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Developing an Inventory to Assess Metacognitive and Neurocognitive Awareness for the Prospective Teachers

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Abstract

The Metacognitive and Neurocognitive Awareness Inventory (MNAI) was developed to evaluate the metacognitive and neurocognitive awareness levels of prospective teachers. This article details the development and validation processes for the MNAI, addressing a key research gap with empirical evidence. Data were collected from a sample of 91 B.Sc. B.Ed. students enrolled in a four-year integrated teacher training program. The MNAI consists of 68 items divided into six subscales. The first three subscales, focused on metacognition, assess planning, monitoring, and evaluation to support teachers in self-regulating their instructional strategies. The remaining three subscales target neurocognitive functions, examining attention, strategic planning, and executive functioning to enhance cognitive processing and the execution of planned content. The analysis examined redundancy, internal consistency, and construct validity to assess the reliability and relationship between metacognition and neurocognition. The overall internal consistency, using Cronbach's alpha, was 0.892, indicating strong reliability. Construct validity, assessed by Kaiser-Meyer-Olkin (KMO) measure, was 0.825, and the Bartlett's test yielded a significant chi-square value of 246.880. The correlation coefficient (r = 0.585) demonstrated a positive relationship between metacognitive and neurocognitive aspects. This study aims to inform the teaching community, encouraging an awareness of self-regulation in teaching practices to foster contemporary improvements in educational methodologies.

Keywords: Metacognition, Neurocognition, Teacher Education, Teaching Strategy.

Introduction

The art of teaching lies in cultivating an active, engaging classroom environment supported by experts and professionals from various disciplines. To foster such an environment, teachers need to develop a cognitive-based teaching competence. Cognitive-based teaching has become essential in diverse classrooms (1, 2). Since the learners are from different socioeconomic, psychological and home environment, the general teaching methods may not support for effective learning (3, 4). Teaching strategies should nourish the classroom environment for a purposeful learning filled with ecstasy to bring out joyful teaching-learning environments. This study attempts to create awareness in metacognitive and neurocognitive intervention among the students of B.Sc. B.Ed. four year integrated programme to plan their teaching strategies. The term metacognition was coined by Flavell (5). Metacognition is categorized as knowledge about cognition and regulation of cognition (6-8). Though the research on metacognition extends from 20th century to 21st century, there are a lot of distractions and learning traps increase tremendously along with. Therefore, regulating the learners was the major task attempted by the researchers. The teacher who plans for teaching, and the learners who needs to acquire new knowledge both, have to self-regulate. There are many researches on assessing self-regulation of the learners to enforce independent thinkers who mind their thinking process (9-12). However, the research was gradually focused to assess the teachers on teaching using metacognitive awareness inventory (13). To develop new facets in teacher education this study ignites the teacher community to plan their classes based on metacognition and neurocognition through this inventory. The rationale of the study continues in reviewing literature to identify how the domains of metacognition and neurocognition tap the teaching skill. To address this, the following review enlightened the study. While searching on teaching strategies related with metacognition it is found

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that science students involved in substantial amounts of planning to solve stoichiometry problems under the influence of metacognitive strategies (14). Teaching was done using the strategies; they were often cognitive in nature, and not metacognitive (15). But, when strategies were taught sequentially it provides opportunities for fostering metacognitive strategy use such as planning, monitoring, and evaluation (16). However, the instructional effectiveness can be ascertained by "teaching with metacognition" (17). Furthermore, isf the teacher self-realises his/her teaching then that would be the initial start for a change in the professional development of teacher. Hence there is a need to take cognisance of their own teaching (18). The micro case study on strategic planning was experimented on teachers as a sample (19). The importance of strategic planning in higher education is that teachers can enhance their decision making, professional efficiency, and time management. The neurology of self-regulation is executive functioning which helps an individual to think and 'develop an awareness of how to think, how to learn and how they master strategies. It also stimulates to think flexibly, plan the time, mentally manipulate information and monitor own progress (20, 21). This pins the investigator to associate the metacognitive domain of self-regulation such as planning, monitoring and evaluation as well the neurology of self-regulations such as executive functioning, attention and strategic planning under the domain of neurocognition. Also in literature review section the investigators tried to comprehend the literature review pertaining to metacognition and neurocognition.

Metacognition

Related researches on self-regulation have sought to develop goal setting, time management, self-attributes, learning strategies, self-evaluation and develop self-motivational beliefs (22). The investigators started the research in using the metacognitive strategies in teaching which is the mental process regulated physically. The review began with literature pertaining to the metacognitive inventory. The first metacognitive inventory was developed to assess children's metacognitive awareness that influence reading through interview study developed with 15 open ended questions on two different grade levels 2nd and 6th grades (23). This inventory assesses the metacognitive knowledge which may be correlated with the efficient memory, problem-solving, and reading skills. With minor modification a revised inventory comprising of planning, monitoring and evaluation to analyse reading awareness and comprehension skills for 8 year and 10 year old children was developed. The research identifies the reading issues and studies on children's knowledge in measuring metacognition (24). Both these study gives substantial insight on metacognitive knowledge but the inventory can be used on primary level of children for analyzing the reading. Following the inventory, another tool was designed to assess the metacognitive activities of young students' reading. This research attempts to identify the students' thinking and about what they think during reading (25). In accordance with the above relevant inventory 'Metacognitive Awareness Inventory' (MAI) for adults consist of eight factors with 52 items were constructed. Encompassing three with knowledge of cognition comprising 17 items and remaining 35 items bifurcated into five factors pertaining to regulation of cognition. Two experiments and two factor model were administered. He reported in the first experiment about the validity and internal consistency of the tool used. As well as six inter correlated factors do not correspond to eight subcomponents of metacognition discussed in earlier studies like declarative, procedural, and conditional knowledge. In second experiment he found the relation between knowledge and regulation of cognition. Also he suggested that each component provides a unique contribution to cognitive performance. The variables used in this study are knowledge of cognition, regulation of cognition, performance, confidence and accuracy (26). Further investigation was carried on reading comprehensive test. This study was then extended to assess the young learners (27). To analyze the theoretical dimensions and subcomponents of cognition the above said researchers used inventories to evaluate the learners' knowledge and their thinking to self-regulate. Later the inventory MAI modified as Metacognitive Awareness Inventory for Teachers (MAIT) to measure the teacher's metacognitive awareness with new approach. The motivation of the study is to measure language teachers' metacognition. To validate the tool the researcher did three phase of study and finally refined 36 items were given to

226 student teachers to validate the inventory. Finally, the researcher revealed the modified inventory consisting of 24 items possesses good reliability and validity (13). Another self-report instrument 'Teacher Metacognitive Inventory' (TMI) was developed to assess the teachers' metacognition in educational practice. The investigators used three components namely metacognitive knowledge, metacognitive experience and metacognitive skill having four subcomponents planning, monitoring, evaluation and debugging in teaching activities in two study. The TMI consisting of 53 items on a 5 point Likert scale type using a paper and pencil method for collecting the responses from the participants for not more than 30 minutes. After validation of the tool the final version consists of 28 items and it was administered to a sample of 226 Chinese in-service middle school teachers involved in teacher training programme. However, personal knowledge was alone given importance rather than mental knowledge to regulate physically (28).

Neurocognition

The scope of neurocognition in the field of education has recently extended to learners in the enhancement of their learning. This develops the investigators to find reviews on neurocognitive inventory. The term neurocognition has widely focused in the field of medical for solving various brain based issues, brain based education and also how neuroscience actually helps traditional teaching (29). Most researches on neurocognition were learning disabilities, schizophrenias, study on neuroimaging, and neuromyth (30-34). Besides, the research on neurocognition becomes wider in the field of education. The study on the declarative/procedural model for mental lexicon and mental grammar in learning language are compared with other model also investigated on neural perspectives. The author interpreted that apart from declarative memory system and procedural memory system there are other cognitive or computational is also needed for both capacities (35). Another study on neuroscience literary tried to explore the perception of neuromyths amongst the prospective teachers. The questionnaire consists of 70 items aimed to investigate the general knowledge on brain, neuromyths, and the participants' neuroeducation attitudes' and their reading habits. The researchers found that 90.3% of the prospective teachers believed in neuroscience knowledge and 47.33% of the assertion was on the brain and 36.86% ascertained neuroscientific issues related to special education. With the results the researchers suggest that the prospective teachers can benefit the academic instruction on neuroscience (36). The research on the primary and secondary school educators to measure the level of awareness investigated in regards to neuroeducation and the corresponding moral limitations (37). In this study, the researchers find the solution for educational awareness and training, awareness on neuroeducational aspects, awareness on neuroscience aspects, and neuroeducation and ethical limitation aspects. Effectiveness of neurocognitive strategies such as sensory association, information sequencing, visual recognition, auditory monitoring, scaffolding and decoding, emotional regulation, cognitive association and cognitive verbal articulation to intervene the graduate teacher trainees to enhance the teaching competency such as content, conceptual, contextual, transactional, management, and evaluation and assessment competency were studied. However there is no interpretation on internal influence of the participants (38). Correspondingly, the awareness on neurocognition was administered among the school teachers using the tool Neurocognitive knowledge Inventory for School Teachers (NKIST). The tool was administered to 400 school teachers and developed insight among the teachers on neurocognitive knowledge in education (39). However the participants were influenced by both personal knowledge and mental knowledge needs to be interpreted. Conversely, metacognition involves conscious cognitive regulation, while neurocognition underpins these processes through implicit brain functions like attention and executive control. Integrating both in the MNAI enables teacher educators to identify gaps in self-regulation and neurological understanding, fostering instructional design that is cognitively effective to improve teaching competencies among the pre-service and in-service teachers.

Inventories

The literature offers reviews on Metacognition awareness inventory for assessing the learners' distend to assess the teachers' awareness. Also, focusing on neurocognition in solving the special educational needs extended to the issues

pertaining to general education. This creates insight for the investigator to continue the reviews on literature to find the relation between metacognition and neurocognition. The tool Metacognitive Awareness Listening Questionnaire (MALQ) developed and validated to assess the second language listener as well as perceived use of strategies while listening to oral texts. The authors determined the redundancy, content validity, clarity and reliability of the instrument. The instrument is a 6-point Likert scale to track the metacognitive awareness and listening performance. The instrument tested a large sample of respondent 966 for factor analysis. A revised version of MALQ was tested for another sample of 512 based on different language listeners. The authors analysed five emerging factors and found three clearly identified factors such as person knowledge, (no) mental knowledge, and directed attention. However listening and directed attention is a function of mental knowledge. Finally, the reliability of each scale is done using Cronbach's alpha reliabilities (40). To find the relationship, a systematic framework provides report on self-knowledge (6). Metacognition is treated as object level, a behavioural dissociation from cognition which shares similarities with influential model of executive functioning. The behavioural method was reviewed and measured metacognition in the field of cognitive neuroscience. The authors measured the psychological determinants of metacognitive accuracy, the neural basis of metacognitive accuracy and the relation between the metacognitive and cognitive control (41). Finding the relation has comparatively fulfilled when reviewing the literature on academic listening test performance predicted by metacognitive and neurocognitive process using MALQ to assess the while listening performance (person knowledge and mental translation). They also investigated post listening performance to measure mental translation and directed attention. The authors examined the relation between the gaze behavior, brain activation and metacognitive awareness of listening test takers and performance (28). However, cognitive neuroscience methods have the potential to deliver important information relevant to design and delivery of educational curricula as well as the quality of teaching itself (42). This clearly infers that successful teaching is the counterpart of successful learning (43). Therefore this study attempts to create awareness among the teachers to self-analyse their personal and mental abilities for teaching physically. It is not easy to assess the mental processing of a person with experimentation using fMRI, FET, EEG, and PET. Here the investigator tries to measure the thinking process physically. Therefore the MNAI is developed to validate and measures the use of metacognitive strategies and neurocognitive strategies in teaching as preliminary determination. One of the classifications of metacognition; regulation of cognition is used as one of the components for planning, monitoring and evaluation of their teaching plans (44, 45). The other component of the inventory is neurocognition to identify the strategic planning, attention and executive functioning is to assess the mental plans of their teaching were studied using 68 items consisting of six subscales (46-48). Finding the research gap, the investigators initially tried to develop the awareness among the prospective teachers to measure the teaching strategies based on metacognition and neurocognition. Hence in this study, the authors address to measure the teaching awareness of the teachers using MNAI. The opinionnaire was administered to the B.Sc. B.Ed. students who have completed two phases of their internship in schools at secondary level. This study addresses the reliability and validity of the newly developed MNAI which perhaps assess the teaching awareness of the B.Sc. B.Ed. students. This study delineate the connection of metacognitive and neurocognitive domains to establish a comprehensive understanding of teaching cognition. Metacognition helps teachers to actively regulate their teaching competencies, while neurocognition provides insight into the implicit brain-based mechanisms. A combined pattern for assessing teaching awareness is provided by relating these two dimensions into a single inventory MNAI which serves as a foundation for teacher preparation in both neuroscientific literacy and reflective practices.

Methodology

The conceptual understanding on metacognition, neurocognition and the relation between the metacognition and neurocognition has been made the researcher to examine the teaching awareness

among the B.Sc. B.Ed. students. The present MNAI is designed to measure the regulated teaching readiness using metacognitive strategies and to mental cognisance of the execution of lessons during the teaching and learning using the neurocognitive strategies. Then the ambiguous and redundant statements were evaluated using the expert commands and for the content validation purpose. Then the tool is analysed for the internal consistency of the opinionnaire using the Cronbach's alpha test. We found the construct validity of the tool using Kaiser-Meyer-Olkin and Bartlett's test to test the sample has equal variance. Finally, we found the correlation coefficient using Pearson correlation to establish the relation between the metacognition and neurocognition.

Tool Description

Ensuing the standards for developing the tool with valid and reliable opinionnaire, we instigated with relevant literature on metacognition, neurocognition and the relation between the metacognition and neurocognition discussed under review of literature section (49-50). We examined the tool for redundancies and then we followed the thematic concepts of metacognition to self-regulate the teaching skills for preparing the opinionnaire (44, 45, 51). Equal importance was drawn for preparing the opinionnaire items on neurocognition (46-48). Initially 75 items were prepared based on two domains such as metacognition and neurocognition to create awareness among the prospective teachers.

- For an example, the statements provided for metacognitive awareness are
- I know I always ready with the lesson plan and check my plan of action. (P)
- I plan all times on methods and strategies when I prepare for lesson plan. (P)
- I observe my class content when I deliver the subject during the class. (M)
- I recognize the use of technological or conventional tools to adopt in the class and check for sequence delivery of content. (M)
- I measure my level of subject knowledge for the prepared lesson plan. (E)

Similarly, the statements provided for neurocognitive awareness are

- I focus on students' attention when switching the mode from lecture to technology and vice versa. (A)
- I manage time schedule for the completion of planned lessons following the teaching approach. (A)
- I determine the objectives of teaching while planning lessons. (SP)
- I execute the cognitive task by recalling the content in posing questions. (SP)
- I focus among learners in learning through illustration of instructional aids through sensory impacts. (EF)
- I am self-restraint in all my teaching plans from the planning stage till I complete the execution of planned lessons. (EF)

The prepared statements were then submitted to experts in the field of cognitive neuroscience. All statements were screened and edited according to the suggested information received from them. Few statements were revised and examined based on the chosen concepts of the study. The items were subjected to the elimination of ambiguity, irrelevant statement, and statement confusing the related items. After the revision, the inventory comprises 68 items. Hence the redundancy of the tool was determined. After the revision and screening of the items, the scale was pre-tried for 91 B.Sc. B.Ed. students to find the relevance of the statement.

Tool Development

The tool developed for this study emphasises on two main cognitions; one is metacognition and the other is neurocognition which may meet the needs of the teachers during planning and execution of the planned content. The 'Metacognition and Neurocognition Awareness Inventory' was constructed for the prospective teachers to self-analyze their teaching plans, self-evaluate their teaching, mind their sequence of content delivery, methodology, materials, and self-regulate their teaching. The response of the opinionnaire is 'Yes' or 'No' type. This study investigated the students of integrated B.Ed. to self-realize and to regulate their teaching lesson plans by neurological intervention. The tool consisting of 68 items entails six subscales, among which three subscales includes planning, monitoring and evaluation related with categorization of metacognition which is regulation of cognition. The first metacognitive subscale planning consists of 8 items, includes the plan of action, planning of instructional material, strategies, activity selection for teaching skills. The second subscale of metacognition, monitoring

describes 11 items focusing about thinking on interaction during class, integration of instructional materials, identification and implementation of teaching methods, monitoring the use of technological or conventional tools for teaching. The third subscale, evaluation includes 14 items embraces on self-observation on pedagogical approach, self-assessing, self-judging the teaching strategies, methods, approaches styles of teaching and classroom management. The proposed three subscales of neurocognition includes; attention, strategic planning, and executive functioning. The subscale, attention comprises 14 items stating to gain student's attention during teaching content, in sequence delivery of content, switching the teaching styles, pedagogical instruction, and time management. The next subscale strategic planning has 10 items, interprets vision on teaching concepts, determine the objectives of teaching, formulate the lessons, organization of teaching skills, and strategic plan to execute the lessons. The third subscale of neurocognition, executive functioning consists of 11 items defining the pedagogical approach to improve the long-term memory, accomplishing the cognitive task, inquiry skill, task initiation and solving, self-reliant, and insisting learning and reasoning. These subscales create awareness to plan lessons, self-monitor their teaching and self-evaluate their teaching using metacognitive intervention and through neurocognitive intervention the teacher develops the ability to build cognitive strategies to deliver the teaching content by strategic planning, arouse the attention in the teaching-learning process, and tap the executive functioning to accomplish the joyful learning environment.

Data Collection

This study comprises the convenient sampling of 91 B.Sc. B.Ed. students from three different programmes of teacher education course. The samples from three different programmes are 25 English, 28 Mathematics, and 38 Physics student teachers of third and fourth year had their practice teaching during their course in three phases of internship. The sample includes 21 rural 30 semi-urban and 40 urban of three different vicinities. The researcher gave a brief overview of the study, elucidated about the tool and explained them to fill out the opinionnaire. Few of them faced difficulties in filling out the opinionnaire were clarified during the collection of data. The participants were provided enough time to give response. The tool has been responded in 25 to 30 minutes by the student teachers.

Results

Methods

The draft version of MNAI is tested among the sample of 91 student teachers of three different programmes. The instructor emphasized and clarified the participants' doubts and was encouraged to fill the opinionnaire through online platform. After collecting the responses the investigator validated the tool using the Kaiser-Meyer-Olkin (KMO) and Bartlett's test. Since the KMO test measures the adequacy of the data for analyzing the factors or variables used in the research. This study uses the six subscales such as planning, monitoring, evaluation, strategic planning, attention and executive functioning. Therefore, the study finds the validity using KMO and Bartlett's test to determine all available data together. The construct validity of the tool is found statistically from Table 1. Validity refers to test what is to be measured, the accuracy of measures and the aim of measure. For a high validity research, the real properties, qualities and variations of the results found using the method KMO will be valid. The validity of the tool is measured using KMO test suited for sample adequacy for each variable in the model and for the complete model. KMO rule of thumb for elucidating the statistics between 0.8 and 1 indicates the sampling is adequate and below 0.5 is not adequate.

Table 1: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin	Measure of Sampling Adequacy.	0.825
Bartlett's Test of Sphericity	Approx. Chi-Square	246.880
	Degrees of Freedom	15
	Significant	0.000

The Bartlett's test of Sphericity used to test the null hypothesis to assess the correlation of an identity matrix. If the significance is less than 0.05 then the factors in the tool are identity matrix where the variables are not ideal for factor analysis. The KMO and Bartlett's test shows the suitability of the data and helps the researcher to structure the tool. Kaiser states that the KMO value > 0.9 was marvelous, >0.8 is meritorious, >0.7 is middling, >0.6 is mediocre and the value less than this is miserable and unacceptable or in general the value between >0.8 and 1 is acceptable. In the Table 1 the KMO value 0.825 indicates the sampling is adequate and acceptable. Also the Bartlett's test of sphericity identifies the correlation matrix to identity and verifies the variance is equal across groups. From the Table 1 it is understood that the approximate Chi-Square value is 246.880 which affirm the tool is fit. These results show that the validity of the tool is satisfactory to use. The total variance based on the average score of six subscales was shown in the Table 2 and the average squared deviation is found to be 75.863. The Table 2 correspondingly shows the percentage of variance between the component planning, monitoring and evaluation which are the domains of metacognition and the neurocognitive domains attention, strategic planning and executive functioning. These results assess the average squared difference between the mean and the data sets. Hence it is inferred that the data set formulated is satisfactory and the tool can be used for further investigation in various dimension.

Table 2: Variance Test for Six Subscales

Component	Total Variance					
	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Planning	3.488	58.135	58.135	3.488	58.135	58.135
Monitoring	1.064	17.728	75.863	1.064	17.728	75.863
Evaluation	.485	8.076	83.939			
Attention	.359	5.986	89.925			
Strategic Planning	.315	5.252	95.178			
Executive Functioning	.289	4.822	100.000			

Reliability

The reliability of the tool is found using the Cronbach's alpha test. The range of Cronbach's alpha reliability coefficient is between 0 and 1. In fact there is no lower limit to the coefficient. The value 1.0 represents greater the internal consistency of the items in the scale. This test is used to find the internal consistency and stability of the questionnaire. The Cronbach's alpha value of range $0.6 > \alpha > 0.5$ indicates that the questionnaire is poor, the value $0.7 > \alpha > 0.6$ shows questionable, $0.8 > \alpha > 0.7$ represents acceptable, the range $0.9 > \alpha > 0.8$ shows that the questionnaire is good. The value $1.0 > \alpha > 0.9$ shows that the internal consistency of the questionnaire is excellent. Reliability can be classified as test-retest reliability, internal consistency, and inter-rater consistency.

Table 3: Reliability Statistic between the Components

Component	Cronbach's Alpha		
	Alpha value	Based on Standardized Item	No. of Items
Metacognitive and Neurocognitive	0.892	0.889	68
Metacognitive	0.804	0.814	33
Neurocognitive	0.857	0.851	35

This study analyzes the internal consistency of the tool which consists of 68 items. Therefore to find the close relation for a set of items, the internal consistency is measured using the Cronbach's alpha test. The measure of reliability found for the developed tool MNAI is 0.892 and 0.889 based on standardized items in Table 3 which shows relatively high internal consistency. Also, the Cronbach's alpha value for the metacognitive component of 33 items is 0.804 and the

neurocognitive component of 35 items is 0.857 which represent that the tool can be used to assess the teachers of pre-service and in-service as well. As per the reliability scale, the range >0.6 to 0.8 is reliable and >0.8 is very reliable. Hence the statistical value found in Table 3 clearly shows that the tool is reliable.

Table 4: Reliability Statistic on Each Subscale of Metacognition and Neurocognition

Component	Alpha value	Cronbach's Alpha Based on Standardized Item	No. of Items
Planning	.287	.327	8
Monitoring	.616	.633	11
Evaluation	.658	.660	14
Attention	.648	.636	14
Strategic planning	.672	.662	10
Executive functioning	.733	.733	11

The opinionnaire of the tool developed is good as per Cronbach's alpha value range α = 0.892 and reliable. The reliability statistics on each subscale is presented in Table 4. The subscale has less reliability α = 0.287 indicating that the planning subscale has less consistency. The subscale monitoring (α = 0.616) and evaluation (α = 0.658) of metacognitive component and as well the subscale attention (α = 0.648) and strategic planning (α = 0.672) of neurocognitive component is questionable reliability and can be acceptable. The subscale executive functioning shows good reliability α = 0.733.

Table 5: Correlation Matrix between the Components

Subscale	P	M	E	A	SP	EF
P	1					
M	.551**	1				
E	.565**	.657**	1			
A	.277**	.593**	.520**	1		
SP	.235*	.524**	.515**	.677**	1	
EF	.216*	.391**	.440**	.576**	.624**	1

Note: P-planning, M-monitoring, E-evaluation (components of metacognition), A-attention, SP- strategic planning, EF-executive functioning (components of neurocognition)

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlation

Relation between the metacognitive and neurocognitive component was analysed using Pearson correlation which gives the statistical measure of linear relation between two variables that range between -1 and 1. When the value is 1 there is perfect relation between the two variables positively and when it is -1 it represents the perfect negative relation. In between the -1 and 1 some researchers have proposed the value as follows. If the correlation coefficient value is of 0.1 or less is considered very weak, 0.1to 0.3 is weak, 0.3 to 0.5 is moderate, 0.5 to 0.7 is strong, 0.7 to 1 is considered to be very strong correlation.

Table 6: Correlation Matrix between Metacognition and Neurocognition

Component	Metacognition	Neurocognition
Metacognition	1	
Neurocognition	.585**	1

The investigators analysed the correlation matrix between the components of metacognition with the components of neurocognition to find the relations between the variables. The matrix presented in Table 5 represents there is a weak correlation (r = 0.277) between the planning and attention. Similarly the subscale planning shows a weak correlation between strategic planning (r =

0.235) and executive functioning (r = 0.216). The subscale monitoring shows a positive strong correlation with the attention (r = 0.593) and strategic planning (r = 0.524). There are also a positive moderate correlation between monitoring and executive functioning (r = 0.391). Likewise, the subscale evaluation also shows a positive strong correlation between the subscale attention (0.520) and strategic planning (r = 0.515). Also, there are a positive moderate correlation between evaluation and executive functioning (r = 0.440). A Pearson correlation was calculated to examine the relation between the metacognition and neurocognition. From the Table 6 the correlation coefficient r (91) = 0.585, p <0.001 indicating a strong positive correlation between the metacognition and neurocognition. This suggests that higher levels of metacognitive ability are associated with enhanced neurocognitive functioning. The significance level confirms that the observed correlation is unlikely to have occurred by chance. This shows the evidence for a meaningful association between the two components.

Discussion

This research aimed to develop and validate the MNAI tool to measure the awareness among the teacher trainees of B.Sc. B.Ed. students. The findings disclose statistically a strong correlation between the metacognitive and neurocognitive strategies. The MNAI tool demonstrated high internal consistency (Cronbach's alpha = 0.892), indicating its potential utility in assessing both pre-service and in-service teacher competencies. These results support that the MNAI provides valuable insights into the cognitive and strategic dimensions of teaching and can guide instructional improvement and teacher training initiatives. To explore further research the applicability of MNAI is recommended across various areas to determine the reliability and validity in different educational systems, languages and cultural contexts. Also, this research can be extended to investigate these competencies among the teachers of all levels. Especially to bring changes in the teacher education programme and classroom experience. This study can further explored to examine how targeted training or professional development activities can enhance metacognitive and neurocognitive competencies by conducting pre-test and post-test. By modifying the MNAI tool, this can also be followed further for experimental study to evaluate the teaching competencies.

Conclusion

This study described the development and validation of the opinionnaire to assess the teaching readiness of the student teachers. Their use of strategies such as metacognition and neurocognition in their teaching were measured using the awareness inventory. This would develop mental knowledge influenced with personal knowledge to self-regulate physically based on teaching interventions in their teaching plans and execution of the lesson plans in classroom. In review of literature, the reviewed article pertaining to metacognitive awareness inventory was designed to create awareness, regulation, assessing the metacognitive domains among the learners. Conversely, there is no awareness inventory to assess the teachers teaching strategies based on metacognition to regulate their teaching plans with contemporary teaching styles, methods, techniques or strategies. Besides the neural based teaching using neurocognitive awareness may enhance the teachers to improve the attention, strategic planning, and executive functioning during classroom teaching. More specifically, planning, monitoring and evaluation were used as metacognitive intervention and neurocognitive intervention realms attention, strategic planning, and executive functioning were used for the development of inventory tool. This study revealed that the MNAI is one such inventory tool to assess the prospective teachers' teaching strategies and it will create awareness among the teachers to incorporate the metacognitive and neurocognitive intervention based teaching competencies. Further research can be done to structure the tool by administering with larger sample and different discipline and also to the in-service teachers for updating the tool. Awareness on cognitive activities by the teachers will certainly contribute to enhance their teaching competency. Findings of this study will give insights to the teachers to strengthen their pedagogical skills.

Abbreviations

EEG: Electroencephalography, FET: Fluoroethylty-rosine (commonly used in FET-PET for brain tumor imaging), fMRI: Functional Magnetic Resonance Imaging, MAI: Metacognitive Awareness Inventory, MAIT: Metacognitive Awareness Inventory for

Teachers, MALQ: Metacognitive Awareness Listening Questionnaire, MNAI: Metacognitive and Neurocognitive Awareness Inventory, NKIST: Neurocognitive knowledge Inventory for School Teachers, PET: Positron Emission Tomography, TMI: Teacher Metacognitive Inventory.

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Author Contributions

Devaki V: Conceptualisation, Methodology, Investigation, Resources, Data Curation, Writing-Original Draft. Ramganesh E: Conceptualisation, Methodology, Validation, Resources, Writing – Review & Editing, Supervision. Amutha S: Methodology, Resources, Writing – Review & Editing.

Conflict of Interest

The researcher has no conflict of interest to disclose.

Ethics Approval

This paper is not currently being considered for publication elsewhere. This study followed ethical guidelines, obtained consent and ensured voluntary participation. This study obtained permission from the relevant institute to carry out this work in an honest and ethical manner.

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