INTERNATIONAL CONFERENCE ON DIGITAL, SOCIAL, AND SCIENCE
VOL. 02 (2025)
ISSN 3063-3303

The Effectiveness of the Use of A'bulo Sibatang-Based Physics Co-Curricular Activity Worksheets on HOTS and Students' Collaboration Skills

Muhammad Tahir[1], Mahir[2*], M. A. Martawijaya[3], Abdul Haris[4], and Mutahharah Hasyim[5]

[1,2,3,4,5]*Department of Physics, Faculty of Mathematics and Natural Sciences, Makassar State University, Makassar, Indonesia*

**Corresponding author: mahir@unm.ac.id*

ABSTRACT

Integrating physics learning with local wisdom can strengthen the understanding of concepts well and support efforts to achieve the Sustainable Development Goals (SDGs) in the aspect of quality education in 2030. These efforts are often constrained by the classroom implementation time, especially in the form of contextual investigations using Student Worksheets (LKPD). This study aims to analyze the effectiveness of using LKPD physics co-curricular activities based on local wisdom by A'bulo Sibatang on higher-order thinking Skills (HOTS) and student collaboration skills. This study uses a mixed method of Explanatory Sequential type. The quantitative method used a pre-experimental one-group pretest-posttest design to measure changes in students' HOTS ability, and the qualitative method used an ethnomethodological approach based on the results of observation using LKPD to measure students' collaboration skills. The study's results showed the effectiveness of the use of LKPD physics co-curricular activities based on the local wisdom of A'bulo Sibatang on the HOTS ability of students who had a significance of 0.001 or less than 0.05. Meanwhile, students' collaboration skills showed positive changes according to observer assessments during LKPD physics co-curricular activities based on local wisdom A'bulo Sibatang. This study concludes that the LKPD physics co-curricular activities based on the local wisdom of A'bulo Sibatang are effectively used on HOTS abilities and students' collaboration skills. This research also contributes to achieving quality education in Indonesia by integrating A'bulo Sibatang culture into physics learning.

***Keywords**: A'bulo Sibatang, HOTS, LKPD, Physics Cocurricular, SDGs*

1. INTRODUCTION

21st-century education demands a paradigm shift in the learning process, from mechanistic to holistic learning oriented towards the development of essential competencies, one of which is Higher Order Thinking Skills (HOTS) and collaboration skills (Haris et al., 2025; Kosasih et al., 2022; Saptono et al., 2020). These skills are not only an indicator of academic success but are also a key foundation in preparing young people who can actively participate in the face of complex and unpredictable global challenges (Kwangmuang et al., 2021; Lu et al., 2021; Shanti et al., 2022). Integrating HOTS and collaborative skills in learning is no longer just an option but a strategic need in forming a student profile that is adaptive, reflective, and ready to face the dynamics of the times.

PT EBIZ PRIMA NUSA

The HOTS domain, which includes the three highest cognitive levels in the revised Bloom Taxonomy, namely analyzing (C4), evaluating (C5), and creating (C6), is the leading indicator of students' complex thinking ability (Lee et al., 2024; Samadi et al., 2024; Utama et al., 2020). At the analysis level, students are trained to parse information, identify relationship patterns, and systematically distinguish relevant and irrelevant arguments. At the evaluation stage, students are expected to be able to assess information, ideas, or solutions based on specific criteria logically, objectively, and argumentatively. Meanwhile, the creative stage requires students to integrate a wide range of knowledge and experience to generate original ideas, innovative solutions, or valuable creative products. This process reflects high-level thinking abilities that are adaptive to social dynamics and global challenges (Dewi et al., 2020; Martawijaya et al., 2023; Rampean & Rohaeti, 2025). These three stages are essential elements in the transformative learning carried out by the Independent Curriculum and play a strategic role in forming students who are independent, creative, and ready to face real-world complexities.

With increasing global social complexity, the world of education is required to produce not only cognitively capable individuals but also adaptive, collaborative, and highly competitive. In response to these challenges and dynamics, the Indonesian government, through the Independent Learning policy and the Independent Curriculum, encourages the strengthening of the Pancasila Student Profile as a framework for developing students' character and competencies holistically. One of the main dimensions in the Pancasila Student Profile is "mutual cooperation," which is substantively closely intertwined with the concept of collaboration in a global context and 21st Century Learning (Nahar et al., 2022; Teuwen et al., 2024; Thornhill-Miller et al., 2023). Collaboration-based learning is expected to increase student involvement, strengthen understanding of concepts, and form positive social dispositions such as empathy, tolerance, and responsibility.

Collaboration skills are an integral part of the Pancasila Student Profile, which emphasizes the importance of cooperation as a vehicle for character formation and social capacity building of students. Meaningful collaboration occurs through physical interaction and the critical and reflective exchange of ideas in academic discussions, group projects, and problem-based learning. In the context of learning, these skills include the ability to listen to the opinions of others, contribute ideas, resolve conflicts constructively, and achieve common goals synergistically (Aunger et al., 2021; Nezami et al., 2024; Paredes-Saavedra et al., 2024). The application of collaboration-based learning improves student learning outcomes and strengthens character and social skills essential for life in society.

The relevance of HOTS and collaboration skills becomes increasingly significant when associated with objectives *Sustainable Development Goals* (SDGs), especially SDGs 4 which emphasizes the importance of inclusive and equitable quality education for all (Aguado-Correa et al., 2023; Maryanti et al., 2022; Ricciolini et al., 2022). Improving the quality of education through learning that encourages high-level and collaborative thinking skills indirectly supports the achievement of other SDGs targets, such as poverty alleviation (SDGs 1) (Filho et al., 2022), industrial innovation (SDGs 9) (Azmat et al., 2023), and partnerships to achieve the goals (SDGs 17) (Pedersen et al., 2023). Therefore, transformation in the learning approach is crucial to realize education that not only

emphasizes knowledge transfer, but also the formation of character and competency across disciplines.

As one of the exact disciplines, physics has unique characteristics that have great potential in developing HOTS and student collaboration skills. Physics concepts that are abstract, complex, and require mathematical modeling can stimulate students' analytical and problem-solving abilities, especially when presented in a real-life context (Becker et al., 2020; Bouchée et al., 2023; Bozzi et al., 2021; Stadermann & Goedhart, 2021). Physics learning directed at exploring phenomena through experiments, group discussions, and joint problem-solving activities has proven effective in encouraging social interaction and cooperative learning. In bridging the gap between abstract concepts of physics and students' concrete experiences, contextual and meaningful learning strategies are needed (Bassachs et al., 2020; Dziob et al., 2022). One approach that can be adopted is integrating local cultural values into learning activities.

Local wisdom is a cultural product that includes customs, norms, rituals, ethics, beliefs, values, customs, and philosophies. In this case, local wisdom is divided into two parts, namely, the material aspect and *non-material*. The material aspect includes elements such as traditional clothing, handicrafts, and traditional buildings. Meanwhile, the *non-material* from local wisdom can be understood as philosophical values (Hamdan & Basrowi, 2024; Muhammad et al., 2022; Sofyan et al., 2019; Warman et al., 2023). A'bulo Sibatang is one of the representations of the local wisdom of the Bugis-Makassar community. Value A'bulo Sibatang contains a philosophy of togetherness, honesty, responsibility, and solidarity. There are four of the eight behaviors of Mabbulo Sipeppa or A'buo Sibatang that are applied, including *Assamaturu ri pa'rappungang* means to be equal in a group, *Sipakalabbiri* means mutual respect, *Siagang baji na kodi pa'mai* meaning together in joy and sorrow, and *A Taste of the Wild* which means justifying each other if it is true. These values align with the collaborative principles and academic integrity needed in the 21st-century learning process (Afrianti et al., 2024; Kurnia et al., 2022; Scott, 2006). In the local context of Indonesia, especially in areas with cultural richness such as South Sulawesi, values such as A'bulo Sibatang have not been widely used as a basis for the development of teaching materials.

Using the A'bulo Sibatang-based Peseta Didik Worksheet (LKPD) can enrich the affective and social dimensions and strengthen the connection between students and their culture and social context, making learning more relevant and sustainable. In particular, in physics learning at the secondary level, LKPD still tends to focus on purely cognitive aspects, such as calculation exercises and formula application, without being systematically designed to encourage HOTS and collaborative skills (Burfeind & Devine, 2020; Hartman-Caverly et al., 2023; Nybo et al., 2020). The LKPD is a worksheet that students can use, containing practicum instructions, experiments that can be done at home, discussion materials, portfolio assignments, and various practice questions. LKPD is used to optimize student participation in the learning process (Bakri et al., 2020; Kahar et al., 2021). Implementing A'bulo Sibatang-based LKPD requires sufficient time, so to ensure its effectiveness, this activity must be integrated with time outside the classroom through extracurricular activities available at school.

Co-curricular activities today are ceremonial or administrative, without a structured and meaningful pedagogical design. This indicates a gap in educational practice, where activities outside the classroom have not been optimally utilized to shape 21st-century competencies (Almazroa & Alotaibi, 2023; Asad et al., 2021; Reddy et al., 2023). Co-curricular activities support education and improve social interaction, leadership skills, discipline, and self-confidence. Co-curricular activities offer an informal platform for mutual interaction that supports participants or individuals in realizing their potential (El-Haggar et al., 2019; Henderson et al., 2022; Li et al., 2021). With the diversity of students in educational institutions, these informal interactions allow them to explore and develop their abilities in a practical and creative way.

21st-century education requires a transformation of the learning approach towards strengthening higher-level thinking skills (HOTS) and collaboration. HOTS includes the ability to analyze (C4), evaluate (C5), and create (C6) in the revised Bloom Taxonomy. Meanwhile, collaborative skills are seen as one of the important pillars in the Pancasila Student Profile and the Merdeka curriculum. Previous research has shown that the integration of local wisdom in learning is able to improve students' conceptual understanding and character (Lubis et al., 2022; Hikmawati et al., 2024). For example, the application of Balinese local culture in science learning increases student engagement and creativity. However, there have not been many studies that explicitly examine the influence of local cultural values such as A'bulo Sibatang in the context of physics learning for HOTS and collaboration.

Planning and implementation of physics-based co-curricular activity worksheet based on A'bulo Sibatang, a contextual approach that combines modern science learning with the values of local wisdom of the Bugis-Makassar community. A'bulo Sibatang, as a cultural concept that emphasizes the importance of togetherness, integrity, and social responsibility, is explicitly used as a value framework in the structure of the worksheet (Martawijaya et al., 2025). The novelty of this research lies in the integration of three important dimensions in contemporary education: the cognitive dimension (HOTS), the social-emotional (collaboration), and the cultural (local values). Most previous studies have tended to separate the development of these competencies or emphasize only one of its aspects. Therefore, this study is designed to examine the effectiveness of the use of Student Worksheets in physics co-curricular activities that are integrated with the local wisdom of A'bulo Sibatang as an effort to strengthen the quality of learning while making a real contribution to the achievement of quality education goals within the framework of the SDGs 2030. In particular, this study is focused on two main objectives: (1) to analyze the improvement of students' HOTS abilities as a result of the implementation of local culture-based LKPD and (2) to identify the development of students' collaborative skills that emerge during contextual learning processes that adopt local values as pedagogical foundations.

2. METHODS

This study uses the mixed method with the model Explanatory Sequential (Creswell, 2014; Sugiyono, 2013); namely, the quantitative approach is carried out first and followed by a qualitative approach to provide a deeper understanding of the quantitative results

obtained. At the quantitative stage, the design used is Pre-experimental with model One-group pretest-posttest, where students were given tests before and after the intervention to measure the improvement of HOTS ability after using LKPD co-curricular activities based on local wisdom of A'bulo Sibatang. Meanwhile, at the qualitative level, Ethnomethodology (Indrawan & Yaniawati, 2017) explores students' collaboration skills that align with the A'bulo Sibatang culture, which is carried out through semi-structured observation and teacher interviews.

The subjects in this study are high school students at one of the schools in the area with an A'bulo Sibatang cultural background. The subjects were selected using purposive sampling techniques, considering that students are actively involved in physics co-curricular activities and have obtained basic materials that support the development of high-level thinking skills (HOTS). The instruments used in this study consist of quantitative and qualitative instruments designed to measure two main aspects, namely HOTS ability and student collaboration skills. The quantitative instrument is in the form of a HOTS description test developed based on the revised Bloom taxonomic indicators at levels C4 (analyze), C5 (evaluate), and C6 (create). Meanwhile, the qualitative instrument is in the form of a collaboration skill observation sheet.

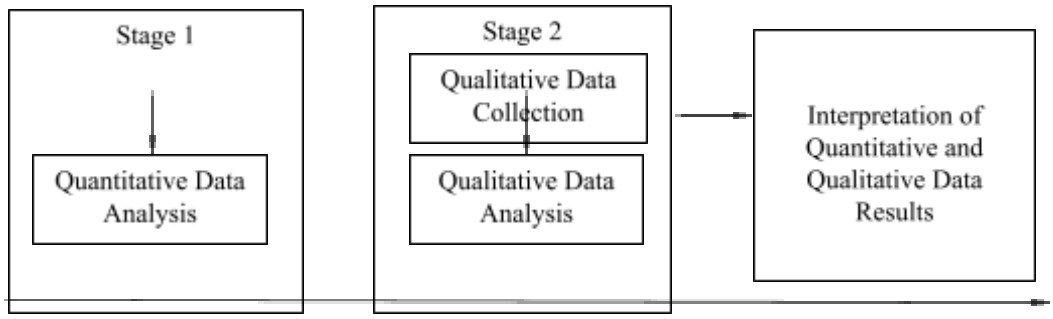

Figure 1. Stages of Research

The data collection process in this study was carried out in stages according to the Explanatory Sequential approach used. At the quantitative stage, data was obtained by implementing pretest and posttest tests on students before and after using LKPD physics co-curricular activities based on the local wisdom of A'bulo Sibatang. Furthermore, at the qualitative stage, data was collected through structured observation during the implementation of co-curricular activities involving the use of LKPD. Data analysis in this study was carried out separately for quantitative and qualitative data, in line with the mixed method Explanatory Sequential approach used. Quantitative data obtained from the results of the students' HOTS ability pretest and posttest tests were analyzed using a non-parametric statistical test paired sample t-test (Wilcoxon Signed Ranks Test). This test aims to determine the significance of the difference in scores before and after the intervention by using a worksheet of co-curricular activities based on the local wisdom of A'bulo Sibatang. The test was performed at a significance level of 5% ($p < 0.05$) to determine whether the changes that occurred were statistically significant. Meanwhile, qualitative data from observation and interviews on collaboration skills were analyzed using a qualitative

ethnomethodology approach based on students' collaborative behavior tendencies reflected in group learning activities based on A'bulo Sibatang culture.

3. RESULTS AND DISCUSSION

The effectiveness of using LKPD in A'bulo Sibatang-based physics co-curricular activities uses a mixed-methods approach by combining quantitative and qualitative data to obtain a comprehensive understanding of the impact of LKPD implementation. The HOTS capabilities were measured through pre-test and post-test, which were analyzed using a non-parametric paired sample t-test (Wilcoxon Signed Ranks Test) to identify statistically significant changes. Meanwhile, structured observations of group dynamics during co-curricular activities were used to capture student collaboration skills transformations. The synergy between quantitative and qualitative findings is the basis for interpreting local values-based learning approaches' effectiveness in strengthening competencies in the 21st century.

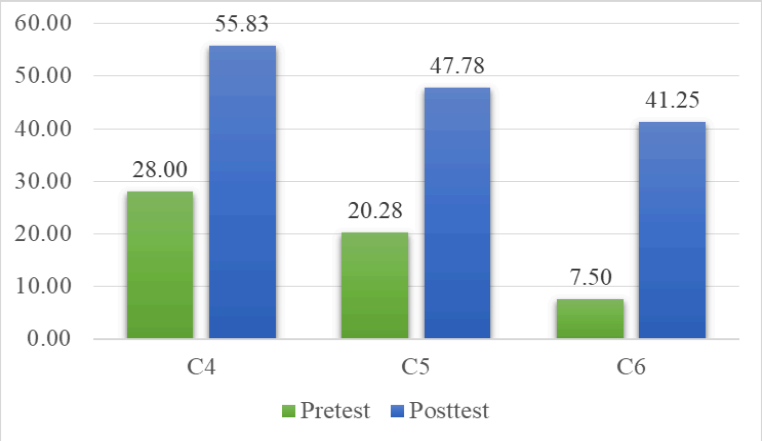

Figure 2. Average Pretest-posttest Scores of Students' Cognitive Level

Quantitative analysis showed that the average HOTS score of students increased substantially after the intervention using LKPD of A'bulo Sibatang-based physics co-curricular activities. Based on the bar chart shown in Figure 2. A comparison of pretest and posttest scores of students' high-level thinking ability can be seen at the three levels of the revised Bloom cognitive taxonomy, namely C4 (analyzing), C5 (evaluating), and C6 (creating). There were significant changes in all categories after learning interventions using LKPD of A'bulo Sibatang-based co-curricular activities.

Table 1. Shapiro-Wilk Normality Test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	Df	Sig.
Pretest Cognitive Scores	.145	24	.200	.964	24	.529
Posttest Cognitive Scores	.199	24	.015	.906	24	.029

The Shapiro-Wilk normality test in Table 1 showed that the students' post-test cognitive scores were not normally distributed with a Sig. of 0.029 or less than 0.05. thus, (Sugiyono, 2015) compared students' average cognitive scores before and after being given co-curricular activity interventions using a non-parametric paired sample t-test (Wilcoxon Signed Ranks Test).

Table 2. T-Wilcoxon Signed Ranks Test

	Cognitive Posttest - Cognitive Pretest
Z	-4.291
Asymp. Sig. (2-tailed)	.001

The results of data analysis obtained from the Wilcoxon Signed Ranks Test t-test in Table 2 show a significant difference of 0.001 or greater than 0.05. Significant improvement in students' HOTS ability in line with findings (Lubis et al., 2022), which reports that the integration of local wisdom values in physics learning is able to increase students' cognitive engagement and creativity. These results confirm that the local cultural context, in this case, A'bulo Sibatang, functions as a cognitive scaffolding that makes it easier for students to build physics concepts in depth and encourages the process of analyzing, evaluating, and creating (indicators C4–C6).

Significant changes in students' scores were evident in the C4 category: the pretest results showed that most students were weak in identifying the relationships between complex physics concepts. Meanwhile, the posttest results showed a significant increase in explaining cause and effect, distinguishing variables, and compiling information from contextual situations in the LKPD. In the C5 category, pretest results, it is known that students tend to give answers based on rote or assumptions without systematic justification. The posttest results show increased students' ability to provide scientific reasons for choosing solutions and evaluate alternative solutions based on data and physics principles. Meanwhile, in Category C6, the pretest results reveal that creative skills have not yet developed, and most students have difficulty formulating alternative solutions or compiling simple experiments. Meanwhile, the results of the posttest showed that students began to be able to design simple experiments or develop problem-solving strategies based on the context provided in the LKPD. A series of improvements in the three HOTS categories showed that using LKPD physics co-curricular activities based on A'bulo Sibatang effectively strengthened students' analytical, evaluative, and creative dimensions.

Qualitative data from semi-structured observations and interviews with teachers on collaboration skills indicated positive changes. The collaborative assessment showed that many groups of students tended to be dominated by one or two members before the intervention. At the same time, after using A'bulo Sibatang-based LKPD, there was an increase in individual responsibility and team coordination indicators. The collaborative skills in these findings support the research (Hikmawati et al., 2024), which shows that learning based on local wisdom increases student interaction and cooperation in completing HOTS assignments. Although the formats are different, both affirm that local values enrich

the social context of learning so that interpersonal communication skills and collective responsibility improve. Indicators used in observation: (a) Active participation in the group; (b) Effective communication skills; (c) Individual and group responsibilities; and (d) Joint decision-making.

Strengthening each indicator through scenarios and activities in the co-curricular LKPD that is designed. The results of observation and changes in collaborative behavior showed a comparison of student behavior before and after the intervention based on observation records. Of the four behaviors of Mabbulo Sipeppa or A'buo Sibatang that are applied, including Assamaturu ri pa'rappungang means equal in the group, Sipakalabbiri means mutual respect, Siagang baji na kodi pa'mai means together in joy and sorrow, and Sipattojeng ri kuntu tojeng which means justifying each other if it is true. Indicates a change in behavior, such as students who were previously passive becoming more involved in discussions. There is role rotation in the group (not just one dominant student). Decision-making is done through deliberation, not individual domination. The qualitative evidence of the dynamics of student interaction shows that the internalization of A'bulo Sibatang values is very good as part of the 21st century social competencies that support the SDGs, in particular: SDG 4 (Quality Education): developing the affective and social aspects of students and SDG 16 (Peace, justice, and resilient institutions): through local value education as a means of forming cooperative citizens. The collaboration formed is not only technical, but also ethical and empathetic, in accordance with the spirit of A'bulo Sibatang.

The application of A'bulo Sibatang local wisdom values in co-curricular LKPD has proven to be effective in strengthening students' collaboration skills. The learning process based on local culture is able to internalize social values that support teamwork and character building. The relationship between HOTS and collaborative skills is also an important finding in this study. Improved analytical and evaluation skills (C4 and C5) allow students to more actively participate in group discussions, express opinions with logical arguments, and resolve conflicts through rational consideration. In contrast, the intensive collaborative process provides a social space for strengthening HOTS skills, such as thinking critically about friends' ideas and formulating solutions together.

4. CONCLUSION

The main contribution of this research is empirical evidence that A'bulo Sibatang structured LKPD not only facilitates the achievement of SDG 4 (Quality Education) cognitive indicators but also strengthens partnerships and collaborations (SDG 17) at the micro level, namely between students. Development of a co-curricular LKPD device that combines scientific measures with elements of local culture, thus offering a sustainable and meaningful contextual physics learning model. Practically, physics teachers can adopt this LKPD to maximize co-curricular time outside of regular lesson hours, overcome practice time limitations in the classroom, and foster HOTS and collaboration simultaneously. Further research is recommended to evaluate the long-term impact of the implementation of A'bulo Sibatang-based LKPD on the character profile of students at various levels of education. In addition, the development of other local wisdom-based learning tools outside Sulawesi also needs to be studied to see the extent to which local cultural values can shape 21st-century skills.

REFERENCES

Afrianti, S. Y., Sidin, A. I., Noor, N. B., Pasinringi, S. A., Ridwan, M., Mallongi, A., Sidin, I., & Bahry, N. (2024). Study on Factors that Influence the High Organizational Citizenship Behavior (OCB) of Makassar Ethnic Nurses in LANTO Hospital DG Pasewang Jeneponto in 2024 . *Pharmacognosy Journal*, *16*(2), 312–318.

Aguado-Correa, F., de la Vega-Jiménez, J. J., López-Jiménez, J. M., Padilla-Garrido, N., & Rabadán-Martín, I. (2023). Evaluation of non-financial information and its contribution to advancing the sustainable development goals within the Spanish banking sector. *European Research on Management and Business Economics*, *29*(1), 1–17. https://doi.org/10.1016/j.iedeen.2022.100211

Almazroa, H., & Alotaibi, W. (2023). Teaching 21st Century Skills: Understanding the Depth and Breadth of the Challenges to Shape Proactive Teacher Education Programmes. *Sustainability (Switzerland), 15*(9), 1–25. https://doi.org/10.3390/su15097365

Asad, M. M., Aftab, K., Sherwani, F., Churi, P., Moreno-Guerrero, A. J., & Pourshahian, B. (2021). Techno-Pedagogical Skills for 21st Century Digital Classrooms: An Extensive Literature Review. *Education Research International*, *2021*, 1–12. https://doi.org/10.1155/2021/8160084

Aunger, J. A., Millar, R., Greenhalgh, J., Mannion, R., Rafferty, A. M., & McLeod, H. (2021). Why do some inter-organisational collaborations in healthcare work when others do not? A realist review. *Systematic Reviews*, *10*(1), 1–22. https://doi.org/10.1186/s13643-021-01630-8

Azmat, F., Lim, W. M., Moyeen, A., Voola, R., & Gupta, G. (2023). Convergence of business, innovation, and sustainability at the tipping point of the sustainable development goals. *Journal of Business Research*, *167*(114170), 1–14. https://doi.org/10.1016/j.jbusres.2023.114170

Bakri, F., Permana, H., Wulandari, S., & Muliyati, D. (2020). Student worksheet with ar videos: Physics learning media in laboratory for senior high school students. *Journal of Technology and Science Education*, *10*(2), 231–240. https://doi.org/10.3926/JOTSE.891

Bassachs, M., Cañabate, D., Serra, T., & Colomer, J. (2020). Interdisciplinary cooperative educational approaches to foster knowledge and competencies for sustainable development. *Sustainability (Switzerland)*, *12*(20), 1–17. https://doi.org/10.3390/su12208624

Becker, S., Klein, P., Gößling, A., & Kuhn, J. (2020). Using mobile devices to enhance inquiry-based learning processes. *Learning and Instruction*, *69*(2020), 1–14. https://doi.org/10.1016/j.learninstruc.2020.101350

Bouchée, T., Thurlings, M., de Putter - Smits, L., & Pepin, B. (2023). Investigating teachers' and students' experiences of quantum physics lessons: opportunities and challenges. *Research in Science and Technological Education*, *41*(2), 777–799. https://doi.org/10.1080/02635143.2021.1948826

Bozzi, M., Raffaghelli, J. E., & Zani, M. (2021). Peer learning as a key component of an integrated teaching method: Overcoming the complexities of physics teaching in large size classes. *Education Sciences*, *11*(2), 1–18. https://doi.org/10.3390/educsci11020067

Burfeind, D. D., & Devine, C. A. (2020). A co-curricular inquiry-based approach to developing technical and transferrable laboratory skills in science graduates. *Higher Education Research and Development Society of Australasia, Inc*, *42*, 10–18.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publication, Inc.

Dewi, R. M., Sholikhah, N., & Fitrayati, D. (2020). High order thinking skills instrument on microeconomics course: A development research. *International Journal of Instruction*, *13*(4), 283–294. https://doi.org/10.29333/iji.2020.13418a

Dziob, D., Górska, U., Kołodziej, T., & Čepič, M. (2022). Physics competition to inspire learning and improve soft skills: a case of the Chain Experiment. In *International Journal of Technology and Design Education* (Vol. 32, Issue 1). Springer Netherlands. https://doi.org/10.1007/s10798-020-09620-y

El-Haggar, N., Mezhoudi, N., & Alrawjih, F. (2019). The impact of co-curricular activities supported by generic skills on students' performance at university level. *International Journal of Innovative Technology and Exploring Engineering*, *8*(11), 4159–4164. https://doi.org/10.35940/ijitee.K1290.0981119

Filho, W. L., Vidal, D. G., Chen, C., Petrova, M., Dinis, M. A. P., Yang, P., Rogers, S., Álvarez-Castañón, L., Djekic, I., Sharifi, A., & Neiva, S. (2022). An assessment of requirements in investments, new technologies, and infrastructures to achieve the SDGs. *Environmental Sciences Europe*, *34*(58), 1–17. https://doi.org/10.1186/s12302-022-00629-9

Hamdan, & Basrowi. (2024). Do community entrepreneurial development shape the sustainability of tourist villages? *Uncertain Supply Chain Management*, *12*(1), 373–386. https://doi.org/10.5267/j.uscm.2023.9.014

Haris, A., Hasyim, M., Ma'ruf, Halim, A. D., Mahir, & Ramadhan, I. (2025). The effectiveness of dynamic problem-solving strategies and innovative assessment tools to improve students' higher-order thinking skills. *Indonesian Journal of Science Education*, *14*(1), 181–191. https://doi.org/10.15294/jpii.v14i1.21433

Hartman-Caverly, S., Chisholm, A., & Glenn, A. (2023). Digital Shred: Case Study of a Remote Privacy Literacy Collaboration. *College and Research Libraries*, *84*(2), 238–259. https://doi.org/10.5860/crl.84.2.238

Henderson, T. S., Michel, J. O., Bryan, A., Canosa, E., Gamalski, C., Jones, K., & Moghtader, J. (2022). An Exploration of the Relationship between Sustainability-Related Involvement and Learning in Higher Education. *Sustainability (Switzerland), 14*(9), 1–21. https://doi.org/10.3390/su14095506

Hikmawati, Suastra, I. W., Suma, K., & Sudiatmika, A. A. I. A. R. (2024). Online lectures

with local wisdom context: efforts to develop students' higher-order thinking skills. *International Journal of Evaluation and Research in Education* , *13*(2), 943–941. https://doi.org/10.11591/ijere.v13i2.25744

Indrawan, R., & Yaniawati, P. (2017). *Metodologi Penelitian Kuantitatif, Kualitatif, dan Campuran untuk Manajemen, Pembangunan, dan Pendidikan*. PT Refika Aditama.

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*, *2021*(96), 14–29. https://doi.org/10.14689/ejer.2021.96.2

Kosasih, A., Supriyadi, T., Firmansyah, M. I., & Rahminawati, N. (2022). Higher-Order Thinking Skills in Primary School: Teachers' Perceptions of Islamic Education. *Journal of Ethnic and Cultural Studies*, *9*(1), 56–76. https://doi.org/10.29333/ejecs/994

Kurnia, G., Setiawan, I., Tridakusumah, A. C., Jaelani, G., Heryanto, M. A., & Nugraha, A. (2022). Local Wisdom for Ensuring Agriculture Sustainability : A Case from Indonesia. *Sustainability*, *14*(8823), 1–13.

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, *7*(6), 1–13. https://doi.org/10.1016/j.heliyon.2021.e07309

Lee, H. Y., Chen, P. H., Wang, W. S., Huang, Y. M., & Wu, T. T. (2024). Empowering ChatGPT with guidance mechanism in blended learning: effect of self-regulated learning, higher-order thinking skills, and knowledge construction. *International Journal of Educational Technology in Higher Education*, *21*(16), 1–28. https://doi.org/10.1186/s41239-024-00447-4

Li, G., Pervaiz, S., & He, Q. (2021). Can Universities be a Gleam of Hope During COVID-19? Entrepreneurial Intentions Approach for Academia in Pakistan. *Frontiers in Education*, *6*(717532), 1–11. https://doi.org/10.3389/feduc.2021.717532

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–13. https://doi.org/10.1186/s41239-020-00238-7

Lubis, S. P. W., Suryadarma, I. G. P., Paidi, & Yanto, B. E. (2022). The Effectiveness of Problem-based learning with Local Wisdom oriented to Socio-Scientific Issues. *International Journal of Instruction*, *15*(2), 455–472. https://doi.org/10.29333/iji.2022.15225a

Martawijaya, M. ., Sujiono, E. ., Halim, A. ., Tho, S. ., Mahir, Palloan, P., & Zharvan, V. (2025). The Impact of Physics Co-Curricular Activities Based on Makassar Local Wisdom on Improving the Pancasila Student Profile and Learning Satisfaction. *Indonesian Journal of Science Education*, *14*(1), 17–31.

https://doi.org/10.15294/jpii.v14i1.13178

Martawijaya, M. A., Rahmadhanningsih, S., Swandi, A., Hasyim, M., & Sujiono, E. H. (2023). The Effect of Applying the Ethno-Stem-Project-Based Learning Model on Students' Higher-Order Thinking Skill and Misconception of Physics Topics Related to Lake Tempe, Indonesia. *Indonesian Journal of Science Education*, *12*(1), 1–13. https://doi.org/10.15294/jpii.v12i1.38703

Maryanti, R., Rahayu, N. I., Muktiarni, M., Al Husaeni, D. F., Hufad, A., Sunardi, S., & Nandiyanto, A. B. D. (2022). Sustainable Development Goals (Sdgs) in Science Education: Definition, Literature Review, and Bibliometric Analysis. *Journal of Engineering Science and Technology*, *17*(1), 161–181.

Muhammad, U. A., Fuad, M., Ariyani, F., & Suyanto, E. (2022). Bibliometric analysis of local wisdom-based learning: Direction for future history education research. *International Journal of Evaluation and Research in Education*, *11*(4), 2209–2222. https://doi.org/10.11591/ijere.v11i4.23547

Nahar, S., Suhendri, Zailani, & Hardivizon. (2022). Improving Students' Collaboration Thinking Skill under the Implementation of the Quantum Teaching Model. *International Journal of Instruction*, *15*(3), 451–464. https://doi.org/10.29333/iji.2022.15325a

Nezami, M. R., de Bruijne, M. L. C., Hertogh, M. J. C. M., & Bakker, H. L. M. (2024). Assessment criteria for inter-organizational collaboration in interconnected infrastructure projects. *Engineering, Construction and Architectural Management*, *31*(9), 3456–3478. https://doi.org/10.1108/ECAM-11-2022-1109

Nybo, S. E., Sahr, M., Young, M., Axford, K., Sohn, M., Lyons, M., & Klepser, M. (2020). Design of a large-scale escape room for first-year pharmacy student orientation. *Currents in Pharmacy Teaching and Learning*, *12*(11), 1340–1347. https://doi.org/10.1016/j.cptl.2020.06.002

Paredes-Saavedra, M., Vallejos, M., Huancahuire-Vega, S., Morales-García, W. C., & Geraldo-Campos, L. A. (2024). Work Team Effectiveness: Importance of Organizational Culture, Work Climate, Leadership, Creative Synergy, and Emotional Intelligence in University Employees. *Administrative Sciences*, *14*(11), 1–25. https://doi.org/10.3390/admsci14110280

Pedersen, A. B., Hickmann, T., Renn, O., Eckert, N., Jax, K., Lepenies, R., Liu, H. Y., Lyytimäki, J., Reis, S., & Rusch, G. (2023). SDGs at the halfway point: How the 17 global goals address risks and wicked problems. *Ambio*, *52*(4), 679–682. https://doi.org/10.1007/s13280-023-01837-0

Rampean, B. A. O., & Rohaeti, E. (2025). The development of an integrated instrument to measure higher order thinking skills and scientific attitudes. *Journal of Turkish Science Education*, *22*(1), 48–62. https://doi.org/10.36681/tused.2025.004

Reddy, P., Chaudhary, K., & Hussein, S. (2023). A digital literacy model to narrow the digital literacy skills gap. *Heliyon*, *9*(4), 1–16.

https://doi.org/10.1016/j.heliyon.2023.e14878

Ricciolini, E., Rocchi, L., Cardinali, M., Paolotti, L., Ruiz, F., Cabello, J. M., & Boggia, A. (2022). Assessing Progress Towards SDGs Implementation Using Multiple Reference Point Based Multicriteria Methods: The Case Study of the European Countries. *Social Indicators Research*, *162*(3), 1233–1260. https://doi.org/10.1007/s11205-022-02886-w

Samadi, F., Jafarigohar, M., Saeedi, M., Ganji, M., & Khodabandeh, F. (2024). Impact of flipped classroom on EFL learners' self-regulated learning and higher-order thinking skills during the Covid19 pandemic. *Asian-Pacific Journal of Second and Foreign Language Education*, *9*(24), 1–15. https://doi.org/10.1186/s40862-023-00246-w

Saptono, A., Suparno, S., Wibowo, A., Ahman, E., Ismiyati, I., & Sukayugi, D. (2020). An analysis of higher-order thinking skills (HOTS) in the learning of economics. *International Journal of Learning, Teaching and Educational Research*, *19*(4), 268–290. https://doi.org/10.26803/ijlter.19.4.16

Shanti, M. R. S., Istiyono, E., & Munadi, S. (2022). The effectiveness of learning to improve students' higher-order thinking skills. *Cypriot Journal of Educational Sciences*, *17*(5), 1576–1587. https://doi.org/10.18844/cjes.v17i5.7220

Sofyan, H., Anggereini, E., & Saadiah, J. (2019). Development of E-Modules Based on Local Wisdom in Central Learning Model at Kindergartens in Jambi City. *European Journal of Educational Research*, *8*(4), 1137–1143. https://doi.org/10.12973/eu-jer.8.4.1137

Stadermann, H. K. E., & Goedhart, M. J. (2021). Why and how teachers use nature of science in teaching quantum physics: Research on the use of an ecological teaching intervention in upper secondary schools. *Physical Review Physics Education Research*, *17*(2), 1–17. https://doi.org/10.1103/PhysRevPhysEducRes.17.020132

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* (19th ed.). ALFABETA, CV.

Sugiyono. (2015). *Statistik Nonparametris untuk Penelitian*. ALFABETA, CV.

Sumantri, I. (2006). *Kedatuan Luwu Ed. 2*. Jendela Dunia.

Teuwen, C. J., Kusurkar, R. A., Schreurs, H., Daelmans, H. E. M., & Peerdeman, S. M. (2024). Interprofessional collaboration skills and motivation one year after an interprofessional educational intervention for undergraduate medical and nursing students. *BMC Medical Education*, *24*(1), 1–9. https://doi.org/10.1186/s12909-024-05262-z

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J. M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(54), 1–32. https://doi.org/10.3390/jintelligence11030054

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2020). The instrument development to measure higher-order thinking skills for pre-service biology teacher. *International Journal of Instruction*, *13*(4), 833–848. https://doi.org/10.29333/iji.2020.13451a

Warman, A. B., Zulkifli, Yustiloviani, Nabilah, W., & Hayati, R. F. (2023). Strengthening Family Resilience Through Local Wisdom: Pulang Ka Bako Type of Marriage in Minangkabau. *Al-Istinbath: Journal of Islamic Law*, *8*(1), 253–268. https://doi.org/10.29240/jhi.v8i1.6971