

# The Effectiveness of a Participatory Learning Model in Improving Seaweed Farmers' Post-Harvest Management Competence

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**Abstract.** This study examined the effectiveness of a participatory learning model in improving the post-harvest management competence of seaweed farmers. This study used a quantitative pre-experimental one-group pretest-posttest design with nine farmers as participants. Competence was measured using a structured test covering post-harvest planning, standard operating procedures, quality control, and market access. Data were analysed using descriptive statistics, the Shapiro-Wilk normality test, a paired-samples t-test, normalised gain, and effect size. The mean score increased from 45.56 to 83.22,  $t(8)=18.51$ ,  $p<.001$ , with a mean N-gain of 0.695 and a very large effect size. The participatory learning model was therefore effective.

**Keywords:** Participatory Learning; Farmer Competence; Post-Harvest; Seaweed Farmers; Pretest-Posttest.

## 1. Introduction

Farmer competence is a key foundation of successful contemporary farming because it shapes planning, decision-making, quality management, and adaptation to changing markets and technologies. In nonformal education, farmer competence is built not only through experience but also through the quality of learning processes delivered through training, extension, farmer field schools, and participatory learning (Batoa et al., 2008; Managanta et al., 2019; Nuraeni et al., 2025; Paltasingh & Goyari, 2018). For this reason, evaluating the effectiveness of learning models for farmers is an important agenda in vocational education and agricultural extension research.

Seaweed is a strategic commodity with high economic value and major roles in food, health, industry, and export markets. Global seaweed production continues to grow as demand for industrial raw materials and functional foods increases (Buschmann et al., 2017; Matanjun et al., 2009). At the downstream level, post-harvest handling strongly determines product quality, safety, yield, and selling price. Drying, storage, moisture control, contamination prevention, and other post-harvest procedures performed according to standards strongly influence seaweed quality (Al Wazzan et al., 2021; Faria et al., 2014; Nor et al., 2020; Vorse et al., 2023).

Despite its economic potential, seaweed farmers often face competence gaps in post-harvest management. These gaps include planning, the application of standard operating procedures (SOPs), quality control, and market access. Similar patterns are reported in other agricultural sectors, where farmers may possess some knowledge yet still struggle to apply it consistently in

practice (Liu et al., 2018; Nurliza et al., 2018; Nurliza, 2020; Nurliza & Fauyan, 2021). In seaweed farming specifically, strong competence is linked to technical, managerial, and market capabilities (Batoa et al., 2008; Nuraeni et al., 2025).

A substantial body of literature suggests that participatory learning and farmer field school approaches can improve knowledge, skills, technical efficiency, and even farmer welfare when they are contextualised and sustained over time (Davis et al., 2012; Feder et al., 2004; Friis-Hansen & Duveskog, 2012; Haryanto et al., 2023; Larsen & Lilleør, 2014; Mariyono et al., 2021; Waddington et al., 2014). At the same time, findings are not always uniform, especially when learning is disconnected from farmers' real needs, practical application, social networks, and post-training support (Tripp et al., 2005; Van den Berg & Jiggins, 2007; Yamazaki & Resosudarmo, 2008).

The participatory learning model positions participants as active learners. In this model, farmers' experience, authentic field problems, collaborative practice, discussion, feedback, and reflection become central to learning. Such an approach aligns with andragogy, experiential learning, and social learning within communities of practice (Kiptot & Franzel, 2015, 2019; Knook et al., 2020; Morgan, 2011; Pawera et al., 2024; Staub & Clarkson, 2021; Tohani & Sugito, 2020). In increasingly complex agricultural knowledge systems, participatory learning is also considered more adaptive for integrating scientific knowledge, local experience, and farm-level decision-making (Fielke et al., 2020; Kusnandar et al., 2021).

Previous work in the Tana Luwu seaweed context reported descriptive improvements in farmer knowledge and awareness after assistance activities. However, it did not test the effectiveness of the learning model quantitatively using pretest-posttest comparisons and statistical effect measures (Ikram et al., 2023). Therefore, this study aimed to examine the effectiveness of a participatory learning model in improving seaweed farmers' post-harvest management competence. Specifically, the study analysed differences between pretest and posttest scores, N-Gain values, and the magnitude of the intervention effect on participant competence.

## 2. Method

This study employed a quantitative approach with a pre-experimental one-group pretest-posttest design. The design was chosen because the study focused on measuring changes in participants' competence before and after the implementation of a participatory learning model. Symbolically, the design is written as  $O_1 \rightarrow X \rightarrow O_2$ , where  $O_1$  denotes the pretest,  $X$  denotes the participatory learning intervention, and  $O_2$  denotes the posttest. The null hypothesis ( $H_0$ ) stated that there was no significant difference between pretest and posttest scores, whereas the alternative hypothesis ( $H_1$ ) stated that a significant difference existed between the two measurements.

The study was conducted with a group of seaweed farmers in Luwu Regency, South Sulawesi. The participants consisted of 9 farmers who attended the full learning programme. Total sampling was applied because the number of programme participants was limited and all participants met the criterion of complete involvement from the beginning to the end of the learning process.

The intervention took the form of a participatory learning model emphasising needs identification, collaborative planning, contextual instruction, discussion, demonstration, practice, and reflection. The learning content covered post-harvest planning, SOP implementation for

drying and storage, quality control, and market access. We measured participant competence using a structured test developed from these four core indicators. We converted scores to a 0–100 scale to facilitate interpretation of changes in competence before and after the intervention.

We collected data twice: before the intervention through a pretest and after all learning sessions through a posttest. We analysed the data using descriptive statistics to obtain the minimum, maximum, mean, median, and standard deviation. We tested the normality of the difference scores (posttest–pretest) using the Shapiro–Wilk test. When the assumption of normality was met, hypothesis testing was conducted using a paired-samples t-test. In addition, learning improvement was evaluated through normalised gain (N-Gain) and Cohen's  $d_z$  effect size.

The statistical formulas used in this study are presented as follows. The mean was calculated as follows.

$$\bar{X} = \Sigma X / n$$

The sample standard deviation was used to estimate score dispersion, whereas learning gain was calculated using N-Gain as follows.

$$g = (\text{Posttest} - \text{Pretest}) / (\text{Maximum Score} - \text{Pretest})$$

The N-Gain criteria were  $g < 0.30$  = low,  $0.30 \leq g < 0.70$  = medium, and  $g \geq 0.70$  = high. A paired-samples t-test was then used to examine differences between pretest and posttest scores using the following formula.

$$t = \bar{D} / (S_D / \sqrt{n})$$

Where  $\bar{D}$  is the mean difference score,  $S_D$  is the standard deviation of the difference scores, and  $n$  is the number of participants. The magnitude of the intervention effect was estimated through Cohen's  $d_z$ .

$$d_z = \bar{D} / S_D$$

### 3. Result

The findings show that all participants experienced higher scores after the implementation of the participatory learning model. Pretest scores ranged from 30 to 60, whereas posttest scores ranged from 78 to 92. In general, these patterns indicate that participants' competence before training was low to moderate, while after the learning intervention it improved to a good or very good level.

Descriptively, the mean pretest score was 45.56 with a standard deviation of 8.89, whereas the mean posttest score increased to 83.22 with a standard deviation of 4.82. The mean score gain reached 37.67 points, equivalent to approximately 82.68% relative to the initial condition. The reduction in standard deviation from pretest to posttest also indicates that the participants not only improved but also became more homogeneous after the learning process.

Individual N-Gain values ranged from 0.604 to 0.800, with a mean N-Gain of 0.695. Based on common classification criteria, this average falls within the medium category and is very close to the high category. Five out of nine participants achieved N-Gain values of 0.70 or higher, while the remaining four participants were in the medium category. This result suggests that the participatory learning model was effective in improving participants' competence.

The Shapiro–Wilk normality test on the difference scores yielded  $W = 0.912$  and  $p = 0.334$ , indicating that the normality assumption was satisfied. A paired-samples t-test then produced  $t(8) = 18.51$  with  $p < .001$ . Accordingly, the null hypothesis was rejected, and the alternative hypothesis was accepted, indicating a significant difference between pretest and posttest scores.

The magnitude of change was also very strong, as reflected by Cohen's  $d_z = 6.17$ . The 95% confidence interval for the mean gain ranged from 32.98 to 42.36.

The histogram visualisations present a consistent pattern. Nearly all posttest bars stand far above the pretest bars for each participant, while the N-Gain histogram shows positive learning gains for all participants. These visual patterns reinforce the tabular and statistical evidence that the participatory learning model was effective in improving seaweed farmers' post-harvest management competence.

**Table 1.** Participant pretest, posttest, gain, and N-Gain scores

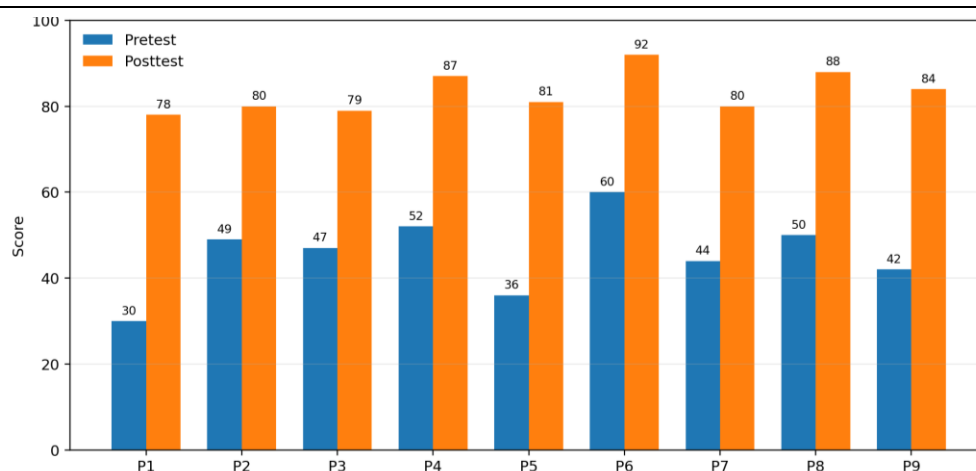
| Participant | Pretest | Posttest | Gain  | N-Gain |
|-------------|---------|----------|-------|--------|
| P1          | 30      | 78       | 48    | 0.686  |
| P2          | 49      | 80       | 31    | 0.608  |
| P3          | 47      | 79       | 32    | 0.604  |
| P4          | 52      | 87       | 35    | 0.729  |
| P5          | 36      | 81       | 45    | 0.703  |
| P6          | 60      | 92       | 32    | 0.800  |
| P7          | 44      | 80       | 36    | 0.643  |
| P8          | 50      | 88       | 38    | 0.760  |
| P9          | 42      | 84       | 42    | 0.724  |
| Mean        | 45.56   | 83.22    | 37.67 | 0.695  |

**Table 2.** Descriptive statistics of pretest and posttest scores

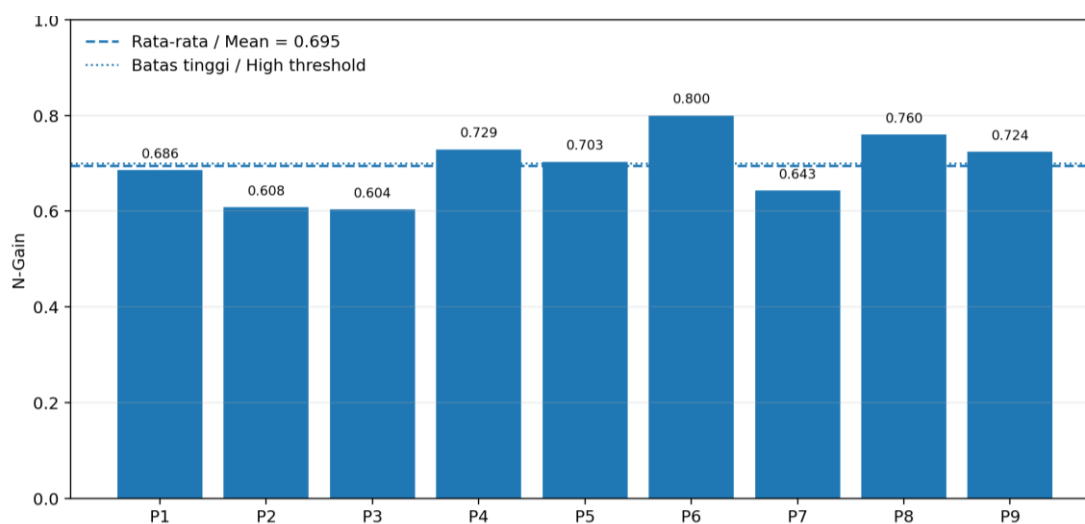
| Statistic          | Pretest | Posttest |
|--------------------|---------|----------|
| N                  | 9       | 9        |
| Mean               | 45.56   | 83.22    |
| Median             | 47.00   | 81.00    |
| Standard deviation | 8.89    | 4.82     |
| Minimum            | 30      | 78       |
| Maximum            | 60      | 92       |

**Table 3.** Normality test, hypothesis test, and effectiveness measures

| Analysis                            | Value 1      | Value 2   | Interpretation |
|-------------------------------------|--------------|-----------|----------------|
| Shapiro-Wilk<br>(difference scores) | W = 0.912    | p = 0.334 | Normal         |
| Paired-samples t-test               | t(8) = 18.51 | p < .001  | Significant    |
| 95% CI of mean<br>difference        | 32.98        | 42.36     | -              |
| Cohen's $d_z$                       | 6.17         | -         | Very large     |
| Group N-Gain                        | 0.692        | -         | Medium         |



**Figure 1.** Histogram of pretest and posttest scores by participant



**Figure 2.** Histogram of participant N-Gain scores

#### 4. Discussion

The findings confirm that the participatory learning model was effective in improving seaweed farmers' post-harvest management competence. From an educational standpoint, the increase in the mean score from 45.56 to 83.22 indicates that learning that engages participants through experience, contextual problems, discussion, and practice is more capable of promoting competence change than one-way instruction. This result aligns with studies on farmer field schools and farmer education that report improvements in knowledge, skills, and learning outcomes when participants are actively involved in the learning process (Davis et al., 2012; Haryanto et al., 2023; Mariyono et al., 2021; Waddington et al., 2014).

Pedagogically, the success of this model can be explained through the principles of andragogy and experiential learning. Adult farmers tend to learn more effectively when learning content is directly related to their work, built around real problems, and immediately applicable. In this study, the topics of post-harvest planning, SOP implementation, quality control, and market access were presented in a context closely linked to the participants' experience. As a result, participants did not merely receive information; they connected new knowledge with prior experience. This is consistent with the view that participatory learning enhances learning meaning, ownership, and readiness to apply knowledge in practice (Kiptot & Franzel, 2015; Knook & Turner, 2020; Morgan, 2011; Tohani & Sugito, 2020).

The mean N-Gain value of 0.695 indicates that competence improvement was in the medium-to-high range. This matters because educational programmes for farmers should rely not only on statistical significance but also on the magnitude of learning gain. An N-Gain close to the high category suggests that the observed change was not a trivial fluctuation but a substantial improvement. All participants obtained positive N-Gain values, meaning that the learning benefits were not confined to only a few participants but were distributed across the entire learning group. This pattern supports the literature showing that active participation and group-based learning can broaden knowledge transfer and accelerate shared competence formation (Friis-Hansen & Duveskog, 2012; Nakano et al., 2018; Staub & Clarkson, 2021).

The very large effect size ( $d_z = 6.17$ ) indicates a strong intervention effect. From a programme evaluation perspective, this suggests that a learning design that involves farmers as active participants can produce meaningful changes at the level of foundational competence. This

conclusion is further supported by the decline in the posttest standard deviation, indicating that participant competence became more evenly distributed after learning. In other words, the model not only improved those who already had relatively better starting points, but also helped participants with lower initial competence catch up. In community capacity-building contexts, such equalisation of achievement is highly valuable because it promotes more consistent group performance (de Lange et al., 2025; Managanta et al., 2019; Nurliza et al., 2018).

Nevertheless, the effectiveness observed in this study should be interpreted at the level of short-term competence improvement. The study did not use a control group; therefore, the score changes could not be compared with a non-treated group. In addition, the number of participants was relatively small, and the posttest was administered immediately after the intervention, meaning that long-term retention could not be established. Previous studies indeed show that the impact of farmer training may vary when measured in terms of behaviour, technology adoption, or farm productivity over time (Feder et al., 2004; Tripp et al., 2005; Van den Berg & Jiggins, 2007; Yamazaki & Resosudarmo, 2008).

A practical implication of this study is that nonformal education programmes for seaweed farmers should be designed in a participatory manner, grounded in authentic problems, and rich in practice. Facilitators should not only deliver content, but also build dialogue, demonstration, simulation, reflection, and field follow-up. Learning should also be connected with complementary support such as information access, marketing networks, post-training assistance, and stronger farmer institutions so that improved competence can be translated into behavioural change and economic performance (Fielke et al., 2020; Kiptot & Franzel, 2019; Kusnandar et al., 2021; Pawera et al., 2024).

In post-harvest seaweed management specifically, participatory learning is highly relevant because post-harvest activities involve procedural skills and complex practical decisions. Moisture handling, drying, storage, sanitation, and product quality require both technical understanding and behavioural consistency. The literature shows that sound post-harvest handling is associated with product safety, selling value, and competitiveness in the seaweed supply chain (Al Wazzan et al., 2021; Faria et al., 2014; Nor et al., 2020; Vorse et al., 2023). Therefore, competence enhancement through an appropriate learning model has strategic value for the sustainability of seaweed farming.

The novelty of this study lies in its quantitative examination of the effectiveness of a participatory learning model in the seaweed farmer context using a pretest-posttest design, paired-samples t-test, N-Gain, and effect size. Earlier work in the same context tended to provide descriptive evidence of improved knowledge, whereas the present study adds statistical evidence regarding the meaningfulness of the observed change. In this sense, the findings strengthen the position of participatory learning as a viable model for competence-based farmer education.

Future research should involve larger numbers of participants, use more deeply validated competence instruments, and add performance observation together with delayed posttests to examine the sustainability of learning outcomes. In addition, quasi-experimental designs with comparison groups would provide stronger evidence regarding the impact of participatory learning on competence and farm performance. Follow-up evaluation linking competence with SOP adoption, product quality, and market access would also enrich the contribution of research in vocational education and agricultural extension (Liu et al., 2018; Slameto et al., 2015).

## 5. Conclusion

This study demonstrates that the participatory learning model was effective in improving seaweed farmers' post-harvest management competence. The mean participant score increased from 45.56 on the pretest to 83.22 on the posttest, representing a mean gain of 37.67 points. The paired-samples t-test revealed a significant difference between pretest and posttest scores,  $t(8) = 18.51, p < .001$ . The mean N-Gain of 0.695 indicates improvement in the medium-to-high category, while Cohen's  $d_z$  of 6.17 reflects a very large effect. Therefore, the participatory learning model is an appropriate nonformal education strategy for strengthening seaweed farmers' competence. Future studies should employ larger samples, comparison groups, and follow-up measurements to produce stronger and more comprehensive evidence of effectiveness.

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