



## Integrating *Anging Mammiri* Cultural Values into Learning to Improve Students' Problem-Solving Skills

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### ABSTRACT

Problem-solving skills are essential in higher education, requiring contextual learning approaches grounded in cultural values. This study aimed to (1) identify students' learning needs and formulate educational values within the *Anging Mammiri* culture, (2) develop a prototype of a culture-based learning model, and (3) test its effectiveness in improving problem-solving skills. A total of 109 participants were involved: 60 students for needs analysis, 5 lecturers and 5 cultural experts in the preliminary stage, 5 expert validators in the development stage, and 44 students (22 experimental, 22 control) in the evaluation stage. The research followed Plomp's (2013) model, consisting of preliminary research, prototype development, and evaluation. Outputs included instructional syntax, lesson plans (RPS and SAP), student worksheets (LKM), essay tests, and assessment rubrics. Validation by five experts showed high feasibility, with scores of 96–100% across content, construct, and language. The *Anging Mammiri* syntax was based on Greenstein's (2012) problem-solving framework defining problems, designing solutions, evaluating alternatives, selecting the best solution, and reflecting and implementing mapped to cultural traditions: *Ma'manu-manu*, *Ma'pese-pese*, *Assamaturu'*, *Tudang Sipulung*, *Ma'ppadendang*, and *Sipakainga*. Effectiveness testing with a pretest–posttest control group showed greater improvement in the experimental group (54.5%) than the control group (35%). Further analysis revealed that experimental group students could analyse problems from multiple perspectives, design contextual solutions, evaluate alternatives critically, and reflect on ecological implications. This study extends Greenstein's framework by integrating local cultural dimensions and contributes contextual learning strategies relevant to ecological issues and the conservation of endemic species.

### KEYWORDS

Cultural value integration; *Anging Mammiri*; problem-solving skills; higher-order thinking skills (HOTS); contextual learning.

## INTRODUCTION

Higher-order thinking skills (HOTS), particularly problem-solving, are essential competencies in twenty-first century higher education. In addition to supporting academic achievement, HOTS prepare students to address increasingly complex social, environmental, and cultural issues (Allen et al., 2019; Greenstein, 2012; Maharani et al., 2022). Facione's (2011) critical thinking framework and Bloom's revised taxonomy (Krathwohl, 2002) emphasise that problem-solving requires analysis, evaluation, and creation. Thus, strengthening HOTS serves not only as a cognitive strategy but also as preparation for adapting to dynamic global and local contexts. However, in Indonesia, instructional practices remain largely lecturer-centred and insufficiently contextualised, so the strengthening of HOTS has not developed optimally (Delany et al., 2018; Herlina et al., 2024). This pattern tends to position students as passive recipients of knowledge. As a result, learning outcomes that require analytical, evaluative, and creative skills are rarely achieved in practice. This condition is consistent with the international PISA report (OECD, 2016), which shows that most Indonesian students perform below level 2 in HOTS. Djidu & Retnawati (2018) likewise confirmed that although educators recognise the importance of HOTS, their ability to design instruction that genuinely fosters these skills remains low. This reflects a clear gap between curriculum objectives and actual achievements in the field.

A review of curriculum documents (CPL–CPMK–RPS) in the Biology Education program, particularly in the Animal Ecology course, shows that learning outcomes are targeted at levels C4–C6. This means that students are expected to analyse ecological patterns and factors, evaluate management alternatives, and design contextual intervention strategies. Therefore, a learning model is needed that not only aligns with these cognitive targets but also translates them into operational learning activities and valid assessment indicators. Local culture-based learning is considered relevant to this need. One such example can be found in the *Anging Mammiri* culture (Bugis–Makassar), which provides a collective, dialogical, and community-oriented learning ecology through the practices of *Ma'manu-manu*, *Ma'pese-pese*, *Assamaturu'*, *Tudang Sipulung*, *Ma'ppadandang*, and *Sipakainga*. Conceptually, these cultural practices align with HOTS indicators. *Ma'manu-manu* and *Ma'pese-pese* support systematic observation and evidence gathering for analysis (C4). *Assamaturu'* and *Tudang Sipulung* facilitate the synthesis of alternatives, comparison of arguments, and consideration of consequences in evaluation (C5). Meanwhile, *Ma'ppadandang* and *Sipakainga* emphasise interaction, feedback, and refinement of solutions within the creative domain (C6) (Aral et al., 2022; Palennari et al., 2023; Rahman et al., 2023; Zahrawati et al., 2022). This study explicitly focuses on strengthening higher-order thinking skills in problem-solving (C4–C6), while character dimensions are treated as supportive rather than primary targets.

From a scholarly perspective, studies on *Anging Mammiri* in higher education are still dominated by descriptive approaches and character-building orientations, and have not yet operationalised C4–C6 indicators in teaching materials or tested their effectiveness (Sakti et al., 2024; Yunus, 2021). Empirically, this creates a theoretical gap in positioning local cultural

practices as cognitive mechanisms supporting analysis, evaluation, and creation. Practically, this study is directed at producing a validated and tested learning model and instruments (RPS, SAP, LKM, essay instruments, and rubrics) within the higher education context. Conceptually, this study integrates culturally responsive pedagogy (Gay, 2013; Ladson-Billings, 2021) and social constructivism (Vygotsky, 1987) with Bloom's revised taxonomy (C4–C6) and (Greenstein's (2012) problem-solving stages.

The development of this study followed Plomp's (2013) research and development model, which consists of three phases: (1) preliminary research involving needs assessment and the formulation of relevant *Anging Mammiri* practices, (2) prototype development of the model and its teaching instruments (RPS, SAP, LKM), and (3) effectiveness assessment. Building on this framework, the study aims to develop and examine a culture-based learning model that integrates the educational values of *Anging Mammiri* into higher education. In line with these objectives, the study addresses three main research questions: **(1)** What are the most pressing student learning needs, and which *Anging Mammiri* educational values are most relevant for integration?; **(2)** How can a prototype learning model based on *Anging Mammiri* values be designed and validated for classroom application?; and **(3)** Is the model more effective in improving students' problem-solving skills compared to conventional instruction?

This study contributes both theoretically and practically. Theoretically, it positions local cultural values as cognitive mechanisms that support analysis, evaluation, and creation in HOTS. Practically, it develops validated and tested pedagogical products, including a model, RPS, SAP, LKM, essay instruments, and assessment rubrics, for implementation in higher education.

## LITERATURE REVIEW

Problem solving skills are a core component of higher order thinking skills (HOTS). Greenstein, (2012) emphasises that these skills involve identifying problems, designing solutions, evaluating alternatives, and reflecting critically on the reasoning process. Polya (1980) also outlined four stages of problem solving that remain a reference in educational practice. However, various studies show that students' problem solving skills are still at a low level. Allen et al. (2024) stressed that the development of critical and creative thinking in higher education must be conducted systematically, while Damopoli et al. (2024) highlighted that these skills reflect not only cognitive outcomes but also readiness to face real life challenges.

The strengthening of problem solving skills can be facilitated through contextual and transformative learning approaches grounded in constructivist theory (Gcabashe, 2024; Gülay Ogelman et al., 2023). Vygotsky (1987) argued that students construct meaning through active engagement and social interaction. In line with this, Delany et al. (2018) showed that contextual learning, which connects subject matter to students' life experiences, contributes to more reflective understanding. (Mezirow, 1998) further explained that transformative learning encourages critical reflection on underlying assumptions, leading to new perspectives that are relevant to social and environmental contexts. Thus, contextual and transformative approaches

have been shown to foster the critical, adaptive, and reflective mindsets that underpin problem solving skills (Chimbunde et al., 2023; Steyn & Vanyoro, 2023).

Beyond pedagogical approaches, the integration of local cultural values is increasingly recognised as a key strategy for strengthening twenty first century competencies (Chaves-Guerrero et al., 2024). The theory of culturally responsive pedagogy (Ajayi, 2025; Gay, 2013; Ladson-Billings, 1995) asserts that culture is not merely a background factor but also a pedagogical resource that can enhance student motivation, relevance, and engagement. Aral et al. (2022) demonstrated that multicultural approaches promote positive attitudes toward diversity, while (Palennari et al. (2023) found that integrating local values strengthens student identity. Similarly, Maideja et al. (2023) noted that culture fosters participatory, reflective, and contextual attitudes aligned with the demands of twenty first century skills.

Local culture serves as a bridge between modern learning theories and traditional wisdom embedded in communities. Cultural values function not only as identity markers but also as learning resources that shape students' thinking, attitudes, and behaviours. Integrating culture into education provides opportunities to increase the relevance of learning while cultivating character in line with social and ecological contexts. One cultural tradition with strong potential as a pedagogical basis is the Bugis Makassar culture, which is rich in values of collaboration, reflection, and social ethics.

The *Anging Mammiri* culture in Bugis Makassar traditions such as Ma'manu manu, Ma'pese pese, Assamaturu', Tudang Sipulung, Ma'ppadendang, and Sipakainga embodies noble values including *sipakatau* (mutual respect), *sipakalebbi* (mutual honour), and *sipakainga* (mutual reminder). These values reflect principles of collaboration, dialogue, and social ethics (Anwar et al., 2023; Jamaluddin et al., 2022). Such values not only function as social norms but also cultivate critical evaluation, collaborative solution design, and reflection on mistakes, which are central to problem solving. Moreover, *Anging Mammiri* emphasises harmony between humans and nature, fostering ecological awareness as part of socially responsible problem solving (Rahman et al., 2023; Zahrawati, Aras, et al., 2022). Nevertheless, previous studies on *Anging Mammiri* have largely remained descriptive and focused on character education, without positioning it as an implementable pedagogical strategy for strengthening problem solving skills (Sakti et al., 2024; Yunus, 2021).

The literature highlights three main theoretical foundations for this study. First, problem solving theory (Greenstein, 2012), which emphasises analytical, evaluative, and reflective competencies as core learning outcomes. Second, constructivist learning theory (Vygotsky, 1987) and its application in contextual (Delany et al., 2018) and transformative learning (Mezirow, 1998), which stress active engagement and critical reflection. Third, culturally responsive pedagogy (Gay, 2013; Ladson-Billings, 2021) which positions culture as a pedagogical resource to strengthen relevance and student engagement. The integration of *Anging Mammiri* values that emphasise collaboration, social ethics, and ecological harmony (Anwar et al., 2023; Jamaluddin et al., 2022) is positioned as a local contextual reinforcement within this broader

framework. In this way, the theoretical framework of the study situates problem solving as the primary variable to be developed through constructivist pedagogy, with the integration of *Anging Mammiri* cultural values as its cultural foundation.

## METHOD

### Research Design

This study employed a research and development (R&D) approach following Plomp's (2013) model, which consists of three main phases: preliminary research, prototyping, and assessment.

#### *Preliminary Research*

The preliminary stage involved several activities. First, a needs analysis was conducted through a diagnostic test to map students' initial problem solving skills. Second, classroom observations were carried out to identify the teaching patterns used by lecturers and the challenges in fostering higher order thinking. Third, interviews were conducted with Bugis Makassar cultural experts to explore *Anging Mammiri* values relevant for developing problem solving skills. The outputs of this stage were a comprehensive description of students' learning needs and a set of *Anging Mammiri* values formulated for educational purposes.

#### *Prototyping Phase*

The prototyping stage produced an initial draft of the learning model, which consisted of: (1) structured instructional syntax, (2) teaching instruments including the semester learning plan (RPS), course unit plan (SAP), and student worksheets (LKM), and (3) problem solving assessment instruments in the form of essay tests and rubrics. This prototype was validated by experts in pedagogy, educational evaluation, and Bugis Makassar culture. Feedback from validators was used to revise and refine the model to ensure its feasibility for classroom implementation.

#### *Assessment Phase*

The assessment stage was conducted through an experimental design using a pretest–posttest control group. The experimental group was taught using the *Anging Mammiri* culture based model, while the control group received conventional problem based learning (PBL). Both groups completed a pretest to measure their initial problem solving skills, followed by a posttest to assess improvement after the intervention. Data from the pretest and posttest were analysed using statistical tests in SPSS to determine differences in the improvement of problem solving skills between the experimental and control groups. The effectiveness test design is presented in Table 1.

**Table 1.**

#### *Research Design Plan*

Group	Pre-test	Treatment	Post-test
C	O1	X	O2
E	O1	X	O2

**Description:**

C: Control (Learning using the Problem-based learning model)

E: Experimental (Learning using the *Anging Mammiri* culture-based model)

O1: Pre-test

O2: Post-test

**Research Participants**

Participants varied according to the stages of Plomp's model. In the preliminary stage, 60 fourth semester students (aged 19–21; 45% male and 55% female) from the Biology Education program participated in the diagnostic test. Five lecturers of the Animal Ecology course were observed to examine teaching patterns and challenges in promoting higher order thinking. To strengthen the cultural dimension, three Bugis Makassar cultural experts and two community leaders were interviewed to identify relevant *Anging Mammiri* values.

In the prototyping stage, five expert validators were involved, including two experts in innovative learning, one expert in educational evaluation, and two experts in Bugis Makassar culture. They assessed the feasibility of the model syntax, teaching instruments (RPS, SAP, and worksheets), and problem solving assessment tools. Their comments were used to improve and finalise the prototype before classroom implementation.

In the assessment stage, two parallel classes were selected through cluster random sampling. One class of 22 students (10 male, 12 female, aged 19–20) was assigned as the experimental group and taught using the *Anging Mammiri* culture based model, while another class of 22 students (9 male, 13 female, aged 19–20) served as the control group and was taught using conventional PBL. In total, 109 individuals participated in this research, including students, lecturers, cultural experts, community leaders, and expert validators.

**Research Instruments and Procedures**

The research instruments were developed according to the stages of Plomp's model. In the preliminary stage, three main instruments were employed: a diagnostic problem solving test, an observation guide, and a semi structured interview guide. The diagnostic test consisted of essay questions designed to measure students' ability to define problems, design solutions, evaluate alternatives, select the best solution, and reflect and implement, based on Greenstein's (2012) higher order thinking skills framework. The observation guide was used to assess lecturers' teaching practices and student activities in class, particularly in relation to opportunities for developing higher order thinking. The semi structured interview guide was used to obtain information from Bugis Makassar cultural experts and community members regarding *Anging Mammiri* values relevant to problem solving skills. The interviews focused on three themes: (1) identifying *Anging Mammiri* values still practised in the community, (2) examining their relevance to higher education learning, particularly in supporting problem solving skills, and (3) exploring the potential for integrating these values into learning activities. These themes were elaborated into detailed questions on *Anging Mammiri* traditions such as *Ma'manu manu*, *Ma'pese pese*, *Assamaturu'*, *Tudang Sipulung*, *Ma'ppadendang*, and

*Sipakainga*. Each question was designed not only to reveal the cultural meaning but also to connect it to the stages of students' problem solving. Data from the observations and interviews were recorded, transcribed, and analysed using thematic coding to identify key themes that formed the basis for model development.

In the prototyping stage, expert validation sheets were used. Validators consisted of learning experts, educational evaluation experts, and Bugis Makassar cultural experts. Validation covered four main components: the learning model syntax, teaching instruments (RPS and SAP), student worksheets (LKM), and problem solving tests and rubrics. The aspects evaluated included content (alignment of objectives, competencies, and problem solving indicators), construct (clarity of syntax, completeness of components, usability of instruments, and clarity of instructions), and language (accuracy, clarity, and conformity to academic conventions). The evaluation used a five point scale and was accompanied by qualitative comments. Validation data were analysed quantitatively to calculate the feasibility percentage of each component and qualitatively to identify suggestions for revising the prototype.

In the assessment stage, the instruments included a problem solving essay test and an analytic rubric. The essay test consisted of five questions developed from Greenstein's (2012) indicators and aligned with Bloom's revised taxonomy (Anderson, 2005; Krathwohl, 2002) at the C4 (Analysing), C5 (Evaluating), and C6 (Creating) levels. Each essay question represented one stage of problem solving: defining the problem, designing solutions, evaluating alternatives, selecting the best solution, and reflecting and implementing. The scoring rubric provided detailed criteria for each aspect and assigned scores from 1 to 5, ensuring objective and transparent assessment. Indicators for each aspect are presented in Table 2.

**Table 2.**

*Problem-Solving Indicators*

<b>Aspect</b>	<b>Indicators</b>	<b>Cognitive Level</b>
<i>Define the problem</i>	Analyse facts, data, and root causes	C4 – Analysing
<i>Design Solutions</i>	Organising information to formulate several alternative solutions	C4 – Analysing
<i>Evaluate solutions</i>	Evaluating the strengths and weaknesses of the proposed solutions	C5 – Evaluating
<i>Select the best solution</i>	Provide logical reasons for choosing the most effective solution	C5 – Evaluating
<i>Reflect and implement</i>	Develop an implementation plan and reflect on the results of problem solving	C6 – Creating

An example of the problem solving test instrument was developed for the topic of Animal Ecology. The essay questions were designed based on Greenstein's (2012) problem solving framework and Bloom's revised taxonomy at the cognitive levels C4–C6.

1. Define the problem (C4 – Analyzing): Analyse the main factors contributing to the decline of the Babirusa (*Babirusa* sp.) population in South Sulawesi.

2. Design solutions (C4 – Analyzing): Propose at least three alternative solutions that could be implemented to protect the Babirusa population in this area.
3. Evaluate solutions (C5 – Evaluating): Explain the strengths and weaknesses of each proposed solution.
4. Select the best solution (C5 – Evaluating): From the solutions you have analysed, choose the one you consider most effective for long term conservation, and provide logical reasons to support your choice.
5. Reflect and implement (C6 – Creating): Develop an implementation plan for the solution you have selected, including program steps, stakeholders involved, and evaluation methods. Reflect also on how this solution could affect the ecosystem as a whole.

The scoring rubric for the problem solving test was developed according to Greenstein's (2012) problem solving indicators and Bloom's revised taxonomy (C4–C6). Scores were assigned on a scale of 1 to 5, depending on the quality of the students' responses. Table 3 (see appendix) presents the rubric used for the problem solving test.

### **Data Analysis**

In the preliminary research stage, the problem solving pretest data were analysed quantitatively using descriptive statistics in the form of means, percentages, and ability categories to provide an initial profile of student skills. Observation data were analysed qualitatively to identify lecturers' teaching patterns and the challenges encountered in fostering higher order thinking. Meanwhile, interview data with lecturers and Bugis Makassar cultural experts were recorded, transcribed, and analysed using thematic coding to identify key *Anging Mammiri* values relevant for learning.

During the prototype development stage, expert validation data were analysed both quantitatively and qualitatively. Quantitative scores from the validators were calculated as averages and feasibility percentages across the aspects of content, construct, and language. Qualitative comments and suggestions from the validators were used to refine and improve the prototype of the *Anging Mammiri* culture based learning model.

In the assessment stage, student problem solving test data were analysed using quantitative procedures. Before the main analysis, prerequisite tests were conducted, including a normality test using the One Sample Kolmogorov Smirnov Test and a homogeneity test using Levene's Test of Equality of Error Variances. The results indicated that the data were normally distributed and that variances between groups were homogeneous, allowing further analysis. The effectiveness of the *Anging Mammiri* culture based learning model compared to conventional Problem Based Learning (PBL) was then examined using two statistical approaches. First, paired sample t tests were applied to compare pretest and posttest results within each group. The results showed significant improvement in both groups ( $p < 0.05$ ), with greater average score increases in the experimental group. Second, independent sample t tests were conducted to compare posttest scores between the groups. The analysis demonstrated that the difference between the experimental and control groups was statistically significant ( $p$

< 0.05), leading to the conclusion that the *Anging Mammiri* model was more effective in improving students' problem solving skills.

## RESULTS

### Identification of Student Learning Needs and Formulation of Educational Values in the *Anging Mammiri* Culture

An initial overview of students' problem-solving abilities was obtained through a pretest consisting of five essay questions in accordance with problem-solving indicators. This pretest was administered to 60 fourth-semester Biology Education students who had taken or were currently taking the Animal Ecology course. The results of the initial test analysis are presented in Table 4.

**Table 4.**

*Initial test results for problem-solving skills.*

Aspect	Indicator	Total Mastery (%)	Mean
Define the problem	Analyse facts, data, and root causes	45.2	2.26
Design solutions	Organise information to formulate several alternative solutions	41.80	2.09
Evaluate solutions	Evaluating the strengths and weaknesses of the proposed solutions	38.40	1.92
Select the best solution	Provide logical reasons for choosing the most effective solution	39.70	1.98
Reflect and implement	Develop an implementation plan and reflect on the results of problem-solving	35.10	1.81
<b>Average</b>		<b>40.44</b>	<b>2.01</b>

Initial test results indicate that students' problem-solving skills are generally still in the low category, with an average score of 2.01 out of a maximum score of 5. The indicator with the highest relative achievement is *Define the problem* (Mean = 2.26; 45.20%), while the lowest indicator is *Reflect & implement* (Mean = 1.81; 35.10%). These findings confirm that before receiving treatment, students still had difficulty designing solutions, evaluating, and especially reflecting on the results of problem solving.

The learning observation activity focused on Animal Ecology lectures conducted by five lecturers from the Biology Education Study Programme at five universities in South Sulawesi. The observation results can be seen in Table 5.

**Table 5.***Learning observation results*

<b>Aspects Observed</b>	<b>Key Findings</b>	<b>Challenges Encountered</b>
Learning Approach	Learning was still dominated by lectures and one-way explanations	Students tended to be passive and only took notes, with low participation in discussions
Student Activities	Students mostly listened to lecturers' explanations	Opportunities for critical thinking, discussion, and problem solving were very limited
Use of teaching materials	Learning materials consisted of presentation slides and standard textbooks	Contextual learning materials linking content to real problems or local culture were not yet available
HOTS development strategies	There were no explicit activities emphasising analysis, evaluation, or creation	The learning process had not been directed towards training higher order thinking skills.
Assessment	Assessment was largely based on written tests and memorisation	Assessment instruments measuring students' problem solving ability had not yet been used

The observation results indicated that lectures were still oriented toward instructional delivery with limited student involvement. Activities that could foster higher order thinking skills, such as analytical discussions, case evaluations, or contextual problem solving, had not yet been consistently implemented.

Interviews with key informants, namely three traditional leaders and two local community members, confirmed consistent information regarding the application of *Anging Mammiri* cultural values in the daily life of the Bugis Makassar community. These findings formulated educational values within the *Anging Mammiri* culture that are relevant to the development of problem solving skills. A summary of the interview results is presented in Table 6 (see appendix).

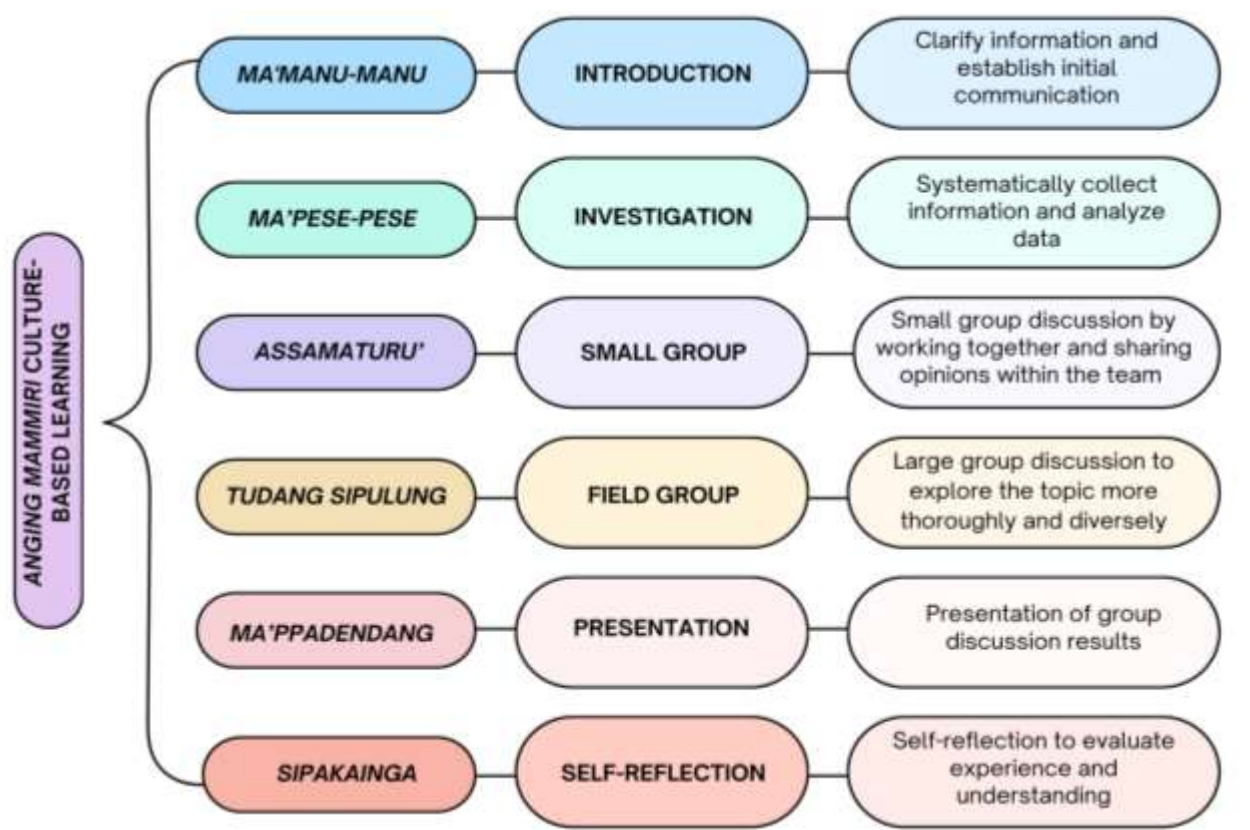
### **Development of the Prototype of the *Anging Mammiri* Culture Based Learning Model Syntax of the *Anging Mammiri* Culture Based Learning Model**

The theoretical framework of this study is grounded in Greenstein's (2012) concept of problem solving skills, which consists of five main stages: defining the problem, designing solutions, evaluating solutions, selecting the best solution, and reflecting and implementing. These five stages were integrated with *Anging Mammiri* cultural values, which were mapped into the instructional syntax. In the *define the problem* stage, students were guided through ***Ma'manu manu*** to clarify information and formulate the problem accurately. The *design solutions* stage

was embodied in *Ma'pese pese*, where students conducted investigations by collecting and analysing data to generate alternative solutions. The *evaluate solutions* stage was implemented through *Assamaturu'*, namely small group discussions aimed at weighing the strengths and weaknesses of each proposed solution. Next, the *select the best solution* stage was reflected in *Tudang Sipulung* and *Ma'ppadendang*, where students engaged in large group discussions and presented their results to select the most appropriate solution through argumentation. Finally, the *reflect and implement* stage was represented by *Sipakainga*, which emphasised self reflection to evaluate the effectiveness of the chosen solution and to design its implementation steps. The stages of this instructional syntax are illustrated in Figure 1.

**Figure 1.**

*Stages of Anging Mammiri Culture-Based Learning*



### Specification of Learning Instruments

#### Semester Learning Plan (RPS) and Course Unit Plan (SAP)

The Semester Learning Plan (RPS) and the Course Unit Plan (SAP) for the Animal Ecology course were developed by integrating the syntax of the *Anging Mammiri* culture based learning model. The RPS included learning outcomes, sub-CPMK, indicators, study materials, methods, media, and assessments, all directed toward strengthening students' problem solving skills. The instructional syntax was applied in sequential stages: *Ma'manu-manu* (Introduction), *Ma'pese-pese* (Investigation), *Assamaturu'* (Small Group), *Tudang Sipulung* (Field Group),

Ma'ppadendang (Presentation), and Sipakainga (Self-reflection). The SAP elaborated the implementation of each stage into structured classroom activities. For instance, in the *Ma'manu-manu* stage, students were engaged in discussing local animal ecology phenomena to analyse problems; in the *Ma'pese-pese* stage, they were directed to investigate conservation data; while in the *Tudang Sipulung* stage, students participated in plenary discussions to collectively select the most appropriate solution.

### **Student Worksheets (LKM)**

The Student Worksheets (LKM) were designed by presenting contextual problems related to issues of endemic animal ecology in Sulawesi, for example, the decline of the Babirusa (*Babyrousa sp.*) population due to habitat degradation. Students were guided to follow the stages of problem solving, beginning with defining the problem, designing solutions, evaluating solutions, selecting the best solution, and reflecting and implementing, all within the context of ecosystem balance. Each stage of problem solving was integrated with *Anging Mammiri* cultural values. *Ma'manu manu* trained students to clarify initial information through respectful communication (*sipakatau*). *Ma'pese pese* emphasised the importance of careful and in depth investigation. *Assamaturu'* fostered collaboration within small groups. *Tudang Sipulung* taught deliberation to reach consensus. *Ma'ppadendang* represented appreciation of achievements in presenting discussion results. Finally, *Sipakainga* emphasised the importance of reflection and reminding one another with mutual respect.

### **Problem Solving Test Instrument**

The test instrument consisted of essay questions developed based on Greenstein's (2012) problem solving indicators and contextualised to animal ecology topics. An example of a question is: "Analyse the main factors contributing to the decline of the Babirusa (*Babyrousa sp.*) population in South Sulawesi and propose realistic conservation solutions." These questions were designed to measure students' abilities in analysing ecological problems, designing data based solutions, evaluating the strengths and weaknesses of conservation strategies, and developing sustainable implementation plans.

### **Scoring Rubric**

The scoring rubric was constructed based on problem solving indicators with a scale of 1 to 5. The assessed aspects included clarity of problem analysis (C4), creativity of proposed solutions (C4), accuracy in evaluating alternatives (C5), rationality in selecting the most effective solution (C5), and the ability to design implementation plans and reflect on ecological impacts (C6). This rubric ensured that the assessment was objective and transparent, and also helped students understand the criteria for success in solving animal ecology problems.

### **Expert Validation**

Validation was conducted by five experts consisting of learning specialists, educational evaluation experts, and Bugis Makassar cultural experts. They assessed the prototype of the instructional syntax, RPS, SAP, LKM, test instruments, and scoring rubrics. The evaluation was

carried out using a 1–5 scale covering content, construct, and language aspects, which were then converted into percentages. A summary of the validation results is presented in Table 7.

**Table 7.**

Expert validation results

Assessment Aspect	n	Average (1–5)	SD	Score (%)	Category
Model syntax	5	4.80	0.27	96	Highly valid
RPS & SAP	5	4.80	0.45	96	Highly valid
LKM	5	<b>4.40</b>	0.42	<b>88</b>	<b>Valid</b>
Essay test	5	4.90	0.22	98	Highly valid
Assessment rubric	5	5.00	0.00	100	Highly valid
<b>Average</b>		<b>4.78</b>		<b>95.6</b>	

### Effectiveness of culture-based learning on problem-solving skills

This study employed a pretest–posttest control group design to examine the effectiveness of the *Anging Mammiri* culture based learning model. Two groups with relatively equivalent characteristics were designated as research groups: the experimental group, which received treatment through the application of the *Anging Mammiri* culture based learning model, and the control group, which followed instruction using the conventional Problem Based Learning (PBL) model. The research procedure began with administering a pretest to both groups to measure students' initial problem solving skills. In the treatment stage, the experimental group was taught using the *Anging Mammiri* instructional syntax, while the control group participated in learning through conventional PBL stages. After the treatment sessions were completed, both groups were given a posttest using the same instrument to assess improvements in problem solving skills.

In the assessment stage, data from the students' problem solving tests were analysed using a quantitative approach. Before conducting the main analysis, prerequisite tests were administered, including a normality test using the One Sample Kolmogorov Smirnov Test and a homogeneity test using Levene's Test of Equality of Error Variances. The results of both tests indicated that the data were normally distributed and that the variances between groups were homogeneous, thereby allowing the main analysis to be carried out. The results of the normality and homogeneity tests are shown in Table 8.

**Table 8.**

*Normality and Homogeneity Test*

Group	p-value (Normality Test)	Conclusion	p-Value (Homogeneity of Variance)	Conclusion
Control	0.95	Normal Distribution	0.85	Homogeneous Variance
Experimenta I	0.92	Normal Distribution	0.90	Homogeneous Variance

Furthermore, the effectiveness of the *Anging Mammiri* culture based learning model compared with conventional Problem Based Learning (PBL) was analysed using two procedures. First, a paired sample t test was conducted to compare the pretest and posttest scores within each group. The results indicated that both groups experienced significant improvement ( $p < 0.05$ ), with the experimental group showing a higher average increase. Second, an independent sample t test was carried out to compare the posttest scores between the groups. The analysis revealed a significant difference between the experimental and control groups ( $p < 0.05$ ), confirming that the application of the *Anging Mammiri* model was more effective in improving students' problem solving skills. The results of the analysis are presented in Table 9.

**Table 9.**

*F-test results comparing the pre-test and post-test problem-solving skills between the control and experimental groups*

Group	Test Type		Mean Pre-test	Post-test Mean	t-value	p-value	Conclusion
Control	Paired (within)	t-test	55.45	74.88	7.85	0.000	Significant
Experimental	Paired (within)	t-test	56.55	87.39	9.62	0.000	Significant
Control versus Experimental	Independent (between post-test)	t-test groups,	74.88	87.39	3.45	0.001	Significant difference

The analysis showed that the problem solving skills of students in the experimental group increased significantly after the implementation of the *Anging Mammiri* culture based learning model. This finding provides empirical evidence that the *Anging Mammiri* model is more effective than conventional Problem Based Learning (PBL) in developing students' problem solving abilities. The *Anging Mammiri* instructional syntax was developed as an integration of Greenstein's (2012) problem solving framework with Bugis Makassar cultural values. The model consists of six main stages, which are described as follows.

### ***Ma'manu-manu* stage**

*Ma'manu-manu* is a tradition aimed at gathering information or clarifying matters before carrying out an important event. Its relevance lies in the importance of the initial stage of the learning process. At this stage, lecturers have the opportunity to clarify the necessary information before introducing new material, thereby creating clear communication with students and avoiding misunderstandings that could hinder the effectiveness of the teaching and learning process. This reflects the value of harmony upheld by the Bugis Makassar community and its relevance in creating a conducive and productive learning atmosphere. The *Ma'manu-manu* tradition is highly relevant to the introductory stage of learning, which serves to prepare students mentally and cognitively before engaging with more complex material. In this stage, students are asked to gather and sit with their peers in small groups to discuss the upcoming topic, establish initial communication, and share their prior understanding of the subject matter. An illustration of the *Ma'manu-manu* stage is presented in Figure 2.

**Figure 2. A.**

*The lecturer directs students to find their partner (small group), and B. Students find their partner*



(A)

(B)

### ***Ma'pese-pese* stage**

*Ma'pese-pese* is a traditional form of investigation that ensures a prospective bride comes from a good background. Its relevance to learning lies in the investigative stage, which teaches the importance of gathering in depth information before making decisions. *Ma'pese-pese* can be adapted to education as an approach for collecting data, analysing information, and ensuring that decisions are made on the basis of comprehensive understanding. This approach is useful in teaching students how to think critically and systematically when solving problems. The *Ma'pese-pese* stage trains students to conduct thorough investigations before making decisions, aligning with the learning process that prioritises analysis and reflection. In this stage, students are encouraged to collect relevant information such as data, literature, and other sources that

support their understanding of the topic under discussion. Data collection can be carried out through various channels, including libraries for books and academic journals, online academic databases such as Google Scholar, JSTOR, or PubMed, and other credible digital resources. This ensures that each step taken is well reasoned and carefully considered. An illustration of the *Ma'pese-pese* stage as applied in the classroom is presented in Figure 3.

**Figure 3.**

*Teams in small groups conduct an investigation*



***Assamaturu'* stage**

The *Assamaturu'* tradition emphasises cooperation and togetherness within the community, which is relevant for developing students' collaborative skills. Through small group discussions or group projects, students are able to collaborate, share opinions, and achieve common goals that enhance their communication skills. At this stage, students work in small groups to analyse and find solutions to the given problems. Each individual actively contributes ideas that are later prepared for wider discussion in a larger group forum. The *Assamaturu'* stage encourages students to sharpen their critical thinking, teamwork, and collaborative problem solving abilities. An illustration of the *Assamaturu'* stage as implemented in the classroom is presented in Figure 4.

**Figure 4.**

*Teams in small groups collaborate to find solutions to problems*



### ***Tudang Sipulung* stage**

*Tudang Sipulung* is a deliberation tradition aimed at reaching consensus when making important decisions. This tradition is highly relevant to discussion based learning, as students can express their opinions, listen to the perspectives of others, and work toward a shared agreement. Extensive group discussions involving all participants to explore topics in greater depth reflect the principles embodied in *Tudang Sipulung*. The values of this tradition teach the importance of deliberation and active participation in the learning process. This aligns with student centred learning models that emphasise discussion and deliberation skills as essential for developing students' critical thinking and collaboration. An illustration of the *Tudang Sipulung* stage as implemented in the classroom is presented in Figure 5.

**Figure 5.**

*Students join a large group for a unified discussion*



### ***Ma'ppadandang stage***

*Ma'ppadandang* is a tradition that celebrates the harvest as an expression of gratitude. This tradition can be adapted to celebrate academic achievements and the outcomes of the learning process. The presentation of discussion results can be regarded as a celebration of student achievement, providing opportunities for students to share their knowledge and outcomes while enhancing motivation and pride in their learning efforts. The groups that present their discussion results may be selected through engaging and interactive methods, such as the educational game *Lojo'lojo*. *Lojo'lojo* is an educational game that combines elements of competition and collaboration to determine which group will present their discussion results. This method makes the selection process more dynamic and enjoyable, allowing students to participate in the game while sharpening their critical thinking skills. The *Lojo'lojo* game begins with each group leader meeting directly with the lecturer. Each leader places their index finger on the lecturer's palm. The lecturer then sings the *Lojo'lojo* song with its distinctive rhythm while moving their hand randomly. When the song ends, the group whose leader's finger is caught by the lecturer is selected to present their discussion results. This approach adds an element of entertainment to the learning process, making the group selection more enjoyable and engaging. The game also creates healthy tension and gives every group an equal opportunity to be chosen. An illustration of the *Ma'ppadandang* stage as implemented in the classroom is presented in Figure 6.

**Figure 6. A.**

Lojo'lojo game to select the group to present B. The selected group presents the results of the discussion



### ***Sipakainga stage***

*Sipakainga* is a tradition of mutual reminding aimed at maintaining social harmony. The values of this tradition are highly relevant in the context of self reflection, as students are encouraged to be open to new understandings and to identify what they have already learned as well as

what still requires deeper comprehension. Similar to the meaning of the *Sipakainga* tradition, which prioritises mutual respect and offering advice with empathy, students are expected to respect the views of others and to be ready to reflect on what they have learned. This self reflection includes writing down what has been understood and what remains unclear during the learning process. In this way, students can identify areas requiring further development and design steps to improve their understanding. Therefore, the *Sipakainga* tradition can be adapted as the final stage of learning to foster a culture of mutual reminding, while also providing students with the opportunity to evaluate themselves and plan improvements for their personal development. An illustration of the *Sipakainga* stage as implemented in the classroom is presented in Figure 7.

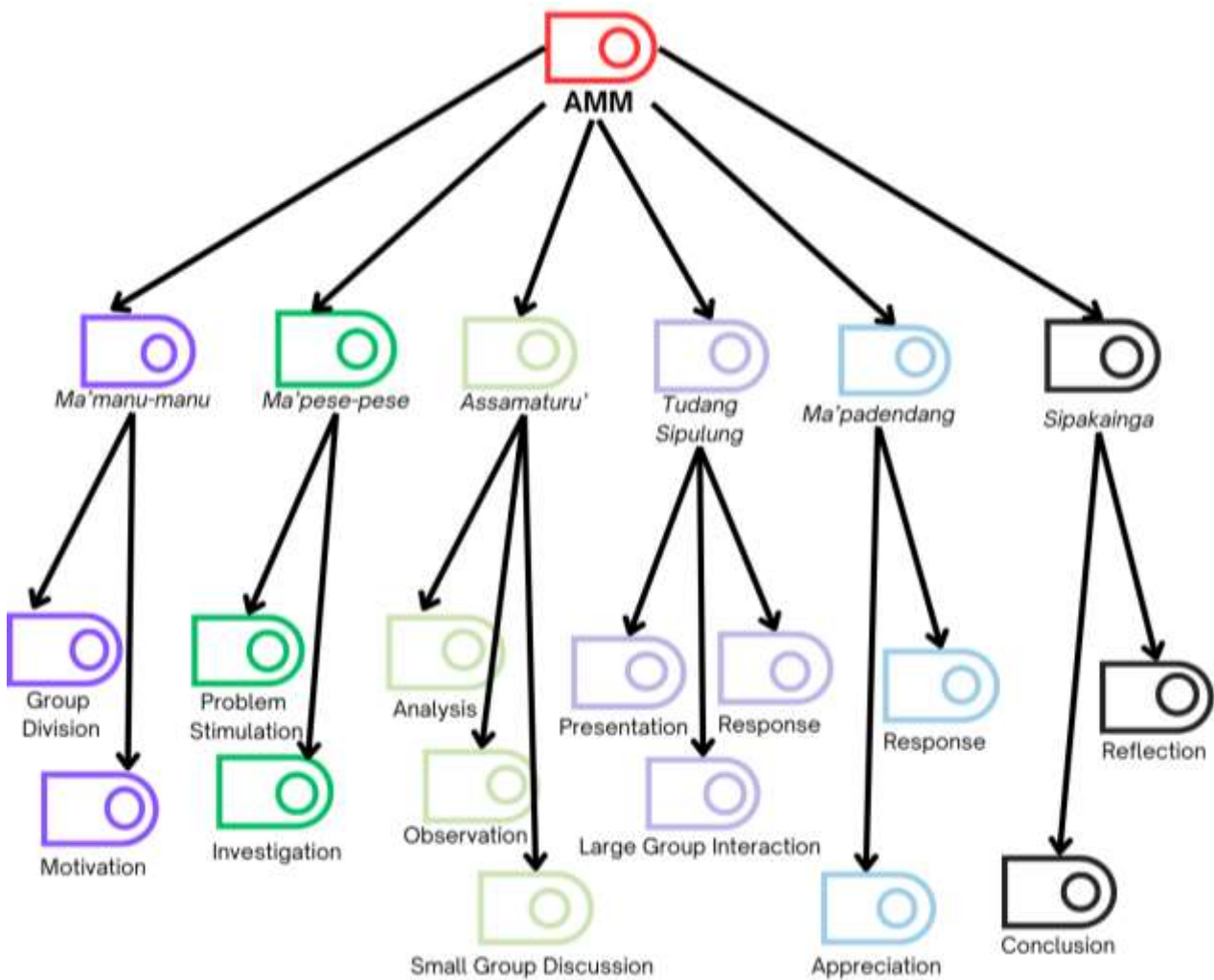
**Figure 7.**

*Students complete the self-reflection*



*Anging Mammiri* (AMM) culture based learning is an innovative approach that integrates the local cultural values of the Bugis Makassar community into the learning process. It is designed to enhance students' academic understanding, instil local wisdom, and foster the practice of problem solving skills. By adopting local cultural philosophies and practices such as *Ma'manu manu*, *Ma'pese pese*, *Assamaturu'*, *Tudang Sipulung*, *Ma'ppadandang*, and *Sipakainga*, learning becomes more contextual, meaningful, and engaging. Each stage of AMM learning is structured to ensure that students actively participate in discussion, reflection, collaboration, and the exploration of real world problems relevant to their environment. The structural diagram of *Anging Mammiri* culture based learning is presented in Figure 8.

**Figure 8.** Structure of *Anging Mammiri* (AMM) culture-based learning



To obtain a more comprehensive picture of the model’s effectiveness, the subsequent analysis focused on the five key indicators of problem solving skills according to Greenstein’s (2012) framework, namely defining the problem, designing solutions, evaluating solutions, selecting the best solution, and reflecting and implementing. The following section elaborates on students’ achievements in each indicator to explain the contribution of the *Anging Mammiri* syntax to strengthening problem solving skills.

**Define the Problem**

At the *define the problem* stage, students were asked to analyse the main factors contributing to the decline of the Babirusa (*Babyrousa sp.*) population in South Sulawesi. The students’ responses demonstrated varying levels of analytical depth. Most students were able to identify ecological factors such as habitat loss due to land clearing and deforestation, as well as illegal hunting that further reduced the population. Some students also added climate change as a factor affecting the availability of natural food sources for the Babirusa, along with conflicts arising from human activities such as land conversion for plantations and settlements. Example of student response:

*“The Babirusa population is declining because its forest habitat is shrinking due to logging.”*

*“In addition to habitat loss, illegal hunting by local communities has also reduced the population.”*

*“In my opinion, climate change also has an impact because the Babirusa’s food sources are decreasing.”*

According to Greenstein (2012), the *define the problem* stage emphasises students’ ability to identify key issues, analyse facts, and critically understand the root causes of problems. After the implementation of the *Anging Mammiri* culture based learning model, students demonstrated multifactor analytical skills. They were able to identify the decline of the Babirusa population not from a single factor, but by connecting various ecological, social, and anthropogenic aspects. This reflects achievement at the multifactor analysis level in line with Greenstein’s problem solving framework. This achievement was supported by the *Ma’manu manu* syntax, which encouraged students to collectively clarify information. Initial discussions grounded in Bugis Makassar cultural values made students more open to exchanging perspectives, resulting in a richer and more integrated understanding of the problem. Compared with the conventional PBL model, the strength of the *Anging Mammiri* model lies in its reinforcement of the collaborative dimension through deliberation, which allows students to build shared meaning and generate more critical analyses. Thus, this model has proven effective in enriching the *define the problem* stage by fostering higher level analytical skills that are both contextual and culturally grounded.

### ***Design Solutions***

At this stage, students were asked to design at least three alternative solutions to protect the Babirusa population in South Sulawesi. The results showed that students were able to propose systematic and multidimensional solutions. The alternatives formulated included habitat rehabilitation through forest reforestation, law enforcement against illegal hunting, the establishment of conservation areas or wildlife sanctuaries, community outreach programmes on the importance of Babirusa conservation, and partnerships with local communities to safeguard forest areas.

Example of student evaluation:

*“Reforestation should be carried out in degraded forest areas to preserve the Babirusa’s habitat.”*

*“There needs to be strict regulations to stop illegal hunting.”*

*“Local communities should be educated so that they also take part in protecting the Babirusa population.”*

The responses reflected students’ ability to conduct multifactor analysis, such as reforestation to preserve habitats, strict regulation of illegal hunting, and community education to encourage participation in conservation. According to Greenstein’s (2012) framework, this stage emphasises the ability to organise information and formulate structured solutions. Through the *Ma’pese pese* (investigation) syntax, students were encouraged to explore ecological, social, and policy related data, resulting in solutions that were more contextual and

applicable. Compared with conventional PBL, the *Anging Mammiri* model strengthened collective values and ecological awareness, making the solutions designed not only academically rational but also relevant to local cultural wisdom.

### **Evaluate Solutions**

At this stage, students were asked to evaluate the strengths and weaknesses of the solutions they had formulated. The results showed that students were able to provide critical considerations, not only by mentioning the solutions but also by weighing their effectiveness and limitations. Example of student evaluation:

**Forest reforestation** → Strengths: able to restore the Babirusa's natural habitat and maintain the ecosystem. Weaknesses: requires a long time to achieve tangible results and involves high costs.

**Law enforcement against illegal hunting** → Strengths: creates a deterrent effect and immediately reduces hunting threats. Weaknesses: field implementation is often constrained by weak supervision.

**Community education and outreach** → Strengths: increases community awareness and participation in a sustainable way. Weaknesses: changes in social behaviour require a long process and consistent efforts.

**Partnerships with local communities** → Strengths: strengthens the sense of ownership and responsibility among communities. Weaknesses: effectiveness is highly dependent on community support and active involvement.

Students' responses demonstrated their ability to weigh the strengths and weaknesses of each alternative solution they had designed. For example, forest reforestation was considered effective in restoring the Babirusa's habitat and maintaining the ecosystem, yet it requires a long time and substantial costs. Law enforcement against illegal hunting was viewed as effective in creating a deterrent effect, but its implementation is often constrained by weak supervision. Community education was regarded as sustainable because it raises public awareness, although behavioural change requires a long process. Meanwhile, partnerships with local communities were seen as strengthening a sense of responsibility, but their effectiveness depends on active community support. According to Greenstein's (2012) framework, this stage requires evaluative skills, namely comparing alternatives objectively by considering ecological, social, and policy factors. The *Assamaturu'* syntax played an important role in this process, as small group discussions enabled students to test arguments, debate the strengths and weaknesses of solutions, and build more mature decisions. Compared with the conventional model, the strength of *Anging Mammiri* lies in the integration of collaborative values into evaluation, allowing students not only to assess individually but also to develop critical thinking skills in a culturally grounded deliberative context.

### **Select the Best Solution,**

At the *select the best solution* stage, students were asked to choose one solution considered the most effective and sustainable for protecting the Babirusa population in South Sulawesi.

Through the *Tudang Sipulung* stage, students were guided to engage in large forum discussions to deliberate on the various alternatives that had previously been evaluated. These discussions enabled them to collectively weigh the strengths and weaknesses of each option, resulting in more comprehensive decisions.

Example of student responses:

*"In my opinion, reforestation is the most effective solution because without forests the Babirusa has no habitat, and all other efforts would be in vain."*

*"Law enforcement is important, but if the habitat remains damaged the population will still decline. Therefore, protecting the forest is the top priority."*

*"Reforestation that also involves local communities will be more sustainable, because it not only restores the ecosystem but also raises community awareness."*

Students' responses indicated a tendency to prioritise reforestation as the main solution. They argued that without habitat restoration, all other efforts would be in vain, making reforestation the top priority. In addition, some emphasised that reforestation would be more sustainable if it involved local communities, as this not only restored the ecosystem but also fostered awareness and participation among residents. In line with Greenstein's (2012) framework, this stage requires students to make decisions based on logical reasoning and to consider long term impacts. The integration of the *Tudang Sipulung* syntax in the *Anging Mammiri* model played an important role, as large group forums enabled students to evaluate multiple perspectives before determining the best option. Compared with the conventional model, this approach was more reflective and collaborative, producing decisions that were not only rational but also contextual and rooted in local cultural values.

### ***Reflect and Implement***

At the *reflect and implement* stage, students were guided to develop an implementation plan for the best solution they had selected while also reflecting on its overall impact on the ecosystem. The *Sipakainga* syntax, a tradition of mutual reminding in Bugis Makassar culture, served as the foundation for students to engage in collective reflection, provide feedback to one another, and assess the feasibility of the proposed plans.

Example of student responses:

*"The solution I chose is reforestation. The implementation involves local government, environmental NGOs, and local communities in planting trees in degraded forest areas. The success will be evaluated by monitoring the increase in forest cover each year."*

*"I designed a community based conservation programme involving schools and traditional leaders. In my reflection, this programme not only restores the Babirusa's habitat but also builds ecological awareness among the younger generation."*

*"Reforestation must be accompanied by a hunting ban. In my reflection, the success of this programme will have an impact on restoring the food chain and maintaining the ecological balance of South Sulawesi."*

The students' responses demonstrated their ability to design concrete strategies involving multiple stakeholders. Some emphasised the importance of reforestation through collaboration with local government, NGOs, and communities, with evaluation conducted by monitoring annual forest cover. Others designed community based conservation programmes involving schools and traditional leaders, reflecting that such initiatives not only restore the Babirusa's habitat but also foster ecological awareness among the younger generation. In addition, several students stressed the need for reforestation accompanied by hunting bans, reflecting that the success of such programmes would restore the food chain and maintain the ecological balance of South Sulawesi. In line with Greenstein's (2012) framework, this stage corresponds to the *creating* level, in which students not only design applicable strategies but also critically reflect on their effectiveness and impact. The integration of *Sipakainga* values in the *Anging Mammiri* model strengthened the process of collective reflection, encouraging students to be open to feedback, revise weaknesses in their plans, and develop socio ecological responsibility. Compared with the conventional model, this approach provided broader opportunities for students to think both applicatively and reflectively, resulting in learning outcomes that are more contextual and sustainable.

## DISCUSSION

### **Identification of Student Learning Needs and the Formulation of Educational Values in the *Anging Mammiri* Culture**

The findings showed that students' problem solving skills at the initial stage were still in the low category, with the highest achievement in the *define the problem* indicator and the lowest in *reflect and implement*. This condition indicates that students were relatively capable of recognising problems but struggled to evaluate solutions in depth and conduct critical reflection. These findings are consistent with Purmintasari et al. (2021), who reported that higher education in Indonesia tends to remain oriented toward knowledge transfer, leaving students less trained in developing higher order thinking skills. However, in contrast to Hmelo-Silver et al. (2007); Pilotti et al. (2021); (Donohue, 2020) who emphasised reflection in the context of conventional Western based PBL, the results of this study show that reflection can be strengthened through the integration of local cultural values, particularly the *Sipakainga* tradition, which emphasises mutual reminding and collective responsibility.

Observations revealed the dominance of lecture methods with limited student involvement and the use of standard learning materials that were less contextual. This situation aligns with Atalan, (2018), who found that the low quality of students' critical thinking skills is often due to instructional methods that provide minimal space for exploration. Interviews with traditional leaders highlighted that *Anging Mammiri* cultural values, such as *Ma'manu manu* and *Assamaturu'*, have direct relevance to the problem solving stages described by Greenstein (2012). This confirms that local wisdom is not merely a cultural backdrop but a pedagogical source that can be integrated with modern educational theories.

A key contribution of this study is the expansion of Greenstein's (2012) problem solving framework by incorporating local cultural dimensions. This approach not only produces cognitive skills but also develops students' socio ecological awareness through the values of deliberation (*Tudang Sipulung*), collaboration (*Assamaturu'*), and collective reflection (*Sipakainga*). The novelty of this research lies in the integration of cultural values into instructional syntax, which has rarely been addressed in PBL studies in Indonesia. Theoretically, this study affirms that (Vygotsky, 1987) constructivist theory and (Mezirow, 1997) transformative learning can be enriched with local perspectives, so that social interaction and critical reflection occur not only within an academic framework but also in a cultural context. Practically, the *Anging Mammiri* model can serve as an alternative contextual learning strategy in developing countries, where students face the challenge of low HOTS due to instructional approaches. Thus, the integration of local culture is not only contextually relevant but also contributes to the global discourse on pedagogical innovation grounded in local wisdom.

### **Development of the Prototype of the *Anging Mammiri* Culture Based Learning Model**

The development of the *Anging Mammiri* culture based learning syntax demonstrated a strong integration between Greenstein's (2012) problem solving theory and the local wisdom of the Bugis Makassar community. Each stage of problem solving was systematically mapped onto cultural traditions, from *Ma'manu manu* (problem clarification) to *Sipakainga* (reflection and implementation). These findings indicate that local culture can function as a pedagogical framework that is coherent with modern educational theories. This aligns with Delany et al. (2018), who emphasised that culturally contextualised learning increases student relevance and engagement more effectively than generic approaches.

The specification of the learning instruments developed namely the RPS, SAP, LKM, test instruments, and scoring rubrics showed that cultural integration did not stop at the conceptual level but was translated into actual teaching practices. For example, the SAP directed students to investigate local ecological phenomena through the *Ma'pese pese* framework, while the LKM presented contextual problems related to the conservation of endemic species. This approach supports the findings of Atalan (2018), who stated that environment based learning not only enhances critical thinking skills but also fosters ecological awareness. Thus, compared with conventional Problem Based Learning (PBL), which tends to be more abstract, the *Anging Mammiri* model is more applicable as it emphasises contextual relevance.

Validation results from five experts, showing very high feasibility scores (92–100%), confirmed that this prototype model was not only innovative but also met academic standards in terms of content, construct, and language. The perfect score of 100% for the scoring rubric indicated that the instrument was designed to be objective, comprehensive, and consistent. These findings reinforce Allen et al. (2019), who highlighted the importance of analytic rubrics for assessing higher order thinking skills transparently and reliably.

Theoretically, this study enriches Vygotsky's (1987) constructivism through the application of *Assamaturu'* and *Tudang Sipulung*, which emphasise social collaboration in

building understanding, and extends Mezirow's (1997) transformative learning theory through *Sipakainga*, which encourages critical reflection and perspective transformation. Practically, this model provides validated, ready to use learning instruments, making it a viable alternative for lecturers to design contextual learning in higher education, particularly in biology and ecology. Nevertheless, the limitation of this study lies in its cultural specificity to the Bugis Makassar context, meaning that application in other regions or cultural settings would require syntax adaptation. This opens opportunities for further research to test the generalisability of the model in other local cultures in Indonesia as well as in global contexts with similar characteristics.

Accordingly, the novelty of this research lies in the systematic integration of an international problem solving framework with local traditions, an aspect that has been rarely explored in previous literature.

### **Effectiveness of Culture Based Learning on Problem Solving Skills**

The findings of this study indicate that the application of the *Anging Mammiri* culture based learning model had a significant impact on improving students' problem solving skills. Its effectiveness became more apparent when compared with conventional Problem Based Learning (PBL). While PBL generally emphasises solution finding through rational discussion, it often produces answers that are academically formal and less grounded in students' social realities. In contrast, *Anging Mammiri* integrates local cultural values such as deliberation (*Tudang Sipulung*) and collective reflection (*Sipakainga*), resulting in solutions that are more applicable, contextual, and that reinforce students' socio ecological responsibility. This fundamental difference makes *Anging Mammiri* more effective in developing reflective, collaborative, and locally relevant learning experiences.

The *Anging Mammiri* culture based learning model also provided several benefits consistent with previous literature. First, students felt more connected to the issues discussed because the solutions were rooted in local culture and values (Calderon Berumen, 2019; Li Peng, 2024; Monem, 2024). Second, learning encouraged students to think creatively in finding culturally appropriate solutions while also critically assessing their effectiveness (Allen et al., 2019; Delany et al., 2018; Jeffreys & O'Donnell, 1997). Third, students learned about environmental issues and were trained to appreciate and preserve nature as part of cultural heritage (Atalan, 2018; Purmintasari et al., 2021). Fourth, students were motivated to take active roles in conserving their surrounding environment through the internalisation of cultural values (Dewiyanti et al., 2023; Prasetyo, 2023). The significant improvement in the experimental group compared to the control group further underlines the urgency of integrating local culture into learning.

The theoretical contribution of this study lies in expanding Greenstein's (2012) problem solving framework through the integration of local cultural values into each stage of problem solving. The *Anging Mammiri* syntax demonstrates that problem solving is not merely a cognitive individual activity but can be enriched with cultural dimensions that emphasise

collaboration, deliberation, and reflection. Thus, this study produces a learning model that bridges modern problem solving theory with pedagogical practices based on local wisdom.

Practically, this study produced a comprehensive set of validated learning instruments, including RPS, SAP, LKM, essay test instruments, and scoring rubrics, with very high validation scores (96–100%). This confirms that the *Anging Mammiri* model is not only innovative but also meets academic standards in terms of content, construct, and language. The practical implication is that this model can be recommended as an alternative learning strategy in higher education, particularly in ecology and conservation courses, and it also has the potential to be adapted across disciplines and in other local cultural contexts.

Nevertheless, this study has limitations. The problem solving dimensions tested were still limited to analytical, evaluative, and reflective aspects within the ecological context, and did not yet fully cover more complex problem solving skills such as advanced creativity, adaptive decision making, or cross disciplinary collaboration. In addition, the research subjects were limited to Biology Education students in a single region, so generalisation of the findings should be made with caution. Therefore, future research is recommended to test the application of the *Anging Mammiri* model in various fields of study, to broaden problem solving indicators to include creativity and adaptability, and to conduct longitudinal studies to assess the long term impact on students' problem solving competencies and ecological awareness.

## CONCLUSION

This study produced a culture based learning model, *Anging Mammiri*, that was valid, practical, and effective in improving students' problem solving skills. The development of the model followed three main stages according to Plomp (2013). First, in the preliminary research stage, the results of the needs analysis through the initial test showed that students' problem solving skills were still in the low category (mean = 2.01 out of 5), with the main weakness in the *reflect and implement* indicator. Classroom observations revealed the dominance of lecture methods, limited student engagement, and a lack of contextual learning materials. Meanwhile, interviews with Bugis Makassar traditional leaders and community members identified six core traditions (*Ma'manu manu, Ma'pese pese, Assamaturu', Tudang Sipulung, Ma'ppadandang, and Sipakainga*) which have direct relevance to the problem solving stages described by Greenstein (2012).

Second, in the prototype development stage, these cultural traditions were mapped onto the instructional syntax and translated into learning instruments, including the Semester Learning Plan (RPS), Course Unit Plan (SAP), Student Worksheets (LKM), essay test instruments, and scoring rubrics. Validation conducted by five experts in learning, evaluation, and culture produced very high feasibility scores (96–100 percent) across content, construct, and language aspects, indicating that the prototype model was ready for implementation. Third, in the assessment stage, effectiveness testing using a pretest and posttest control group design showed that the experimental group using the *Anging Mammiri* culture based model

experienced greater improvement in problem solving skills than the control group taught with conventional Problem Based Learning (PBL). The mean posttest score of the experimental group reached 87.39, while the control group achieved 74.88, with a statistically significant difference ( $p = 0.001$ ). Further analysis revealed that students were not only able to define problems from a multifactor perspective but also to design contextual solutions, critically evaluate alternatives, select sustainable solutions, and engage in reflective implementation.

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APPENDIX

**Table 3.**

*Problem-Solving Test Assessment Rubric*

Aspect	Score 5	Score 4	Score 3	Score 2	Score 1
<b>Define the problem</b> (C4 – Analyse)	Analyses the problem very clearly, connecting factors such as predation, hunting, and habitat destruction with relevant data	Analyses the problem fairly clearly, mentioning most factors with limited data	Mentions some factors but provides shallow or incomplete analysis	Mentions only one factor without sufficient explanation	Unable to identify the causal factors of the problem
<b>Design solutions</b> (C4 – Analyse)	Proposing ≥4 creative, realistic solutions, demonstrating in-depth analytical skills based on data/theory.	Proposing 3 relevant solutions with sufficiently clear explanations	Proposing 2 simple solutions with insufficiently detailed explanations	Only proposing 1 solution with limited explanation	Unable to propose relevant solutions
<b>Evaluate solutions</b> (C5 – Evaluate)	Evaluates all solutions with critical argumentation, systematically comparing strengths and weaknesses based on scientific evidence or real context	Evaluates most solutions with fairly clear explanation	Provides only a simple evaluation of one solution	Provides a very limited and shallow evaluation without comparison	Unable to evaluate solutions
<b>Select the best solution</b> (C5 – Evaluate)	Selects the best solution with logical reasoning, strong evidence, and long-term ecological considerations	Selects a relevant solution with fairly logical reasoning	Selects a solution with simple reasoning and no in-depth analysis	Selects a solution without clear justification	Unable to select a relevant solution
<b>Reflect and implement</b> (C6 – Create)	Designs a systematic and realistic implementation plan, involving relevant stakeholders, and reflects on ecological impacts	Develops a fairly clear implementation plan with limited reflection	Develops a simple plan without in-depth reflection	Provides a very limited and unrealistic plan, only in the form of general ideas	Unable to develop an implementation plan

**Table 6.**

Interview results with traditional leaders and their relevance to problem solving

Question	Answer	Relevance to Problem Solving
What is meant by <i>Anging Mammiri</i> culture in the lives of the Bugis-Makassar community? What are the traditional customs of the <i>Anging Mammiri</i> culture that are still preserved today?	The <i>Anging Mammiri</i> culture is a philosophical and cultural symbol in the lives of the Bugis-Makassar people, representing harmony between humans, nature, and traditional values. Literally, " <i>Anging Mammiri</i> " means "gentle breeze," and this has become a metaphor for a balanced life, full of peace, and rooted in a sense of togetherness. <i>Anging Mammiri</i> is also often understood as the spirit or soul of the Bugis-Makassar community, which maintains the relationship between humans and their environment and customs.	The cultural values of <i>Anging Mammiri</i> can be used as a basis for developing students' problem-solving skills. The integration of these values encourages students to think critically, design contextual solutions, evaluate alternatives, and reflect deeply on the results.

Question	Answer	Relevance to Problem Solving
	<p>The traditional customs of <i>Anging Mammiri</i> that are still practised today are</p> <ol style="list-style-type: none"> <li>1. <i>Ma'manu-manu</i></li> <li>2. <i>Ma'pese-pese</i></li> <li>3. <i>Assamatur'</i></li> <li>4. <i>Tudang Sipulung</i></li> <li>5. <i>Ma'ppadendang</i></li> <li>6. <i>Sipakainga</i></li> </ol>	
What is the main purpose of <i>Ma'manu-manu</i> in Bugis-Makassar customs?	<p><i>Ma'manu-manu</i> is a tradition that aims to gather information or clarify matters in accordance with custom before holding a major event, such as a wedding, celebration, or other traditional event. The main objectives are:</p> <ol style="list-style-type: none"> <li>1. To avoid misunderstandings.</li> <li>2. Establishing initial communication</li> <li>3. Maintaining social harmony.</li> </ol>	The <b><i>Ma'manu-manu</i></b> tradition is relevant to the <i>problem definition</i> stage of problem solving. Through initial clarification and communication activities, this tradition teaches the importance of gathering accurate information, preventing misunderstandings, and building a common understanding before seeking solutions.
What is the cultural significance of <i>Mapese-pese</i> for the Bugis-Makassar community?	<i>Ma'pese-pese</i> has various deep cultural meanings, namely: This tradition aims to ensure that the prospective bride comes from a good background, in accordance with customary norms, and has a character that meets the expectations of the prospective groom's family. The prospective groom's family shows respect to the prospective bride's family by conducting a customary investigation, because everything is done carefully and through customary channels.	This tradition emphasises the importance of investigation and caution before making big decisions. Its relevance to problem solving lies in the <i>design solutions</i> stage, as students are taught to systematically collect information, analyse data, and design alternative solutions based on comprehensive understanding.
What is the main purpose of the <i>Assamaturu'</i> tradition in Bugis-Makassar society?	The <i>Assamaturu'</i> tradition has the main purpose of creating harmony and togetherness within the community, as well as strengthening social and spiritual relationships among community members. <i>Assamaturu'</i> comes from the word "turutur", which means "together" in the Bugis-Makassar language ( ), so this tradition emphasises the concept of mutual cooperation and togetherness. <i>Assamaturu'</i> often appears in daily activities, such as communal harvesting, building traditional houses, or thanksgiving ceremonies.	This tradition emphasises mutual cooperation and togetherness in completing joint tasks. Its relevance to problem solving lies in the <i>evaluate solutions</i> stage, as collaboration and communication enable students to weigh the advantages and disadvantages of solutions more objectively through teamwork.
How does the <i>Tudang Sipulung</i> tradition function as a forum for deliberation in Bugis-Makassar society?	<i>Tudang Sipulung</i> , which literally means "sitting together," in large groups is a tradition of deliberation that is deeply rooted in the lives of the Bugis-Makassar community. This tradition serves as a forum for discussion to reach consensus on various aspects of life, such as social, cultural, economic, and political issues.	This tradition of deliberation provides a forum for discussion to reach consensus. Its relevance to problem solving lies in the stage of <i>selecting the best solution</i> , as students learn to listen to diverse perspectives, consider various opinions, and collectively choose the best solution.
What is the essence of the <i>Mappadendang</i> celebration in Bugis-Makassar society?	The <i>Ma'ppadendang</i> celebration is an important tradition in Bugis-Makassar society, held to celebrate a successful harvest and express gratitude to the Creator for the abundant fruits of the earth. The main essence of this celebration encompasses spiritual, social, and cultural	The tradition of celebrating the harvest is an expression of gratitude for the results of hard work together. Its relevance to problem solving lies in the <i>reflection</i> stage, because students are encouraged to appreciate the process, be grateful for

Question	Answer	Relevance to Problem Solving
	values that are part of the community's life and symbolise respect for nature as the source of life for the agrarian Bugis-Makassar community.	the results achieved, and make reflection an important part of learning.
What is the essence of the <i>Sipakainga</i> tradition in maintaining social harmony among the Bugis-Makassar community?	The tradition of <i>Sipakainga</i> in Bugis-Makassar culture has the main essence of being a means of reminding each other and maintaining moral values to create social harmony. <i>Sipakainga</i> comes from the words <i>sipa</i> (mutual) and <i>kainga</i> (reminding), which means giving advice and guidance to each other in a kind and respectful manner.	The tradition of reminding each other to maintain social harmony. Its relevance to problem solving lies in the <i>reflect &amp; implement</i> stage, as students are trained to be open to criticism, evaluate themselves, and improve their problem-solving strategies with mutual respect.