Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

Development and Validation of Meta-Learning Assessment Tool (MLAT) to Assess Meta-learning in Secondary Stage Students

B. M. Lakshmi[1] and Dr. Anil Kumar K.[2]
[1]Research Scholar, Regional Institute of Education (NCERT), Mysuru, INDIA.
[2]Professor of Education, Department of Education, Regional Institute of Education, (NCERT), Mysuru, INDIA.

[1]Corresponding Author: lakshmibmrao@gmail.com

www.sjmars.com || Vol. 4 No. 1 (2025): February Issue

Date of Submission: 10-01-2025	**Date of Acceptance:** 21-01-2025	**Date of Publication:** 05-02-2025

ABSTRACT

Meta-learning is encouraged among formal operational stage learners as a key goal of secondary education. The objective is to make students independent learners, who can direct their learning process independently i.e, with minimal guidance by the time they complete their schooling. s. Meta-learning, or "learning to learn," is a crucial skill that enables students to adapt and apply learning strategies effectively in their learning. The assessment of meta-learning becomes crucial to understanding the progress of the implied skills among students. Teachers must adapt strategies that can improve meta-learning in their students, without evaluating which, such improvisations are difficult to achieve. This article focuses on the development and validation of a meta-learning assessment tool, tailored to measure the meta-learning in secondary school students. The process involved establishing a theoretical framework item generation, expert reviews, pilot testing, and comprehensive statistical analyses for validity and reliability. The results indicate that the assessment tool is both reliable and valid, offering a robust tool for educators to measure and enhance meta-learning skills among students.

Keywords- Meta-learning, learning to learn, meta-learning assessment tool.

I. INTRODUCTION

Learning to learn or "Meta-learning" is a 21st-century competency central to independent and lifelong learning. It involves understanding how one learns best, being aware of different learning strategies, and developing the ability to adapt those strategies to new contexts or challenges. Currell (2019) describes learning about learning or meta-learning as an ability that helps learners understand how they learn. This active process of thinking about how one learns helps to identify fun or challenging moments during a learning task, that in turn make a person self-aware of their own strengths and drawbacks. When practised in classrooms the learning shifts to a new level. In meta-learning, learners drive their learning process by taking control of it through intrinsic motivation (Biggs, 1981). As stated by Watkins (2019) "if learning is the process of creating knowledge by making sense of your experience, meta-learning is the process of making sense of your experience of learning". Meta-learning involves understanding and applying effective learning strategies while adapting them to different tasks or situations. It fosters reflection, self-awareness and a growth mindset, helping students strive toward their goals and adjust their behaviors accordingly. Engaging in meta-learning enables students to regularly evaluate their learning goals, strategies, and performance, building a foundation for lifelong learning. By mastering a repertoire of learning strategies, students can independently acquire new knowledge and skills to solve problems, both in and beyond school (Rubin 2016, Chan 1987).

In this study, meta-learning is operationalized as the ability of the learner to be aware of one's abilities and additionally, to demonstrate abilities, e.g., how to generalise, solve problems, think critically, monitor learning tasks, control and regulate their learning process, reflect on and evaluate their learning. These are the steps through which meta-learning is developed.

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

The purpose of this study is to develop and validate a tool to measure meta-learning in secondary school students since there are no objective tools available at present.

II. REVIEW OF LITERATURE

Through the literature review has enabled identification of measurement tools such as w Meyer's (2004) reflections on Learning Inventory to gauge meta-learning (Lindblom, Ylanne, 2004; Meyer, Ward, & Latreille, 2010) and the Metacognitive Awareness Inventory to determine metacognitive awareness (Schraw & Dennison, 1994; revised by Telecki, 2018). Meta-learning competence was measured using the My Learning Questionnaire constructed by Kunt, Jarmoc & Skalimowska (2019).

The above review highlights the availability of tools designed to measure meta-learning at the higher education level and the lack of similar tools for the secondary school level. Given this gap, the researcher recognized the need to develop a novel tool. The theoretical framework for the tool is based on steps of meta-learning (Chan L.,1987). These are as follows:

1. Knowledge of generalisation, critical thinking, and problem-solving abilities
2. Monitoring of ability-related task
3. Control over the task
4. Reflecting on the purpose of learning
5. Evaluation of learning

III. RATIONALE FOR THE DEVELOPMENT OF META-LEARNING ASSESSMENT TOOL (MLAT)

The students of secondary school level are in the formal operational stage of cognitive development. This phase of schooling sees the onset of abilities such as generalization, critical thinking and problem-solving. Developing generalization, critical thinking, and problem-solving skills in 9th-grade students is vital for their academic success, and lifelong learning (Halpern, 1998, Bransford, Brown, & Cocking, 2000). These skills enhance students' ability to analyze and apply knowledge across contexts, fostering adaptability and independence. They are essential for decision-making, emotional resilience, and effective collaboration, preparing students to navigate real-world challenges and contribute to solving global issues (D'Zurilla & Goldfried, 1971, Paul & Elder, 2006). By integrating these abilities into education, students build a foundation for academic achievement, innovative thinking and social competence, equipping them for success in an increasingly complex and interconnected world (Brookfield, 2012). The students of 9th grade are at a critical developmental stage where these skills can be cultivated effectively, by making them aware of their abilities and their applications to become effective learners. Therefore, these abilities are focused in this study under the "knowledge about the ability" component of meta-learning.

IV. PREPARATION OF THE TOOL

Components of Meta-Learning Assessment Tool (MLAT)

The components of meta-learning adopted for this study were based on the steps of meta-learning (Chan 1987 and Seng, A. S. H., Tey, S. H., & Fam, A. 1993) and indicators/ behaviours demonstrating meta-learning steps were listed.

Table 1: Meta-Learning components and their indicators

Sl.no.	Components of Meta-learning	Indicators/ Behaviours
1	Knowledge of Generalization ability (KG)	● Identifies attributes ● Compares attributes and generalise ● Transfer of learning
	Knowledge of Critical thinking ability (KCT)	● Analyses the information and draws conclusions ● Evaluates ability/ Information / Conclusion ● Ask questions/ Verifies information
	Knowledge of Problem-solving ability (KPS)	● Identities/ Defines a problem ● Selects alternatives ● Evaluates the solution / One's ability

ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

2	Monitoring of ability-related tasks (MAT)	• Checks the appropriateness in selection of the strategy • Checks the progress of a task • Check for errors • Checks the progress of a task
3	Control of the learning task (CLT)	• Set goals and achieve them • Set goals and achieve them • Checks the progress of learning • Set goals and achieve them • Checks the progress of learning
4	Reflections on the purpose of learning (RPL)	• Reflects on goals of learning • Analyses the effectiveness of learning
5	Evaluation of the learning (EL)	• Evaluates the strategies used • Assesses learning gains • Assesses the quality/ Quantity of learning

Development of Meta learning Assessment Tool (MLAT)

The tool consists of two parts with Part A - the Meta-learning *Ability* Test - is a content- independent test-based on generalisation, critical thinking and problem solving abilities and Part B is the Meta-learning *Assessment* Tool which is a self-reporting questionnaire.

MLAT Part A- Knowledge of the Abilities Test

The Meta-Learning Ability Test (MLAT) is designed to test the knowledge about the abilities chosen in this study such as generalisation ability, critical thinking ability and problem-solving ability in 9th grade students.

Situation-specific items were constructed for each ability and reviewed by experts from education and science pedagogy to establish content validity. The tool was trialed by administering the test for secondary school students to estimate the discrimination index of the items.

Table 2.1: Distribution of items according to difficulty index (DIF I) and discrimination index (DI).

Difficulty level	< 30%	Question is too difficult
	>70%	Question is too easy
Discrimination index	<0.15	Discard or defective
	0.15-0.25	Revise
	0.25-0.35	Good
	>0.35	Excellent

Source: Garg, R., Kumar, V., & Maria, J. (2018)

Table 2.2: Item Analysis and Discrimination Index for MLAT part A

Ability	Number of Item	Difficulty Index	Discrimination Index	
Generalisation ability	1	54	0.44	Accepted
	2	38	0.44	Accepted
	3	48	0.48	Accepted
	4	78	0.2	Retained
	5	56	0.48	Accepted
	6	26	0.28	Accepted
Critical thinking ability	7	36	0.4	Accepted
	8	40	0.24	Accepted
	9	36	0.48	Accepted
	10	72	0.56	Accepted

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

	11	48	0.08	Accepted
Problem solving	12	58	0.6	Accepted
	13	34	0.44	Accepted
	14	58	0.68	Accepted
	15	34	0.44	Accepted
	16	12	0	Rejected

Item No.16 has a low discrimination index and hence was rejected.

The researcher decided to retain Item no. 4 even with a 0.2 discrimination index (slightly lower than the expected level of 0.25) since it was considered important as per the weightage.

Consequently, the Meta Learning Ability Test consists of 15 items.

Table 3: Sample items (Knowledge of generalization, critical thinking and problem-solving abilities) of MLAT Part A

1. Identify the organism based on the following characteristics (Generalization ability)
    a. Lives inside another organism called the host
    b. It depends on the host for nutrition
    c. Causes harm to the host

    a. Saprophyte
    b. Parasite
    c. Autotroph
    d. Symbiont

2. Many apartments in metropolitan cities use treated fresh water for flushing toilets. The purpose behind this is to assess critical thinking ability
    a. Conservation of resources
    b. Recycling of resources
    c. Prevention of pollution
    d. Environment planning

3. Imagine you're in a hospital helping a friend in the emergency room. Two patients arrive with the same injuries - deep cuts in their fingers and bleeding. Both injuries were treated by applying pressure to stop the bleeding. bleeding.
    a. Patient A: after applying pressure the bleeding stops quickly.
    b. Patient B: experienced continuous bleeding despite applying pressure.

    Both patients are similar in age and overall health. What is the most likely inference for the difference in their bleeding times? (Problem-solving ability)
    a. Patient A has a higher red blood cell count for better oxygen transport
    b. Patient B has a lower white blood cell count, making them more susceptible to infections
    c. Patient A has an iron deficiency, leading to slower blood clotting
    d. Patient B has a problem with their platelets, which are essential for blood clotting

MLAT Part B- A Self- Reporting Questionnaire.

- After deciding the components of the scale, the items were constructed. The initial tool had 89 items. The preliminary list was submitted for validation by experts,to establish content validity
  Based on the suggestions, the necessary modifications were made keeping in mind the construct, clarity, and readability of the items. The language errors were rectified. 77 items were finalised.
- The tool is a four point rating scale. Items are rated as Never, Sometimes, Often, Always and assigned a score ranging from 0 to 3. with clearly written directions for rating the scale.

Scoring

For the items that are scored positively, the points awarded range from 3 to 0 from always to never respectively. For the items that are scored negatively the order ranges from 3 to 0 from never to always. The score of all the items is

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

added to provide a final score. A high total score represents a high level of meta-learning in students whereas a low score represents a poor level of meta-learning in students.

Table 4: Weightages of Components

Sl. No.	Components	Item No.	Total Items	Percentage
1	KG	1,2,3,4,5,6,7,8,9,10	10	12.98
	KCT	11,12,13,14,15,16,17,18,19,20	10	12.98
	KPS	21,22,23,24,25,26,27,28,29,30	10	12.98
2	MAT	31,32,33,34,35,36,37,38,39,40,41	10	14.28
3	CL	42,43,44,45,46,47,48,49,50,51,52	11	14.28
4	RL	53,54,55,56,57,58,59,60,61,62,63,64	12	15.58
5	EL	65,66,67,68,69,70,71,72,73,74,75,76,77	13	16.88
Total			**77**	**99.96**

Tryout

A tryout was conducted to obtain feedback about the tool from secondary school students, on the clarity of instructions, statements/items, the wording of items, ease of completion, while answering it. For the tryout, secondary schools in Bengaluru were selected and the participants were 110 students from these schools.

Table 5: List of schools selected for tryout

Sl.no.	School	Boys	Girls	Total
1	A	17	14	31
2	B	20	26	46
3	C	12	21	33
TOTAL				**110**

V. PREPARATION OF THE FINAL VERSION OF THE TOOL

Step1. Item analysis

Selection of Items

The top-down process of item selection was applied to select the items for the tool. The item analysis procedure as Edward described (1969, pp. 152-153) was followed. The tool after expert review was administered to 110 secondary school students for the tryout. The item analysis was conducted to establish the t value for each statement as the criterion group. t-test was performed for each statement to find the mean difference between the high and low criterion groups. Edward (1969) suggests that statements with t values greater than 1.968 are to be retained while those scoring lesser than 1.968 are to be rejected. After the item analysis, a total of 77 items were retained.

Step 2: Editing and preparation of final draft Items with t values> 1.75 were selected and the final scale was prepared.

Step 3: Validation of the Tool

Validity

The validity of the tool was established through face validity by five experts' review and the content validity with reference to the relevance and clarity of the items with respect to the meta-learning components indicators. The Content validity Ratio (CVR) was determined by applying Lawshe's formula

$$CVR = \frac{N_e - (\frac{N}{2})}{N/2}$$

Where, Ne is the number of experts identifying an item as "essential" and N is the total number of experts (N/2 is half the total number of experts). CVR describes the validity of individual items. To estimate the validity for the entire tool content validity index (CVI) is calculated which is the mean of the CVR of all the items. The items with CVR value equal or more than 0.78 are accepted as good content validity (Gilbert, Gregory E. et al, 2016).

Items with lower than 0.78 were rejected. The final tool consisted of 50 items with the CVI **0.79** and the tool has good content validity

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

Reliability

Reliability of the tool was established by using the split-half method and finding out the internal consistency using cronbach's alpha.

Split-Half method

It is the procedure or method of splitting the test into halves to find the correlation between the two halves. The reliability of the tool was established through the split-half method using spss. Cronbach's alpha value for correlation between forms was 0.73 and the Spearman Brown's Coefficient formula the Rho coefficient was applied for understanding the reliability. The obtained Spearman Brown coefficient was 0.847 for unequal lengths as part one consisted of 39 items and part two consisted of 38 items. The obtained Spearman Brown's value is greater than the required value of 0.8 therefore, the items are set to be reliable.

The Item Total Correlation: item-total statistics determined the discriminatory power of the items. According to Cristoal et.al (2007), the subscales with corrected item-total correlation lower than 0.30 are not acceptable unless the investigator finds the item extremely necessary.

The scores of the two halves were correlated and the reliability coefficient of the present test was 0.861

Table 6: Split-Half Method of MLAT

No. of Items		Cronbach's Alpha Value
Part 1	39 a	0.77
Part 2	38 b	0.811
Total N of Items	77	

Table 7: Correlation Coefficient for Reliability of MLAT

Correlation between Forms	0.734	
Spearman- Brown Coefficient	Equal Length	0.847
	Unequal length	0.847
Guttman Split-Half Coefficient	0.846	

Internal consistency is usually measured with Cronbach's alpha, a statistic calculated from the pairwise correlation between items. Internal consistency ranges between, negative infinity and one. Coefficient alpha will be negative whenever there is greater within-subject variability than between-subject variability. A commonly accepted rule of thumb for describing internal consistency is as follows (George, D., & Mallery, P., 2003)

The minimum acceptable value for Cronbach's alpha is 0.70; below this value, the internal consistency is considered low. Therefore the items that had a low Cronbach's alpha value showing poor internal consistency were omitted from the tool (Streiner 2003, Voske 2008)

Table 8: Cronbach's Alpha value of MLAT

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
0.879	**0.880**	**71**

Table 9: Item-wise vale of cronbach's alpha

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	206.82	491.049	0.147	0.879
2	206.61	483.378	0.302	0.878
3	206.48	486.784	0.189	0.879
4	206.48	487.83	0.183	0.879
5	206.17	481.906	0.339	0.877
6	206.35	488.323	0.179	0.879
7	206.34	487.748	0.199	0.879
8	206.8	478.895	0.413	0.876
9	206.65	486.194	0.208	0.879

ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

10	206.43	480.155	0.351	0.877
11	206.2	479.629	0.345	0.877
12	206.77	492.764	0.062	0.88
13	206.48	484.876	0.21	0.879
14	206.14	484.284	0.259	0.878
15	206.64	481.334	0.324	0.877
16	206.56	480.01	0.344	0.877
17	206.27	485.741	0.195	0.879
18	206.49	490.803	0.126	0.879
19	206.53	482.839	0.289	0.878
20	206.24	478.072	0.368	0.877
21	206.08	483.36	0.291	0.878
22	206.65	477.754	0.441	0.876
23	206.55	493.645	0.037	0.881
24	206.62	474.917	0.426	0.876
25	206.75	489.439	0.138	0.88
26	206.24	478.109	0.378	0.877
27	206.38	478.073	0.401	0.876
28	205.89	480.538	0.414	0.877
29	206.17	480.566	0.344	0.877
30	206.25	491.054	0.112	0.88
31	205.99	481.514	0.367	0.877
32	206.5	478.069	0.374	0.877
33	206.4	481.857	0.33	0.877
34	206.38	484.495	0.247	0.878
35	206.63	491.557	0.078	0.88
36	205.98	484.202	0.261	0.878
37	206.5	480.766	0.357	0.877
38	206.48	481.096	0.369	0.877
39	206.56	482.083	0.32	0.877
40	206.76	485.76	0.207	0.879
41	206.45	482.726	0.288	0.878
42	206.05	487.685	0.189	0.879
43	206.25	478.15	0.378	0.877
44	206.15	477.728	0.389	0.876
45	206.13	485.36	0.267	0.878
46	206.42	474.301	0.459	0.876
47	207.03	487.183	0.178	0.879
48	205.95	481.814	0.351	0.877
49	206.36	478.362	0.389	0.877
50	206.11	480.025	0.386	0.877
51	206.4	476.646	0.414	0.876
52	206.51	486.821	0.204	0.879
53	206.45	486.819	0.172	0.879
54	206.45	479.057	0.404	0.876

55	206.27	489.118	0.134	0.88
56	206.32	481.32	0.312	0.877
57	206.25	479.251	0.402	0.876
58	206.57	486.999	0.191	0.879
59	206.05	476.98	0.483	0.876
60	206.17	478.144	0.402	0.876
61	206.56	491.423	0.099	0.88
62	206.11	482.942	0.308	0.878
63	206.5	476.986	0.422	0.876
64	206.13	482.167	0.334	0.877
65	206.27	481.118	0.34	0.877
66	205.83	485.465	0.305	0.878
67	206.38	481.174	0.335	0.877
68	206.42	489.2	0.159	0.879
69	206.62	484.862	0.264	0.878
70	206.43	483.256	0.273	0.878
71	206.13	485.892	0.223	0.879

The establishment of validity and the reliability resulted in finalization of the meta-learning assessment tool with 50 items with cronbach's alpha coefficient of 0.808 which is considered to have a good reliability

Table 10: Final Items Weightages of Components

Sl. No.	Components	Item No.	Number of Items	Percentage
1	KG	1,2,3,4,5,6	6	12
	KCT	7,8,9,10,11,12,13,14	8	16
	KPS	15,16,17,18,19	5	10
2	MAT	20,21,22,23,24,25,26	7	14
3	CT	27,28,29,30,31,32,33,34	8	16
4	RL	35,36,37,38,39,40,41	7	14
5	EL	42,43,44,45,46,47,48,49,50	9	18
Total			**50**	**100**

Table 11: Cronbach's Alpha value of Final MLAT

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.808	0.802	50

Table 12: Sample of items of MLAT part B

Component of Meta-learning steps	Sample Items
Knowledge of generalization ability	I apply my previous learning to perform similar or new tasks
Knowledge of critical thinking ability	I question the information given before accepting it
Knowledge of problem-solving ability	I think of many ways of solving a problem
Monitoring of ability related task	I can identify where I am going wrong in a task
Control of the task	I fix my time for a task
Reflections on the learning	I know why I am learning a topic
Evaluation of learning	I can adopt to new methods of learning

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-1 || February 2025 || PP. 7-15 https://doi.org/10.55544/sjmars.4.1.2

VI. RESULTS

The final MLAT consists of 15 items in Part A and 50 items in Part B. Statistical analyses confirm its reliability and validity. The results of the tryout indicated that the students demonstrated meta-learning in them. The tool provides a practical means for educators to assess the level of meta-learning present in them and to enhance its level among secondary students.

VII. DISCUSSION

The MLAT addresses the critical need for assessing meta-learning in secondary education. By focusing on abilities relevant to formal operational stage learners, the tool aligns with developmental needs and educational goals. Educators can use the MLAT to identify strengths and gaps, tailoring interventions to foster independent learning.

VIII. CONCLUSION

It can thus be concluded that the current meta-learning assessment tool is validated and reliable for measuring meta-learning in secondary school students. It bridges the gap in assessment resources for this age group and supports the development of independent learning competencies. Future research could explore its application across diverse educational contexts.

REFERENCES

[1] Biggs, J. (1981). The process of learning.
[2] Brookfield, S. D. (2012). Teaching for critical thinking.
[3] Chan, L. K. (1987). Meta-learning framework.
[4] Watkins, C. (2019). Learning and meta-learning.
[5] Schraw, G., & Dennison, R. S. (1994). Metacognitive awareness inventory.
[6] Currell, G. (2019). Understanding meta-learning.
[7] Meyer, J. H. F., Ward, P., & Latreille, P. (2010). Reflections on learning inventory.