

The Songkok Recca Ethno-STEAM Learning Model in Improving Complex Problem-Solving Skills in Concrete Age Children

Andi Rosdaliani¹, Andi Muhammad Irfan Taufan Asfar², Andi Muhamad Iqbal Akbar Asfar³, Andi Nurannisa⁴, Ainun Adelia⁵, A. Sindi Cristina⁶

^{1,2,4,5}Department of Mathematics Education, Muhammadiyah University of Bone, Indonesia

³Department of Chemical Engineering, Ujung Pandang State Polytechnic, Indonesia

⁶Department of Indonesian Language Education, Muhammadiyah University of Bone, Indonesia

rosdalianiandi@gmail.com¹, tauvanlewis00@gmail.com², andiifalasar@gmail.com³, andinurannisa30@gmail.com⁴, ainunadeliagalaxyceelloppo@gmail.com⁵, andisindicristina@gmail.com⁶

Abstract: Complex Problem Solving (CPS) is an essential skill required in the workplace, but students' achievements in this aspect are still relatively low, especially in mathematics. This study introduces Etno-STEAM Songkok Recca, an innovative learning model to improve CPS skills in concrete-age children. The objectives of this study are: (1) to develop a valid, practical, and effective Etno-STEAM Songkok Recca model; (2) to explore the philosophical value of Songkok Recca in mathematics learning; and (3) to identify the effects of the Etno-STEAM Songkok Recca model. The research used the R&D method with a Borg & Gall design modified by Sukmadinata, conducted in two elementary schools involving trial, experimental, and control classes. The results showed that the model met the criteria of being highly valid (average score of 3.83–3.88), practical (100% response from teachers and 81.25–95% from students), and effective (N-Gain of the experimental class was 0.72 in the high category, compared to 0.41 in the control class in the moderate category). Therefore, the Songkok Recca Ethno-STEAM model can be an alternative to contextual mathematics learning that not only strengthens cognitive abilities but also instills local cultural values so that the learning process is more meaningful and enjoyable.

Keywords: Complex Problem Solving, Ethno-STEAM, Songkok Recca, Mathematics Learning, Local Wisdom.

Article History:

Received: 02-09-2025

Online : 07-10-2025



This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license

A. INTRODUCTION

Complex Problem Solving (CPS) is an essential 21st-century skill that includes the ability to analyze, identify, and solve problems. The Future of Jobs Report (World Economic Forum, 2025) states that CPS is a key skill required in the world of work. In addition, CPS is also very important for children of concrete age in developing critical and analytical thinking skills from an early age because at this stage of development, children learn through direct, concrete, and contextual experiences. CPS skills not only help students understand abstract concepts but also support them in solving problems in real-life situations. However, facts show that the CPS abilities of students in Indonesia are still low. A similar condition was found in Bone Regency, especially at the elementary school level, with an average mathematics score of only 46.15 (Puspendik, 2019). These results are also reinforced by the Minimum Competency Assessment

(AKM), where the majority of students showed achievements below the standard (Assidiq, Agustin and Ripaldi, 2025). This is also evidenced by the 2022 PISA results, which show that the average mathematics score of Indonesian students is only 366, far below the OECD average of 489.

Observations and interviews at several elementary schools in Bone Regency show that nearly 60% of students are unable to identify and determine number patterns, especially in multiplication. This finding is in line with the research by Indriyani and Muthi (2024) that many students have difficulty understanding multiplication material. In fact, some students feel stressed when trying to solve multiplication problems (Nurazani et al., 2024). A number of students choose to skip math class because they are afraid and experience high anxiety (Sugiarti and Kusmayanti, 2022). This condition indicates the need for alternative solutions in the form of learning models that enable students to learn in a meaningful and contextual way, so that they can increase their motivation to learn through learning that is integrated with everyday life, while introducing mathematics and local culture to students.

One approach that has the potential to support the creation of meaningful, contextual, and culture-based learning is Ethno-STEAM (Science, Technology, Engineering, Art, and Mathematics). This is in line with Vygotsky's social constructivism theory, which emphasizes the importance of social and cultural interaction in learning (Asfar, Asfar, & Nurannisa, 2021). One of the famous cultural icons in Bone Regency is the Songkok Recca, which is rich in mathematics in every pattern of its trajectory and has great potential to become a learning medium to enrich students' understanding of mathematical concepts. The Songkok Recca, which is a cultural symbol that not only serves as a marker of Bugis identity but also reflects life values such as perseverance, creativity, and cooperation (Aryani, 2023). However, the younger generation today is unfamiliar with the philosophy of the Songkok Recca. This is due to cultural shifts caused by modernization, coupled with the lack of integration of local culture into the learning process. As a result, education as a means of cultural inheritance does not function optimally. Therefore, this research aims to develop a mathematics learning model using the songkok recca as a teaching aid to improve students' Complex Problem Solving (CPS) skills while preserving the Bugis Bone culture from an early age.

In addition to culture, technology plays an important role as an interactive learning medium in supporting the Ethno-STEAM approach. One platform that can be integrated into learning is Live Worksheet. Live Worksheet allows students to work in groups, divide tasks, and solve problems in a structured manner (Sinaga, 2023). This platform can be used to design questions based on the Songkok Recca diagonal pattern (2 over - 2 under) or (2 riase na 2 riawa), which guides students to identify problems, evaluate information, and find solutions, thereby supporting the development of Complex Problem Solving (CPS) skills. Research by Mardhatilah, Zaini, and Kaspul (2022) states that the use of digital applications in learning is very effective in improving students' analytical, evaluative, and creative skills. The integration of Live Worksheet into the Songkok Recca-based Etno-STEAM model enables the creation of a concrete, contextual, and relevant learning experience in line with the current curriculum's learning objectives, namely the development of reasoning, critical thinking, and contextual problem-solving competencies.

This research aims to develop an Etno-STEAM Songkok Recca-based learning model assisted by Live Worksheet as an interactive digital media. Rifai (2022) explains that in the application of STEAM learning, integration with digital media can facilitate learning reflection to be in line with learning objectives. The integration of Live Worksheet into the Etno-STEAM Songkok Recca learning model is expected to support the development of students' Complex Problem Solving (CPS) skills while creating joyful, mindful, and meaningful learning. This is in line with the research by Sinaga et al. (2023), which states that the use of digital media such as Android applications is effective in improving CPS, which is key to 21st-century technology-based mathematics learning.

Nurannisa et al. (2022) also emphasize that in addition to technology integration, incorporating local wisdom rich in values into education can bridge traditional knowledge with contemporary knowledge. Similar support is shown by research by Enjelina, Damayanti, and Dwiyanto (2024), which concludes that the integration of culture in mathematics learning can increase learning motivation while preserving local culture. In addition, local wisdom-based mathematics learning provides opportunities for students to understand concepts in depth by utilizing local culture (Asfar, Asfar, and Nurannisa, 2021). However, to date, no research has been found that examines the multiplication pattern of Songkok Recca. The majority of research only discusses the cultural values of Songkok Recca in Bone Regency (Sumantri and Faisal, 2023). In fact, the Songkok Recca pattern is rich in mathematical meaning, especially the multiplication pattern, so it has the potential as a medium for mathematics learning. Therefore, the novelty of this research lies in the development of a valid, practical, and effective Songkok Recca Ethno-STEAM learning model assisted by Live Worksheets that supports the CPS of children of a concrete age while contributing to the preservation of local culture by integrating the philosophical values of Songkok Recca into learning. This research also supports the achievement of Sustainable Development Goals (SDGs) point 4 (quality education), Asta Cita point 8 (harmonizing life with culture), and is in line with the thematic PKM point 6 (strengthening education, science, and technology).

B. METHOD

The research will be conducted offline for four months at two locations, namely SD Negeri 277 Palattae and SD Inpres 12/79 Palattae. This research is classified as R&D (Research and Development), using a method to examine the systematic development of a learning model that must meet the criteria of validity, practicality, and effectiveness (Sugiyono, 2021) to improve students' Complex Problem Solving skills. This research uses the Borg and Gall model modified by Sukmadinata (Slamet, 2022), which consists of three stages, namely preliminary study, product testing, and experimental testing. This research was conducted in fourth grade classes selected through purposive sampling based on expert considerations. Data analysis aimed to determine the validity, practicality, and effectiveness criteria of the Songkok Recca Ethno-STEAM learning model development product.

C. RESULTS AND DISCUSSION

The development of the Songkok Recca Ethno-STEAM learning model was carried out to support students' CPS skills. Before conducting trials, the learning model was first validated

by expert judgement to determine its validity based on subject matter experts, design experts, and model experts.

1. Model Validity Test

Table 1. Model Validity Results

	Assessment Aspects	Expert Score		Average Score	Category
		1	2		
Subject Matter Expert	Curriculum	4,00	3,75	3,88	Very valid
	CPS Materials and Objectives	4,00	3,50	3,75	Very valid
	Grammar and Instructions	4,00	4,00	4,00	Very valid
	Average Total			3,87	Very valid
Model Designer	Syntax/Model Flow	3,80	3,70	3,75	Very valid
	Illustrations and Diagrams of Models	4,00	4,00	4,00	Very valid
	Average Total			3,88	Very valid
Implementation Specialist	Implementation	4,00	4,00	4,00	Very valid
	Suitability for Students	4,00	3,75	3,88	Very valid
	Supporting Media	3,75	3,50	3,62	Very valid
	Average Total			3,83	Very valid

Based on the validation results, the average total score of subject matter experts was 3.87, indicating a highly valid category. Thus, in terms of curriculum suitability, relevance of the material to the objectives of Complex Problem Solving, and clarity of grammar and instructions, the Etno-STEAM Songkok Recca learning model has met the validity standards. In terms of model design (clarity of syntax/flow and suitability of illustrations), the total average score was 3.88, which is in the highly valid category, indicating that the model design is clear, coherent, and easy for users to understand. Meanwhile, in terms of implementation (feasibility in the classroom, suitability to student characteristics, and supporting media), a total average of 3.83 was obtained, which is also in the highly valid category. This shows that the Etno-STEAM Songkok Recca learning model is suitable for implementation in grade IV concrete age children with the support of appropriate supporting devices. Overall, the total average obtained was 3.86, so this learning model is considered highly valid and can be used in the trial phase with minor revisions if necessary.

2. Learning Device Validity Test

Table 2. Learning Tool Validity Results

Assessment Aspects	Expert Score		Average Score	Category
	1	2		
Learning Tools and Objectives	4,00	4,00	4,00	Very valid
Experimental Class	4,00	3,75	3,88	Very valid
Teaching Module	3,83	3,83	3,83	Very valid
Teaching Materials	4,00	3,75	3,88	Very valid
Assessment Sheet CPS Question Grid	4,00	3,70	3,85	Very valid
Student Worksheet	4,00	4,00	4,00	Very valid
Average Total			3,91	Very valid

Based on the validation results, the average total learning device score was 3.91, indicating a highly valid category. In terms of learning tools and objectives, the devices were assessed as being fully aligned with the curriculum and the objectives of Complex Problem Solving development. In terms of the teaching modules for the experimental class, an average score of 3.88 was obtained, which is in the highly valid category, indicating that the teaching modules were designed in accordance with the model syntax and were easy for teachers to use. The teaching materials obtained an average score of 3.83 and the assessment sheets obtained an average score of 3.88, both of which are in the highly valid category. This shows that the materials and assessment instruments support the learning process optimally.

Meanwhile, the CPS question grid obtained an average score of 3.85, proving that the question indicators were in line with the learning objectives and the students' ability levels. The Student Worksheets (both printed and Live Worksheets) obtained an average score of 4.00, which means they are highly valid and suitable for use in facilitating hands-on activity-based learning and the integration of the local culture of Songkok Recca. Overall, these results indicate that the Songkok Recca Ethno-STEAM Model learning tools have met the validity criteria and are ready for use in the trial phase with minor revisions as suggested by the validators.

3. Practicality Test

The practicality of the Songkok Recca Ethno-STEAM learning model developed was measured based on the responses of teachers and students as users using the following four indicators.

Table 3. Results of the Teacher Practicality Test

Practicality Test Indicators	Teacher 1	Teacher 2	Teacher 3
Syntactic Clarity of the Model	30	31	29
Feasibility of Activities	24	23	24
Ease of Classroom Management	26	25	27
Student Engagement	22	23	22
Time Suitability	14	15	14
Effectiveness of the Model	17	18	17
Total Score	133	135	133
Percentage (%)	95	96,4	95
Criteria	Very Practical	Very Practical	Very Practical

Based on the results of the teacher response analysis, the average practicality score of the learning model reached 95.47%, which is classified as very practical. The syntactic clarity indicator of the model received a high score because the learning flow was systematically structured and easy to follow. The indicator of activity feasibility showed that teachers were able to implement each stage of learning according to plan. Ease of classroom management was also rated as good, followed by high student engagement in discussions, practice, and problem solving. The timeliness and effectiveness of the model received good to very good ratings, indicating that this model is able to help students achieve Complex Problem Solving skills optimally. Overall, the Songkok Recca Ethno-STEAM Learning Model is considered very

practical for use in fourth grade elementary school, both in terms of planning and implementation. This is also supported by the positive responses of students in each trial class.

Table 4. Students' Practicality Results

	Average Practicality Test Score				Total Score	Note
	Management	Activity	Knowledge	Effectiveness		
Limited Trial	26,85	11,65	22,20	14,35	75,05	Practical
Percentage (%)	96,15	96,92	92,50	89,69		
Criteria	Very Practical	Very Practical	Very Practical	Very Practical		
Extensive Trial	27,10	11,78	23,00	15,00	76,88	Practical
Percentage (%)	97,35	97,50	95,83	93,75		
Criteria	Very Practical	Very Practical	Very Practical	Very Practical		
Experimental Trial	27,25	11,85	23,50	15,60	78,20	Practical
Percentage (%)	98,04	98,33	97,92	97,50		
Criteria	Very Practical	Very Practical	Very Practical	Very Practical		

Based on Table 4 above, the practicality of the Songkok Recca Etno-STEAM learning model based on student responses showed positive results at each stage of testing. In limited trials, the percentage of practicality was in the practical category with the highest score on the student activity indicator (96.92%). This shows that even though it is still in the early stages of implementation, students have been quite active in participating in the learning process. In the large-scale trial, all indicators were in the practical category with the highest average scores in student activity (97.50%) and learning management (97.35%). Meanwhile, in the experimental trial, all indicators reached the practical category with the highest percentages in material comprehension (97.92%) and model effectiveness (97.50%). These results prove that the Songkok Recca Etno-STEAM learning model is well accepted by students, facilitates active engagement, improves understanding, and supports the achievement of students' Complex Problem Solving skills in mathematics multiplication.

4. Effectiveness Test

The effectiveness of the Songkok Recca Ethno-STEAM learning model can be seen in the improvement of pretest and posttest results as follows.

Table 5. Description of Control Class and Experimental Class Data

Statistical Description	Control Class		Experimental Class	
	Pretest	Posttest	Pretest	Posttest
Mean	57,45	74,25	54,80	95,20
Minimum	32,00	38,00	40,00	88,00
Maximum	73,00	98,00	76,00	100,0
Standard Deviation	13,20	15,05	9,80	3,25

Table 5 shows that before treatment (pretest), the average score for Complex Problem Solving skills of students in the experimental class (54.80) was slightly lower than that of the

control class (57.45). However, after implementing the Songkok Recca Ethno-STEAM Learning Model, the average posttest score of the experimental class increased sharply to 95.20, which was much higher than that of the control class (74.25). This increase was also evident in the minimum and maximum scores, where the minimum score of the experimental class rose from 40.00 to 88.00, while the control class only rose from 32.00 to 38.00 at its lowest score. The standard deviation in the experimental class decreased significantly from 9.80 to 3.25, indicating that the students' learning outcomes were more evenly distributed after the implementation of the learning model.

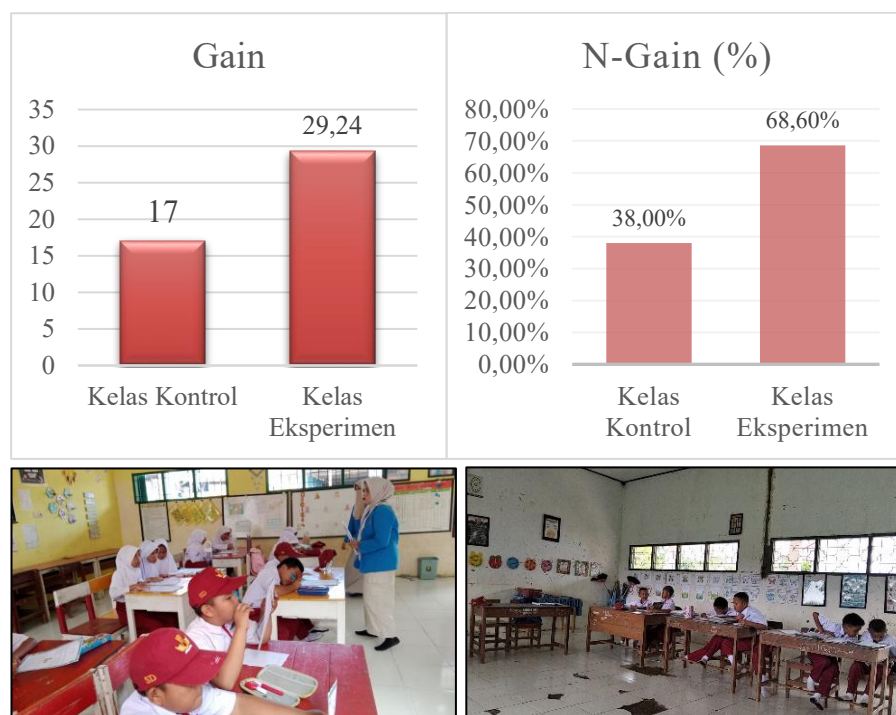


Figure 1. Comparison of N-Gain Scores between the Control Class and the Experimental Class

Based on the results of data analysis, the improvement in students' Complex Problem Solving (CPS) abilities can be seen through a comparison of gain scores and N-Gain Scores between the control class and the experimental class. In the control class, the gain score obtained from the difference between the posttest and pretest scores was 17.00 with an N-Gain percentage of 38%. This percentage is in the low (ineffective) category according to Hake's (1999) criteria, which means that the problem-based learning model used in the control class did not have a significant impact on improving students' CPS abilities. Conversely, in the experimental class that received treatment using the Etno-STEAM Songkok Recca learning model, the gain score obtained was 29.24 with an N-Gain percentage of 68.6%, which is in the moderate (effective) category. These results show that the application of the Etno-STEAM Songkok Recca model was able to provide greater improvement in CPS skills compared to conventional learning.

The difference in the percentage increase between the control class and the experimental class indicates that the use of a local wisdom-based learning model (Songkok Recca) combined with the STEAM approach contributes significantly to learning outcomes. The characteristics

of the model, which integrates elements of ethnopedagogy, creative processes, and real problem-solving activities based on local culture, make learning more contextual, interesting, and meaningful for students. Therefore, these findings reinforce the evidence that the development of the Songkok Recca Ethno-STEAM learning model is not only theoretically valid and practical to use, but also effective in improving the CPS skills of elementary school students, especially in grade IV at the research location.

D. CONCLUSIONS AND SUGGESTIONS

Based on the results of research and discussion of the Live Worksheet-assisted Etno-STEAM learning model in mathematics lessons for fourth grade students at SD Negeri 277 Palattae and SD Inpres 12/79 Palattae, it was concluded that the Etno -STEAM Songkok Recca Assisted Live Worksheet learning model is very valid based on the assessment of subject matter experts, design experts, and implementation experts, with an overall average score of 3.86. The responses from teachers and students indicate a very high level of practicality. Teachers assessed the model syntax as clear, easy to follow, and appropriate for classroom conditions. The average percentage of practicality for teachers reached 95.47%, while students scored above 90% on all indicators, proving that the model is practical for field application. The experimental test results showed that the N-Gain score for the experimental class was 0.72 (high category), which was better than the control class score of 0.38 (medium category). This proves the effectiveness of the model in improving students' understanding of multiplication concepts as well as their critical, collaborative, and communicative thinking skills.

ACKNOWLEDGMENTS

Thank you to the Ministry of Education, Science and Technology, SD Negeri 277 Palattae, SD Inpres 12/79 Palattae, the Epicentrum UNIM Bone Team, and Muhammadiyah University Bone.

REFERENCES

- Aryani, A. 2023. Resepsi Siri' dalam Penciptaan Film Teater Malebbi. *Disertasi*. Institut Seni Indonesia Yogyakarta.
- Asfar, A.M.I.T., Asfar, A.M.I.A., & Nurannisa, A. (2021). Integration of local traditions Bugis-Makassarese: Learning strategies to improve mathematical communication. *Journal of Physics: Conference Series*, 1808(1), 1-10.
- Assidiq, S., Agustin, Z.A. & Ripaldi, R. (2025). Efektivitas Penggunaan Media Pembelajaran Virtual Reality Berbasis Etnomatematika Terhadap Hasil, Minat dan Motivasi Belajar Siswa Sekolah Dasar. *Disertasi*. Nusa Putra University.
- Enjelina, R.F., Damayanti, R., & Dwiyanto, M. (2024). Penggunaan pendekatan culturally responsive teaching (CRT) untuk meningkatkan hasil belajar matematika siswa kelas V SD. *Edutama: Jurnal Ilmiah Penelitian Tindakan Kelas*, 1(1), 39-51.
- Indriyani, L., & Muthi, I. (2024). Peningkatan pemahaman konsep operasi hitung perkalian dengan penggunaan media saku perkalian. *Jurnal Pendidikan, Bahasa dan Budaya*, 3(3), 231-237.

- Mardhatilah, R., Zaini, M., & Kaspul, K. (2022). Effect of movement system LKPD-electronic on learning outcomes and critical thinking skills of students. *Practice of The Science of Teaching Journal: Jurnal Praktisi Pendidikan*, 1(2), 53-64.
- Nurannisa, A., Asfar, A.M.I.T., Asfar, A.M.I.A., Syaifullah, A., & Nurlinda. (13 Juli 2022). Integration of Bugis-Makassar sulapa eppa wasaluji in developing logical-mathematical intelligence of students based on android applications. *AIP Conference Proceedings*. Amerika. pp. 1-8.
- Nurazani, A., Safitri, M., Nasution, K. & Sofiyah, K. (2024). Analisis kesulitan siswa dalam memahami konsep dasar perkalian dan pembagian di SDN 200512 Salambue. *Jurnal Ilmiah Multidisiplin Terpadu*, 8(12), 70-78.
- Puspendik. 2019. *Laporan Hasil Ujian Nasional 2019*. URL: [https://Hasilun.Pusmenjar.Kemdikbud.Go.Id](https://hasilun.pusmenjar.kemdikbud.go.id). Diakses tanggal 10 Mei 2025.
- Rifai, M. 2022. Pembelajaran STEAM sebagai pembelajaran inovatif. *Jurnal Multidisiplin Madani*, 2 (8), 3469-3474.
- Sinaga, A.V. (2023). Peran teknologi dalam pembelajaran untuk membentuk karakter peserta didik abad 21. *Journal on Education*, 6(1), 2836-2846.
- Sinaga, W.S.E., Yusnadar, Y., Syahri, W. & Muhaimin, M. (2023). Pengembangan multimedia interaktif berbentuk aplikasi android berbasis multipel representasi pada materi kesetimbangan kimia. *Jurnal Inovasi Pendidikan Kimia*, 17(2), 81-91.
- Slamet, F.A. (2022). *Model Penelitian Pengembangan (R&D)*. Edisi ke-1. Institut Agama Islam Sunan Kalijogo. Malang.
- Sugiarti, S., & Kusmayanti, I. (2022). Analisis tingkat math anxiety dalam pembelajaran matematika siswa sekolah dasar di masa pandemi Covid-19. *Jurnal Pendidikan Dasar*, 13(1), 96-102.
- Sugiyono. (2021). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Edisi ke-2. Alfabeta Bandung. Bandung.
- Sumantri, D.S., & Faisal, M. (2023). Pengembangan dan pola pembinaan industri kreatif 'songkok recca' Desa Pacing Kabupaten Bone. *Jurnal Harmoni*, 13(2), 175-198.
- World Economic Forum. (2025). *The Future of Jobs Report 2025*. URL: <https://www.weforum.org/publications/the-future-of-jobs-report-2025/digest/>. Diakses tanggal 10 Mei 2025.