5555/ijosmas.v2i4.64

Díaz-Simón, N., & Ansari, D. (2025). Learning arithmetic strategies: The roles of individual and contextual factors. In J. J. B. T.-A. in C. D. and B. LOCKMAN (Ed.), *Foundations of Literacy* (Vol. 68, pp. 187–221). JAI. https://doi.org/https://doi.org/10.1016/bs.acdb.2025.03.004

Dwivedi, Y. K., Jeyaraj, A., Hughes, L., Davies, G. H., Ahuja, M., Albashrawi, M. A., Al-Busaidi, A. S., Al-Sharhan, S., Al-Sulaiti, K. I., Altinay, L., Amalaya, S., Archak, S., Ballestar, M. T., Bhagwat, S. A., Bharadwaj, A., Bhushan, A., Bose, I., Budhwar, P., Bunker, D., … Walton, P. (2024). "Real impact": Challenges and opportunities in bridging the gap between research and practice – Making a difference in industry, policy, and society. *International Journal of Information Management*, *78*, 102750. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2023.102750

Feng, S., Zhang, H., & Gašević, D. (2025). Mapping the evolution of AI in education: Toward a co-adaptive and human-centered paradigm. *Computers and Education: Artificial Intelligence*, *9*, 100513. https://doi.org/https://doi.org/10.1016/j.caeai.2025.100513

Gog, T. Van, Hoogerheide, V., & Harsel, M. Van. (2020). *The Role of Mental Effort in Fostering Self-Regulated Learning with Problem-Solving Tasks*. 1055–1072.

Gonzalez, R., Gasco, J., & Llopis, J. (2024). Towards organisation 4.0. An empirical study. *International Journal of Information Management*, *75*, 102746. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2023.102746

Hadi , M. Z. P., Hartono, R., & Rozi , F. (2024). Problem Solving and Decision Making in Educational Context. *Jurnal Ilmu Sosial Dan Humaniora*, *2*(4), 461–470. https://doi.org/10.57248/jishum.v2i4.408

Hao, L., Yusoff, S. M., & Tian, K. (2026). Impacts of AI-enhanced task-based learning on EFL postgraduates' higher order thinking skills and English academic writing self-efficacy. *Journal of English for Academic Purposes*, *80*, 101652. https://doi.org/https://doi.org/10.1016/j.jeap.2026.101652

Hyeon, R., & Oh, W.-O. (2025). Virtual reality education for preventing safety incidents in pediatric hospital settings: Quasi-experimental design pre-post-testing. *Journal of Pediatric Nursing*, *80*, 56–63. https://doi.org/https://doi.org/10.1016/j.pedn.2024.11.005

Kahar, M. S., Syahputra, R., Arsyad, R. Bin, Nursetiawan, N., & Mujiarto, M. (2021). Design of Student Worksheets Oriented to Higher Order Thinking Skills (HOTS) in Physics Learning. *Eurasian Journal of Educational Research*, *96*, 14–29.

Kim, A. (2025). Exploring how institutional structures shape instructional quality: The roles of teacher education, employment, and development in fostering higher-order thinking skills. *Thinking Skills and Creativity*, *58*, 101954. https://doi.org/https://doi.org/10.1016/j.tsc.2025.101954

Kohn, P. (2024). Simulations and Role-Plays: Enhancing Decision-Making and Problem-Solving Skills. In *Elevating Leadership: Innovative Teaching Methods for Developing Future Leaders* (pp. 41–57). Emerald Publishing Limited.

Kong, S.-C., & Wang, Y.-Q. (2024). Dynamic interplays between self-regulated learning and computational thinking in primary school students through animations and worksheets. *Computers & Education*, *220*, 105126. https://doi.org/https://doi.org/10.1016/j.compedu.2024.105126

Kosasih, A., Supriyadi, T., Firmansyah, M. I., & Rahminawati, N. (2022). Higher-Order Thinking Skills in Primary School. *Journal of Ethnic and Cultural Studies*, *9*(1), 56–76.

Kusumaningtyas, D. A., Manyunu, M., & Kurniasari, E. (2024). *DOI: 10.23917/ijolae.v6i1.23125 Received: September 29*. *6*(1), 14–31. https://doi.org/10.23917/ijolae.v6i1.23125

Li, J., Goei, S. L., & Van Joolingen, W. R. (2023). A case study of teacher learning in enacting maker pedagogy through lesson study. *International Journal for Lesson and Learning Studies*, *12*(3), 240–256. https://doi.org/https://doi.org/10.1108/IJLLS-04-2023-0042

Liu, Z., Cheon, S., Stanbury, A., Jiao, X., Xing, W., & Kang, H. (2026). Towards contextual-based AI: A scoping review of artificial intelligence in X reality for personalized learning. *Computers and Education: Artificial Intelligence*, *10*, 100523. https://doi.org/https://doi.org/10.1016/j.caeai.2025.100523

Parrales, E. B. A., Palma, J. K. T., Álava, R. A. Q., & Campuzano, M. F. P. (2020). The cognitive process and influence in learning. *International Journal of Linguistics, Literature and Culture*, *6*(2), 59–66.

Peterson, R. (2010). The persistence of low expectations in special education law viewed through the lens of therapeutic jurisprudence. *International Journal of Law and Psychiatry*, *33*(5), 375–397.

https://doi.org/https://doi.org/10.1016/j.ijlp.2010.09.009
Powell, J., Chairs, S., D'Adamo, C. R., Wolf, J., & Feinman, M. (2024). Worksheet-Based Delivery System to Improve Participation and Engagement in Basic Science. *Journal of Surgical Education*, *81*(11), 1558–1564. https://doi.org/https://doi.org/10.1016/j.jsurg.2024.07.026
Retno, R. S., Purnomo, P., Hidayat, A., & Mashfufah, A. (2025). Conceptual framework design for STEM-integrated project-based learning (PjBL-STEM) for elementary schools. *Asian Education and Development Studies*, *14*(3), 579–604. https://doi.org/https://doi.org/10.1108/AEDS-08-2024-0188
Rizki, I. A., Mirsa, F. R., Islamiyah, A. N., Saputri, A. D., Ramadani, R., & Habibbulloh, M. (2025). Ethnoscience-enhanced physics virtual simulation and augmented reality with inquiry learning: Impact on students' creativity and motivation. *Thinking Skills and Creativity*, *57*, 101846. https://doi.org/https://doi.org/10.1016/j.tsc.2025.101846
Samputri, S. (2020). Science process skills and cognitive learning outcomes through discovery learning models. *European Journal of Education Studies*.
Sarina, S., Pasaribu, M., Nurjannah, N., Paramita, I., & kami Sani, N. (2025). Development of Student Worksheets Based on HOTS Model Problem Based Learning to Improve Student Learning Outcomes. *Journal of Innovative Physics Education Research*, *1*(2), 57–66.
Solinska-Nowak, A., Magnuszewski, P., Curl, M., French, A., Keating, A., Mochizuki, J., Liu, W., Mechler, R., Kulakowska, M., & Jarzabek, L. (2018). An overview of serious games for disaster risk management – Prospects and limitations for informing actions to arrest increasing risk. *International Journal of Disaster Risk Reduction*, *31*, 1013–1029. https://doi.org/https://doi.org/10.1016/j.ijdrr.2018.09.001
Turan, U., Fidan, Y., & Yıldıran, C. (2019). *Journal of History Culture and Art Research (ISSN : 2147-0626) Critical Thinking as a Qualified Decision-Making Tool*. *8*(4), 1–18. https://doi.org/10.7596/taksad.v8i4.2316
Wang, Y.-N., Hsu, A.-Y., Huang, S.-C., Chuang, H.-C., & Hsu, W.-C. (2025). A 3-month integrated exercise intervention improves diagnostic parameters of sarcopenia in ambulatory community-dwelling older adults with Dementia: A two-group pre-test/post-test design. *Geriatric Nursing*, *63*, 590–596. https://doi.org/https://doi.org/10.1016/j.gerinurse.2025.04.026
Wu, T.-T., Sari, N. A. R. M., Chen, H.-R., & Huang, Y.-M. (2026). Enhancing students' knowledge construction and affective-domain learning objectives through computational thinking integrated into project-based learning in online learning environments. *Thinking Skills and Creativity*, *59*, 102013. https://doi.org/https://doi.org/10.1016/j.tsc.2025.102013
Xiao, X., Li, Y., He, X., Fang, J., Yan, Z., & Xie, C. (2025). An assessment framework of higher-order thinking skills based on fine-tuned large language models. *Expert Systems with Applications*, *272*. https://doi.org/10.1016/j.eswa.2025.126531
Yee, M. H., Yunos, J. M., Othman, W., Hassan, R., Tee, T. K., & Mohamad, M. M. (2015). Disparity of Learning Styles and Higher Order Thinking Skills among Technical Students. *Procedia - Social and Behavioral Sciences*, *204*, 143–152. https://doi.org/https://doi.org/10.1016/j.sbspro.2015.08.127