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Knowledge gain and training impact among fisheries trainees: A hierarchical layered knowledge analysis framework (HLKA)

Vinod Kumar¹, Jitendra Chauhan², Anil Datt Upadhyay³, Vipul Singh Badguzar⁴ and Tripti Tanjay⁵

¹ PG scholar (Fisheries extension), College of Fisheries, Central Agricultural University, Imphal, Manipur, India

²⁻³ Professor (Fisheries extension), College of Fisheries, Central Agricultural University, Imphal, Manipur, India

⁴ Late Shri Punaram Nishad College of fisheries Kawardha, Chhattisgarh, India

⁵ Ph.D. Scholar (Fisheries extension), College of Fisheries, Central Agricultural University, Imphal, Manipur, India

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Corresponding Author: Vinod Kumar

Abstract

Training programmes often involve human resources, time and costs of organisations which need to justify these resource uses by demonstrating quantifiable qualitative and quantitative outcomes. Evaluating a training program in terms of knowledge gained and training impact is essential for making necessary improvements, allocating resources wisely, and ensuring that the program aligns with organisational goals and trainees' needs. This study aims to evaluate the training programmes in terms of knowledge gain, confidence level and training impact in the training programmes organised by the College of Fisheries (CAU), Lembucherra, in 2022-23. The Hierarchical Layered Knowledge Assessment framework (HLKA) was used in the present study. 140 trainees were selected who participated in training programmes of the College of Fisheries, Tripura, using the complete enumeration sampling technique. The knowledge gained was analysed on the basis of three-layered knowledge gained: layer 1, Recall and recognition, layer 2, Conceptual Understanding, layer 3, Applied Knowledge. The average knowledge scores for three layers are 71.14%, 71.00% and 64.21%, respectively. Relative knowledge gained was 84.42 per cent, OPKI value was 69.82% and Training impact index (TII) computed score was 58.66. The result of the present study revealed that the farmer trainees who participated in the training programmes organised by the College of Fisheries benefited; their skills, knowledge and attitudes were improved.

Keywords: Knowledge gain, OPKI, training impact index, HLKA, college of fisheries Tripura

Introduction

In the wake of emerging food and nutrition challenges, aquaculture is an imperative option for providing good-quality animal protein to undernourished people. According to the Food and Agriculture Organisation (FAO, 2024) ^[17], 713 and 757 million people, corresponding to 8.9 and 9.4 per cent of the global population, respectively, may have faced hunger in 2023. Sustainable development goal 2 (SDG 2) is ensuring access to safe, nutritious and sufficient food for all people all year round and eradicating all forms of malnutrition by 2030. Fish and fishery products as a source of animal protein can be one remedy to the attainment of Sustainable Development Goal 2 agenda (zero hunger). According to hand *handbook* on fisheries statistics (2023), fisheries and aquaculture remain to be as an important source of food, nutrition and livelihood to 28 million fishers and fish farmers. The world fisheries sector depends on the culture and capture fisheries, however, due to over-exploitation and habitat degradation fishery stocks are declining in the sea and oceans, aquaculture is the only option for fish production, but due to the limitation of inland fisheries resources, it is challenging to full fill the protein requirement for growing papulation at existing infrastructure. Improving the infrastructure according to

modern farming technology and providing the training and skills to the farmers to exploit production technologies sustainably. Aquaculture production not only provides livelihood to the farmers but also reduces stress on capture fisheries. India is the 3rd largest aquaculture and fish-producing country, contributing 16 per cent of total inland and 5 per cent of marine production in the world fish production (Handbook on Fisheries Statistics, 2023) ^[23]. Total fish production has reached a time high of 175.45 lakh tonnes during 2022-23, comprising 44.32 lakh tonnes of marine output and 131.13 lakh tonnes of inland production (Handbook of Fisheries Statistics, 2023).

In agriculture economic land, labour, capital and management are considered as factors of production (Parker *et al*, 1972) ^[45]. Labour is the most important factor that mobilizes production functions. Farmers' contribution to aquaculture is significant in transforming the raw materials (seed, feed, fertilisers etc.) into marketable fish. There are five types of capital: social, political, human, financial, and environmental capital (Etongo and Gill, 2022) ^[14]. Human capital consists of human resources and skills and knowledge associated with them which are important to enhance the workforce in aquaculture sectors for success and effectiveness, individuals and organizations must

continuously gain knowledge to remain competitive (Sheikh, 2008) ^[51]. Imparting knowledge, abilities, skills, or attitudes (KASAs) to participants involves a process governed by certain strategies. Training is one of the strategies for imparting skills and knowledge to the trainees. In order to attract and empower rural youths in agriculture and allied sectors, Indian council of Agriculture Research (ICAR) launched a project named “Attracting and Retaining Youth in Agriculture” (ARYA), in 2015-16 to provide, business, sustainable income, employment opportunities and capacity development to the rural youth in agriculture and allied sectors. This can be achieved by implementing various skill development training programmes (Anonymous, 2020) ^[2].

Lynton and Pareek (2002), define training as the development and delivery of information that people will use after attending the training. Training is a process in which trainees develop information, skills, and attitudes through a programme sequence. It also fills the gap between what they have and what they require (Beach, 1980) ^[6]. Training is a structured communication process for workforce development that seeks to bring about desired changes in knowledge (K), skills (S), practise (P), attitude (A), behaviour (B), and other things (O) that correspond with a position's requirements (Misra, 1999) ^[37]. “Learning by doing” and “seeing and believing” are two important principles of extension education. Learning by doing is associated with the educational theory called “experiential education” which holds that learning happens using the transformation of experience (Kolb & Kolb, 2005) ^[29]. Behavioural change is a pre-requisite for technological adoption, which is mostly governed by attitude (Ndah *et al.*, 2011; Wandji *et al.*, 2012; Olatunji and Nwaogwugwu, 2013) ^[41, 57, 43]. The training programme is a strategy to change the attitude, boost confidence, and morale, and motivate them through experimental learning leading to better performance (Khairul and Kamariah, 2011) ^[27]. Training is related to direct financial costs, time of employees devoted to training, training planning, and time of managers (Kumar *et al.*, 2024) ^[30]. Many researchers agreed in the 1990s that most investments in training were wasted (Ford and Weissbein, 1997) ^[18]. Therefore, training *evaluation* is the most key component of any training program. Evaluating the processes of the training programme helps to make subsequent changes in training and development programmes, *i.e.*, to optimise processes and increase yields or outputs in every organisation (*i.e.*, knowledge, skills, attitudes) (*e.g.*) (Ferris *et al.*, 1999; Aragon-Sanchez *et al.*, 2003; Park *et al.*, 2003; Mollahoseini and Farjad, 2012; Chalupa, 2020) ^[16, 3, 44, 39, 7]. According to Harper and Bell (1982) ^[24] *evaluation* as planned collection, collation and analysis of information to make judgements about worth. Goldstein (1993) ^[19] outlines *evaluation* as the “systematic collection of descriptive and judgmental information necessary to make effective decisions related to selection, adoption, value and modification. The method of training *evaluation* was first introduced by Donald L. Kirkpatrick, who published it in an article for the US Development and Training *Journal* in 1959 consisting four levels reaction, learning, behaviours, and results, respectively (Aragon-Sanchez *et al.*, 2003; Hrmo *et al.*, 2019) ^[3, 25]. According to Kirkpatrick (1996) ^[28], training

evaluation determines the intervention's effectiveness.

Training is subjected to huge investment in the development of training strategies, need to evaluate to what extent training is effective and worthwhile, *evaluation* becomes an essential part of the process. Most of the organization and training centres do not collect adequate data to evaluate the effect of their training programme, many training remain poorly evaluated (Goldstein, 1993; Mann, 1996) ^[19, 34]. Most of the training is evaluated through participants' reactions collected at the end of the course. However, only a small number of programs use methods like pre- and post-tests or assessments completed by the participants themselves (Phillips and Phillips, 2016) ^[47]. Furthermore, many evaluations lack methodological rigor, are context-specific, and do not incorporate feedback from diverse stakeholder perspectives. Previous research studies on various training institutions have focused on the effect of the training program on the extension methods, there are limited studies conducted on the training *evaluation* of the fisheries training programmes. With this aspect, the present *study* aims to evaluate the various fisheries training programs conducted by the College of Fisheries, Tripura, Agartala (CAU), both on-campus and off-campus, in terms of knowledge gain and overall effectiveness. The objectives of the present *study* are-

1. To assess the knowledge gained by trainees in intended training programmes

Materials and Methods

Description of study area

The northeast region of India is selected for the present *study* as the states have rich fish biodiversity, immense fisheries resources and a prevalence of fish farmers. The Northeast region of India, comprising eight states Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim covers approximately 2.55 lakh km² (about 8% of India's total *area*) of which 43% is situated at the elevation of 300m, 30% in the elevation range of 300-1200m and 27% in the elevation of above 1200m above MSL. The region is divided into two biogeographic zones Eastern Himalaya and Northeastern India based on vegetation and climate (Ministry of home affair GOI, 2025) ^[36]. Around 80% of farmers are small or marginal, with shrinking landholdings due to population growth (De & Singh, 2017) ^[12]. To provide technical support to fish farmers, the College of Fisheries, Lembucherra (CAU), Agartala, offers both on- campus (at college) and off-campus (at KVK and Village) training in areas like pond management, feed formulation, fish processing, entrepreneurship, and capacity building. Farmers from the northeastern region who participated in a different training programme conducted by the College of Fisheries Lembucherra, Agartala, were selected for the study.

Sample and procedures

Complete enumeration sampling technique was used in the present *study* where trainees from different states of the north east region participated in on and off-campus training programmes organised by the College of Fisheries, Tripura, Agartala (CAU). Total 140 farmers trainees from on-campus training programmes off-campus (KVK and village panchayat) were selected to evaluate the training

programmes in terms of “knowledge and skill” gained and “effectiveness” of the training programmes.

Methodology

In the present *study*, a mixed methodological approach was used where qualitative and quantitative data were collected by using a semi-structured interview schedule

Hierarchical Layered Knowledge Assessment (HLKA) approach:

Hierarchical Layered Knowledge Assessment (HLKA) is the most versatile methodology for training *evaluation*, which can be tailored to the different kinds of agricultural and industrial training programmes. This methodology merges the structured framework of Bloom's taxonomy of learning. The taxonomy was a means to express the different kinds of intellectual skills and abilities (Wilson, 2016) [58]. It consists of six levels: (I) remembering, (II) understanding, (III) applying, (IV) analysing, (V) evaluating, and (VI) creating. It emphasises layered data analysis, contextual adaptation and applied knowledge to measure knowledge and skill gain to evaluate the training programmes. methodology has been broken down as follows:

Pre-Test Mapping (Baseline Knowledge Profiling)

It is the first step of this model, where responses are collected from trainees prior to the training programmes to assess the baseline knowledge and skill level of the trainees. It consists diagnostic quiz, multiple choice and true-false questions for baseline assessment. A knowledge heatmap is generated as an output of pre-test mapping by calculating the topic-wise scores and confidence levels of the respondents. A knowledge heatmap is a visual representation tool consisting of rectangular cells of different colours, representing the combined topic-wise performance scores and confidence levels of individual respondents or groups.

Post-training knowledge layered test

It is the second step of the model, consisting of three layers: recall and recognition, conceptual understanding, and applied knowledge, which are aligned with Bloom's taxonomy of learning. Responses are collected in different forms: closed-ended (multiple-choice questions, true/ false) and open-ended (descriptive and applied questions) from the trainees after the training programmes to assess the improvement in knowledge and skills as a result of the training.

Layer 1: Recall and recognition

Remembering involves using memory to recall or recognise information. It includes retrieving definitions, facts, lists, or repeating what has been previously learned.

Layer 2: Conceptual understanding

Understanding involves creating meaning from various forms of communication, whether written, visual, or through actions. This can include interpreting, giving examples, categorising, summarising, drawing conclusions, making comparisons, or providing explanations.

Layer 3: Applied knowledge: Applying involves using a method or process by performing or implementing it. It refers to situations where knowledge is put into practice, often through outputs such as models, presentations, interviews, or simulations.

Confidence level

Confidence involves a degree of belief that one relies on something. It was measured by using a 5-point Likert scale from high confidence [5] to low confidence [1]. Confidence judgments are widely acknowledged as important in evaluating knowledge (De Finetti, 1965; Good, 1979) [10, 20]. Confidence can be understood as a type of probability prediction (Dawid, 1986) [9], representing an estimate of how likely it is that a given answer is correct.

Post-test analysis

The collected data were analysed, and average score, overall score and confidence score were calculated by using statistical tools, and a knowledge growth curve was generated.

1) The following formula calculates the average score and overall score:

$$\text{Average score} = \frac{\sum_{i=1}^n \text{Score}_i}{n}$$

$$\text{Overall Score} = \sum (\text{Weight}_{\text{layer}} \times \text{Average score}_{\text{layer}})$$

2) The relative knowledge gain is calculated using the formula:

$$\text{Relative Knowledge gain} = \frac{\text{Post test} - \text{Pretest}}{\text{Pre test}}$$

Conceptual framework of Hierarchical Layered Knowledge Assessment (HLKA):

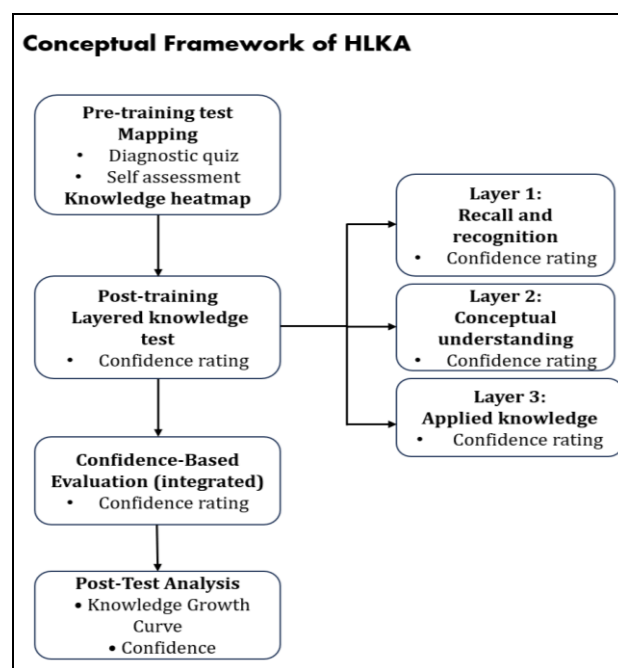


Fig 1: Conceptual framework of HLKA

Review of Literature

The existing study related to the training programme, knowledge gain and other aspects are presented in Table 1

Table 1: Training Programmes and Knowledge Gain

S. No.	Author(s) & Year	Key Findings
1	Bandura (1997) ^[5]	Self-efficacy influences learning, motivation, behavioural change and adoption of practices.
2	Zimmerman (2000)	Self-efficacy is a strong predictor of learning achievement and persistence.
3	Alvarez, Salas & Garofano (2004)	Training effectiveness should include learning, confidence and behavioural change.
4	Colt <i>et al.</i> (2011)	Absolute, relative and normalized gains effectively measure learning outcomes.
5	Favazzo <i>et al.</i> (2014)	Positive relationship exists between knowledge and confidence.
6	Riar & Kaur (2014)	Knowledge gain is useful for comparing effectiveness of extension methods.
7	Goodson <i>et al.</i> (2015)	Confidence measures improve interpretation of learning outcomes.
8	Priyadharshini <i>et al.</i> (2017) ^[49]	Training improved self-confidence and adoption behaviour.
9	De <i>et al.</i> (2019)	Fisheries training improved learning outcomes and professional competence.
10	Lucero & Chen (2020)	Confidence links knowledge acquisition to behavioural intention.
11	Tabibzadeh <i>et al.</i> (2020)	Confidence ratings help identify overconfidence and underconfidence.
12	Singh & Tanwar (2020)	Fish farming training significantly improved trainees knowledge.
13	Argade <i>et al.</i> (2023)	Skill development training improved fish farmers knowledge and attitudes.
14	Masta & Janjhua (2023)	Self-efficacy positively influences training effectiveness.
15	Jayaratne <i>et al.</i> (2024)	Knowledge gain is a key indicator of extension programme effectiveness.
16	Paul <i>et al.</i> (2024)	Composite frameworks provide comprehensive training evaluation.
17	Som <i>et al.</i> (2024)	Training impact indices effectively measure fisheries training outcomes.

Result and Discussion

A) Socio-economic profile

The socio-economic profile of the trainees was assessed using variables such as age, gender, caste, educational qualification, family size, annual income, occupation, fisheries experience, pond area, innovativeness, market orientation, scientific orientation, economic orientation, mass media exposure, and extension contact. Observed from the figure 2, the socio-economic profile of the trainees revealed that most respondents were young (59.04%), female (60.11%), belonged to the Scheduled Tribe category (44.68%), and had education up to the high school level (39.36%). Similar findings were reported by Argade *et al.* (2023) ^[4], who observed that a majority of fish farmer trainees belonged to the younger age group. Most trainees had medium-sized families (57.98%), which is in line with the findings of Nirmalkar *et al.* (2022) ^[42], and possessed pond areas up to 0.40 ha (64.89%), corroborating the results of Upadhyay *et al.* (2012) ^[56]. The majority of respondents had 1-5 years of fisheries experience (64.36%), supporting the observations of Lawal (2021) ^[31], who reported that less

experienced fish farmers are generally more receptive to new technologies and improved practices. Aquaculture was the primary occupation for 62.77 per cent of the trainees. Most respondents belonged to the medium annual income category (81.91%) and exhibited medium levels of innovativeness (77.66%), market orientation (67.02%), scientific orientation (70.21%), and economic orientation (63.23%). Similar trends were reported by Dubey *et al.*, 2011; Goswami, 2016) ^[13, 22], who found that fish farmers commonly exhibit moderate levels of adoptionrelated characteristics. Furthermore, the majority had medium levels of mass media exposure (58.51%) and extension contact (61.70%). Singh and Tanwar (2020) ^[52] emphasized that extension services, ICT tools, and social media platforms play a crucial role in disseminating information and enhancing technology adoption among fish farmers. These findings indicate that the trainees were predominantly small-scale fish farmers with moderate socio-economic status and considerable potential to benefit from training and extension intervene.

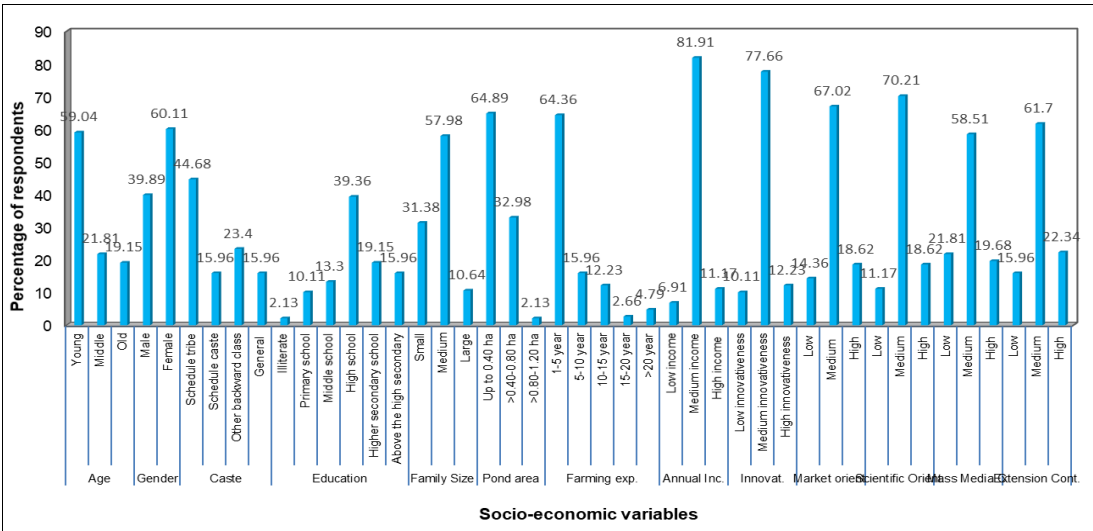


Fig 2: Socio-economic profile of respondent

B) Assess the Knowledge gain using HLKA framework

1. Pre-test score

To assess the baseline knowledge of fisheries farmers prior to the training programme, a pre-test consisting of ten multiple-choice questions covering various aspects of scientific fish culture was administered. The results revealed considerable variation in the respondents' level of knowledge across different subject areas. (Table 2) Among the statements, the highest proportion of correct responses was recorded for the question, "Which colour of water is good for fish growth?", where 71.43 per cent (100 respondents) answered correctly with an average confidence level of 3.51. This finding indicates that the farmers possessed relatively good knowledge regarding pond water quality management, which is a fundamental aspect of fish culture. In contrast, the lowest proportion of correct responses was observed for the question, "Saprolegniasis disease is mostly occur in which stage of fish?", where only 15.00 per cent (22 respondents) provided the correct answer. Despite the low level of knowledge, the average confidence level for this question was relatively high (3.55), suggesting the presence of overconfidence among the respondents

regarding fish disease management. Similar observations were reported by Argade *et al.* (2023) ^[4], who found that fish farmers had varying levels of knowledge across different aquaculture practices prior to training and that skill development programmes significantly improved their knowledge levels. Similar knowledge gaps were observed in areas related to liming requirements (27.14%), fish seed stocking time (30.71%), and nursery pond management (33.57%). Misra *et al.* (2024) ^[38], who reported that most participants exhibited medium to high knowledge levels after undergoing integrated fish-cum-poultry farming training, indicating that well-structured training programmes can significantly enhance farmers' understanding and adoption of scientific aquaculture practices. From the Table 2 and Figure 2 the overall average percentage of correct responses in the pre-test was 37.86 per cent, indicating a relatively low level of baseline knowledge among the fisheries farmers before attending the training programme. The mean confidence level across all statements was 3.36 on a five-point scale, reflecting moderate confidence among respondents.

Table 2: Pre-test knowledge score

S. N.	Statements	Frequency of Correct responses (percent)	Average Confidence level
1.	Which colour of water is good for fish growth	100 (71.43%)	3.51
2.	How much cow dung is required to fertilize one hectare of pond?	44 (31.43%)	3.51
3.	How much Lime is required to correct the water pH?	38 (27.14%)	3.31
4.	What is the optimum stocking density of fish culture (fingerling/ kani)?	65 (46.71%)	3.21
5.	What percentage of feed should be given per kg of fish body weight	57 (40.71%)	3.20
6.	Name of the fish found in bottom of the pond?	53 (37.86%)	3.32
7.	IMC Fish breed during which season?	61 (43.57%)	3.37
8.	Fish seed should be stocked in which time?	43 (30.71%)	3.32
9.	Which stage of fish is culture in nursery pond?	47 (33.57%)	3.34
10.	Saprolegniasis disease is mostly occur in which stage of fish?	22 (15%)	3.55
Average:		53 (37.86%)	3.36

2. Layer 1: Recall and Recognition

A total of ten objective questions covering fundamental aspects of fish culture, including water quality management, fish species identification, feeding practices, and pond management, were administered to the trainees after completion of the training programme. The results presented in Table 3 indicate a substantial improvement in the recall and recognition ability of the trainees. Among the ten statements, the highest percentage of correct responses was recorded for the question "Name one Indian major carp", where 87.14 per cent (122 respondents) answered correctly with an average confidence level of 3.77. This finding suggests that the trainees effectively retained information related to commonly cultured fish species. Similarly, high levels of correct responses were observed for questions related to fish feed ingredients (80.71%), healthy pond water colour (83.57%), and feeding practices (77.14%), indicating successful knowledge retention in key areas of scientific fish culture. Muddam *et al.* (2020) ^[40] reported that training programmes on composite fish culture significantly improved the knowledge level of fish farmers regarding scientific aquaculture operations. In contrast, the

lowest percentage of correct responses (66.43%) was recorded for the question "How much lime is required to correct the water pH?". Despite having the lowest correct response rate within this domain, the question received the highest average confidence level (3.98), suggesting that some trainees may have overestimated their understanding of liming requirements. The average confidence level across all statements was 3.68 on a five-point scale, indicating a relatively high degree of confidence among the trainees regarding their acquired knowledge. The confidence scores ranged from 3.49 to 3.98, with the lowest confidence observed for the question "Name one ingredient used in fish feed" and the highest confidence associated with liming requirements. Singh and Tanwar (2020) ^[52], observed that a majority of trainees attained high levels of knowledge immediately after training. (Table 3 and Figure 2) Overall, the average frequency of correct responses for Layer 1 was 76.14 per cent, which is substantially higher than the pre-test average score of 37.86 per cent. This improvement demonstrates that the training programme was effective in enhancing the trainees' recall and recognition of essential fisheries-related information.

Table 3: Layer 1: Recall and Recognition

S. N.	Statements	Frequency of Correct responses (percent)	Average Confidence level
1.	What is the optimum pH range for freshwater fish culture?	94 (67.14%)	3.58
2.	Name three Indian major carps used in composite fish culture.	99 (70.71%)	3.67
3.	How much Lime is required to correct the water pH?	93 (66.43%)	3.98
4.	Name two commonly used ingredients in fish feed.	113 (80.71%)	3.67
5.	What is the recommended feeding frequency in fish culture?	106 (75.71%)	3.70
6.	Name one Indian major carp.	122 (87.14%)	3.77
7.	What happens if the oxygen in water is very low?	105 (75.00%)	3.64
8.	What is the best time to feed fish?	108 (77.14%)	3.68
9.	Name one ingredient used in fish feed.	109 (77.86%)	3.49
10.	What is the colour of healthy pond water?	117 (83.57%)	3.64
Average:		106 (76.14%)	3.68

3. Layer 2: Conceptual Understanding

Unlike the recall and recognition layer, this domain evaluated the respondents' ability to explain the underlying principles and rationale behind various aquaculture management practices. A total of ten descriptive questions were administered after the completion of the training programme. The results presented in Table 4 indicate that the trainees exhibited a satisfactory level of conceptual understanding across the different aspects of fish farming. Among the statements, the highest percentage of correct responses was recorded for the question “*Explain how low dissolved oxygen affects fish health*”, where 96.43 per cent (135 respondents) correctly explained the adverse effects of oxygen depletion on fish growth and survival. The average confidence level associated with this statement was 4.07, indicating a high level of certainty among the trainees regarding this concept. Masta and Janjhua (2023) ^[35] emphasized that self-efficacy plays a significant role in successful training outcomes and influences the application of learned practices in real-life situations. Further, Sumarwono *et al.* (2017) ^[54] found that training interventions significantly improved participants' self-confidence alongside their knowledge and skills. High proportion of respondents correctly answered questions related to feeding time (85.00%) and the importance of liming in fish culture (81.43%), reflecting a sound understanding of essential pond management practices. Conversely, the lowest percentage of correct responses was

observed for the statement “*Why is lime added to fish ponds?*”, where only 57.14 per cent (80 respondents) provided a satisfactory explanation, accompanied by a relatively low confidence level of 3.50. The average confidence level across all statements was 3.80 on a five-point scale, which was higher than that observed in the recall and recognition layer (3.68). Similarly, Roy *et al.* (2018) ^[50] observed that fisheries training programmes enhanced participants' comprehension of inland fisheries management concepts, enabling them to make informed management decisions. Muddam *et al.* (2020) ^[40] also reported that trained fish farmers exhibited a better understanding of pond management, feeding, and water quality management practices compared to their pre-training status. This finding indicates that the training programme not only enhanced factual knowledge but also improved the trainees' confidence in explaining scientific aquaculture concepts. Misra *et al.* (2024) ^[38] documented significant improvements in trainees' understanding of integrated fish farming concepts following structured training interventions. From Table 4 and Figure 2 Overall, the average frequency of correct responses in Layer 2 was 71.00 per cent, demonstrating a substantial level of conceptual learning among the trainees. Although the score was slightly lower than that of the recall and recognition layer (76.14%), it indicates that a majority of the respondents were able to comprehend and explain the scientific rationale behind key aquaculture practices.

Table 4: Layer 2: Conceptual Understanding

SN.	Statements	Frequency of Correct responses (percent)	Average Confidence level
1.	Explain how low dissolved oxygen affects fish health.	135 (96.43%)	4.07
2.	How does overfeeding affect pond water quality?	99 (70.71%)	3.51
3.	Why is liming done before and during fish culture?	114 (81.43%)	4.05
4.	Explain the relationship between feed quality and fish growth.	84 (60.00%)	3.85
5.	Why is pond preparation important before stocking fish?	92 (65.71%)	3.79
6.	Why is lime added to fish ponds?	80 (57.14%)	3.50
7.	Why should healthy seed be selected for stocking?	90 (64%)	3.81
8.	What is the best time to feed fish?	119 (85.00%)	4.11
9.	Why is feeding done at fixed times?	85 (60.71%)	3.44
10.	Why is composite fish culture better than single species culture?	96 (68.57%)	3.93
Average:		99.4 (71.00%)	3.80

4. Layer 3: Applied Knowledge

Applied level is the last layer of Hierarchical Layered Knowledge Assessment (HLKA). It is to assess the trainees' ability to apply the knowledge and concepts acquired during the training programme to practical fish farming situations.

This layer represents the highest level of learning within the framework, as it evaluates decision-making and problem-solving abilities under real or simulated field conditions. A total of ten application-oriented questions were administered to the trainees after the completion of the training

programme. The results presented in Table 5 indicate that the trainees demonstrated a moderate to high level of applied knowledge regarding scientific fish culture practices. Among the statements, the highest percentage of correct responses was recorded for the question “What steps will you follow to prepare a pond before stocking fish?”, where 76.43 per cent (107 respondents) provided correct responses with the highest confidence level of 4.25. Priyadharshini *et al.* (2017) ^[48] reported that participation in agricultural training programmes was positively associated with increased self-confidence among farmers. This finding indicates that the trainees acquired practical knowledge regarding pond preparation, which is a critical prerequisite for successful fish culture. Roy *et al.* (2018) ^[50] observed that while fisheries training programmes significantly improved farmers' knowledge and awareness, the application of scientific management practices required continuous guidance and practical exposure. Similarly, 71.43 per cent of the respondents correctly explained how they would apply the knowledge gained during training in their own ponds, suggesting a positive intention towards the adoption of scientific fish farming practices. Argade *et al.* (2023) ^[4] similarly reported that skill development programmes enhanced farmers' technical competencies; however, practical adoption of scientific aquaculture practices depended on opportunities for hands-on learning and fieldlevel demonstrations. A substantial proportion of respondents (68.57%) were able to identify oxygen depletion problems and recommend appropriate corrective measures when fish were observed gasping at the water

surface. Likewise, 67.14 per cent of the trainees correctly described the necessary management practices to be undertaken before stocking fish in a newly prepared pond. These findings indicate that the training programme successfully enhanced the trainees' practical understanding of pond management and water quality management practices. However, comparatively lower percentages of correct responses were observed for questions related to disease prevention (59.29%), correction of acidic pond water (60.71%), removal of unwanted fish from ponds (55.00%), and management of foul-smelling pond water (54.29%). Misra *et al.* (2024) ^[38] found that although trainees exhibited substantial knowledge gains following training, the successful application of scientific fish farming practices was influenced by experience, resource availability, and continued technical support. The relatively low confidence level associated with these questions further suggests that some trainees were uncertain about applying scientific recommendations under field conditions. From Table 5 and Figure 3 the average confidence level for Layer 3 was 3.64 on a five-point scale, while the average frequency of correct responses was 64.21 per cent. Although this score was lower than those observed for the Recall and Recognition (76.14%) and Conceptual Understanding (71.00%) layers, the result is expected because application-oriented questions require trainees to integrate factual knowledge and conceptual understanding to solve practical problems. The lower score therefore reflects the greater complexity of applied learning rather than a deficiency in training effectiveness.

Table 5: Layer 3: Applied Knowledge

S. N.	Statements	Frequency of Correct responses (percent)	Average Confidence level
1.	What steps will you follow to prepare a pond before stocking fish?	107 (71.43%)	4.25
2.	What management practices will you adopt to prevent fish diseases?	83 (59.29%)	3.56
3.	If fish are gasping at the water surface, what does it indicate, and what action will you take?	96 (68.57%)	3.76
4.	How will you select suitable fish species for a newly constructed pond?	89 (63.57%)	3.45
5.	What corrective measures will you take if the pond water becomes acidic?	85 (60.71%)	3.52
6.	What will you do before stocking fish in a new pond?	94 (67.14%)	3.79
7.	What action will you take if pond water smells bad?	76 (54.29%)	3.42
8.	What will you do if unwanted fish are present in the pond?	77 (55.00%)	3.67
9.	What will you do to increase fish production?	92 (65.71%)	3.79
10.	How will you apply what you learned in training to your pond?	100 (71.43%)	3.16
	Average:	89.9 (64.21%)	3.64

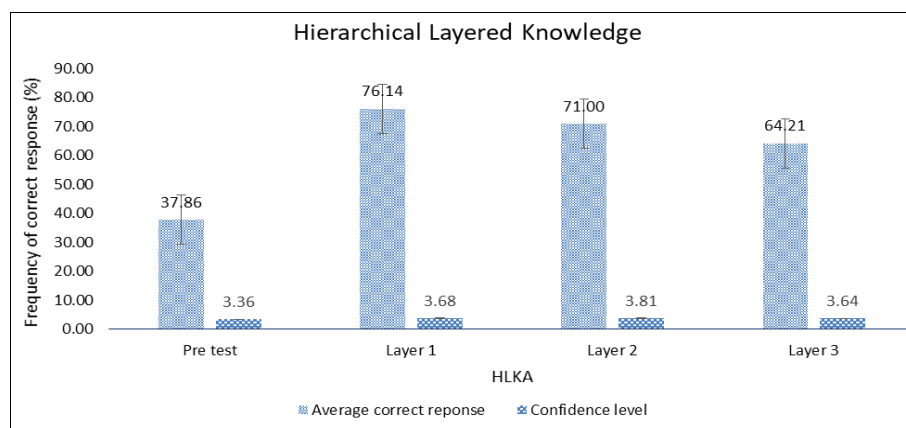


Fig 3: layered wise average frequency of correct response and confidence level

Overall Post-Training Knowledge Index (OPKI)

OPKI is a composite indicator used to measure the overall knowledge acquired by trainees after completion of a training programme. It combines the scores obtained in the three layers:

- Layer 1 - Recall and Recognition
- Layer 2 - Conceptual Understanding
- Layer 3 - Applied Knowledge

$$OPKI = \frac{L1K + L2K + L3K}{3}$$

Equal Weighting Approach

$$OPKI = (0.3 \times L1K) + (0.3 \times L2K) + (0.4 \times L3K)$$

(The higher weight assigned to Layer 3 reflects the importance of practical application in fisheries training programmes)

Where:

- L1K = Layer 1 Knowledge Score (%)
- L2K = Layer 2 Knowledge Score (%)
- L3K = Layer 3 Knowledge Score (%)

An OPKI value of 69.82% indicates that, on average, trainees acquired nearly 70 per cent of the desired post-training knowledge and skills. The result suggests that the training programme was effective in improving participants' knowledge, understanding, and practical competencies related to scientific fish culture.

Relative Knowledge Gain (RKG)

$$RKG = \frac{OPKI - \text{Pre Test score}}{\text{Pre Test Score}} \times 100$$

Relative Knowledge Gain (RKG) was calculated to assess the percentage increase in trainees' knowledge relative to their baseline knowledge level before attending the training programme. The analysis revealed a Relative Knowledge Gain of 84.42 per cent, indicating that the trainees' post-training knowledge increased by approximately 84 per cent over their initial knowledge level. Argade *et al.* (2023) [4] observed significant positive improvements in fish farmers' knowledge following skill development training programmes conducted in Bihar. Singh and Tanwar (2020) [52] reported that vocational training programmes on integrated fish farming significantly enhanced trainees' knowledge levels, confirming the usefulness of knowledge gain measures in evaluating fisheries training programmes. The high relative knowledge gain demonstrates that the fisheries training programme was highly successful in improving the participants' understanding of scientific fish culture practices.

Training Impact Index (TII)

$$TII = \frac{OPKI + (OCI \times 20) + (OPKI - \text{Pre Test score})}{3}$$

The Training Impact Index (TII) was computed to evaluate the overall effectiveness of the fisheries training programme by integrating post-training knowledge, confidence level, and knowledge gain. The calculated TII value was 58.66, indicating a moderately high level of training impact among the participants. De *et al.* (2019) [11] reported that composite measures provide a comprehensive assessment of training quality by simultaneously considering learning outcomes, professional relevance, and participant perceptions. Som *et al.* (2024) [53] concluded that composite indices are effective tools for quantifying the overall impact of training interventions and identifying areas requiring improvement. Paul *et al.* (2024) [46] reported that composite indices provide a more robust and policy-relevant assessment of training outcomes than single indicators alone.

Conclusion

The present study demonstrated that the fisheries training programmes organized by the College of Fisheries, Tripura, significantly enhanced the knowledge, understanding, practical skills, and confidence of fish farmers in North-Eastern India. The Hierarchical Layered Knowledge Assessment (HLKA) framework effectively captured learning outcomes across different cognitive levels, including recall and recognition, conceptual understanding, and applied knowledge. The Overall Post-Training Knowledge Index (OPKI) of 69.82 per cent indicated that a substantial proportion of trainees acquired the desired post-training knowledge and competencies. The Relative Knowledge Gain (RKG) of 84.42 per cent further confirmed a considerable improvement in knowledge and skills compared to the baseline level. The findings also revealed high confidence levels among trainees, suggesting improved readiness to apply scientific fish farming practices under field conditions. Although the highest performance was observed in the recall and recognition domain, comparatively lower scores in the applied knowledge layer indicate the need for strengthening practical and field-oriented components of training programmes. Overall, the results confirm that the training interventions were effective in enhancing the cognitive and practical capabilities of fish farmers. The study further establishes the usefulness of the HLKA framework as a comprehensive tool for evaluating training effectiveness and generating evidence-based insights for the design and improvement of future fisheries capacity-building programmes.

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