

Investigation Of Metacognitive Awareness In Learning Programming Course Using Multiple Criteria Decision Making Algorithm: Topsis

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Abstract

Writing Computer Program Is Regarded As A Difficult Skill To Master By Both Specialists And Students. Metacognition Has Been Identified As A Fundamental Figure In Becoming An Effective Computer Programming Student. Metacognition Is Defined In Instructive Brain Science As The Observation And Control Of One's Discernment Exercises. To Perceive The Inter Correlation Analysis, 1145 Engineering Students Used The Metacognitive Awareness Inventory (Mai), Brain Dominance, Multiple Intelligence, Kolb's Learning Style Identification, And Big-Five Personality Assessments. It Is Considered, In Addition To Descriptive Statistics Of Metacognitive Awareness, To Understand How It Corresponded With Their Exhibition In A Python Programming Course On A Stratified Sample Of 125 Students Evaluated Using Solo Taxonomy Adopted For Programming Course. The Outcome Of Correlation Test Revealed That Of The Declarative, Procedural, And Conditional Knowledge Subcomponents Of Knowledge About Cognition, There Is A Significant Association With Declarative Knowledge In The Students' Positive Performance In Python Programming. The Findings Also Revealed A Positive Relationship Between Learning Python Programming And Planning, Information Management System, Debugging Strategies, And Evaluation. The Descriptive Statistics For The Metacognitive Awareness Inventory Subcomponents Are Also Discussed In This Paper. This Study Consists Of Two Major Components Namely Metacognitive Modeling, Which Suggests A Self-Questionnaire For Incorporating Metacognition Into Classroom Sessions, Activities And Assessment, And Also Topsis Algorithm Which Provides Best Decision Based On Priorities.

Keywords: Metacognition, M-Tpack, Metacognitive Modeling, Solo Taxonomy, Topsis

1. INTRODUCTION

For Many Years, "Metacognition" Has Been Employed In Educational Psychology [1] As A Powerful Indicator Of Academic Success. But What Exactly Is Metacognition? We Implicitly Engage In Metacognitive [2] Processes Practically Daily. It Has Been Noted As A Crucial Component For Being A Successful Learner Because Of Its Connection To Intellect. In Contrast To Hart, Who Defines Metacognition As The Systematic Series Of Acts That Allowed A Person To Perceive, Reflect, Or Experience His Or Her Own Cognitive Series Of Actions, Flavell Describes Metacognition As The Control One Has Over Their Own Cognition And Learning. Robert Sternberg Integrated These Two Concepts In The Middle Of The 1980s And Addressed The Meta Components Of Metacognition In His Triarchic Theory Of Human Intelligence. According To Sternberg, The Higher-Order Executive Processes That Direct And Monitor Cognition As Well As The Meta Components That Decide What Needs To Be Done, Watch What Is Being Done, Evaluate What Has Been Done, And Collaborate With The Performance Components That Carry Out A Task As Well As The Knowledge Acquisition Components That Help People Learn How To Perform Are Collectively Referred To As Metacognition. Since This Ability Is Crucial To Effective Learning [3], It Is Critical To Investigate The Activity And Development Of Metacognition In Order To Understand How Novices Can Be Trained To Better Use Their Cognitive Resources Through Metacognitive Skill Regulation [4]. According To Flavell's Research, Metacognition Is Comprised Of Metacognitive Regulation Of Cognition And Metacognitive Knowledge Of Cognition (Kc).The Term "Metacognitive Knowledge" Relates To The Reflective Part Of Learning And Can Be Defined As The Knowledge That Can Be Used To Influence Cognitive Processes As Well As Our Awareness And Realization Of Our Own Cognitive Processes. Declarative, Conditional, And Procedural Knowledge Are The Three Subcomponents That Schraw And Moshman Further Divide Metacognitive Knowledge [5] . Declarative Knowledge (Dk), Which Can Be Characterized As Our Understanding Of How We Acquire Knowledge, Has An Impact On How We Learn. Procedural Knowledge (Pk) Is Understood To Be Information About Memories Or Practices That Operate Well For Us. Conditional Knowledge (Ck) Can Be Defined As

Understanding Why And When By Combining Procedural And Declarative Knowledge. It Allows Students To Allocate Resources As They Develop Strategies. As A Result, It Improves The Strategy's Effectiveness. On The Other Hand, Metacognitive Regulations Are The Real Behaviors We Engage Into Speed Up The Process Of Learning And Memorization. The "Regulation" Of Metacognition Is Comprised Of Three Components: Planning (Pl), Monitoring, And Assessing. The Processes Of Selecting Cognitive Resources And Methods That Are Appropriate For The Cognitive Activities At Hand Are Referred To As Planning. Monitoring Entails Evaluating A Person's Learning Or Strategy Use. While Evaluation Entails The Process Of Evaluating The Learned Knowledge. Numerous Studies Suggest That Metacognition Plays A Role In Academic Achievement, As Measured By Grade Point Average (Gpa) In Tertiary Education, And Is A Fundamental Predictor Of It. According To The Information Provided Regarding Metacognition And Its Significance, The Learning Process Can Be More Effective If A Learner Is Given The Chance To Successfully Build His Or Her Metacognitive Knowledge Skills. The Potential To Succeed Academically Results From This.

Metacognition Is Critical For Successful Learning Because It Allows People To Better Manage Their Cognitive Skills And Identify Weaknesses That Can Be Remedied By Developing New Cognitive Skills. Metacognition Is The Ability To Think About How One Performs A Skill. Recent Research Indicates That Metacognitively Aware Learners Are More Strategic And Perform Better Than Unaware Learners, Allowing People To Plan, Sequence, And Monitor Their Learning In A Way That Directly Improves Performance. Students' Cognition Knowledge Corresponds To Their Understanding Of Themselves, Strategies, And The Conditions Under Which Those Strategies Are Most Effective. The Foundation For Conceptual Knowledge Is Declarative, Procedural, And Conditional Knowledge. Understanding How Students Plan, Implement Strategies, Monitor, Correct Comprehension Errors, And Evaluate Their Learning Is Referred To As Cognition Regulation.

A) Benziger Thinking Style Assessment: Dr. Katherine Benziger And Dr. Richard Haier, A San Diego Neurosurgeon, Collaborated To Examine The Brain Using Mri And Pet Images. Btsa[6] Implications Make It Easier To Understand One's Own Strengths And Weaknesses, Pursue Self-Improvement, And Manage Relationships And Teams. The Four Components Considered In Thinking Style Are Basal Left(Bl),Basal Right(Br), Frontal Left(Fl), Frontal Right(Fr)

B)Kolb's Learning Style Preferences: Active Experimentation (Ae), Abstract Conceptualization (Ac), Reflective Observation (Ro), And Concrete Experience (Ce) Are The Four Types Of Learning Capacity Involved In Learning. Kolb's Approach [7] Asserts That Learning Style Is Important In At Least Five Areas: Behavioral/Personality Analysis, Educational Specialization, Professional Career, Current Employment, And Adaptive Competencies.

C) Howard Gardner's Theory Of Multiple Intelligences: Gardner Believes That Everyone Has A Distinct Intelligence Profile To Varying Degrees. Mi[8] Is Divided Into Three Categories: Analytical (Which Promotes The Process Of Analysis; Includes Naturalistic, Musical, And Mathematical Intelligence), Introspective (Which Looks Inward With An Emotive Connection To One's Own Experiences And Beliefs; Includes Linguistic, Interpersonal, And Bodily-Kinesthetic Intelligence), And Interactive (Allows One To Express Themselves And Explore Their Environment; Includes Intrapersonal And Visio-Spatial Intelligence)

D) Big -5 Personality: The Big-Five Theory Describes Five Major Aspects Or Dimensions Of Personality: Openness, Conscientiousness, Extraversion, Agreeableness, And Neuroticism (Also Known As The Five-Factor Model, Or Ffm). The Acronym Ocean Is Frequently Used To Refer To The Big-Five Personality Traits[9]. It Is Further Expanded By Dividing Each Factor In The Five-Factor Model (Ffm)[10] Into Two Archetypes, Resulting In Ten Elements Totaling 5 Plus (+5). Each Type Is Represented By Two Opposite Ends Of The Spectrum: The Social End Is Made Up Of S (Social), C (Calm), O (Organized), A (Accommodative), And I (Inquisitiveness), While The Reserved End Is Made Up Of R (Reserved), L (Limbic), U (Uncertainty), And I (Inquisitiveness) (Unorganized), E (Ego Centric), And N (Non-Curious).

This Research Article Answers The Following Questions:

- Which Of The Following Declarative, Procedural, Or Conditional Knowledge Will Have A Positive Impact On Students' Python Programming Performance?
- Which Strategies For Planning, Information Management, Monitoring, Debugging, And Evaluation Will Improve Students' Python Programming Performance?
- Which Type Of Knowledge Are Students More Proficient In: Declarative, Procedural, Or Conditional? More Inefficient?
- In Terms Of Planning, Information Management, Monitoring, Debugging, And Evaluation, Which Strategies Do Students Excel At? More Inefficient?
- Which Metacognitive Subcomponents Have The Most Influence On Python Programming Learning?
- Which Metacognition Awareness Subcomponents Have A Moderate Or Strong Association?
- Which Intelligence Is Affected By Metacognitive Components?
- Does The Metacognitive Awareness Inventory Influence Or Associate With The Learner's Learning Style, Thinking Style, And Personality Traits?
- Is It Possible To Integrate Metacognition In Pedagogy?

II. METHODS AND INSTRUMENTS: METACOGNITION ASSESSMENT

A) Dataset:

1145 Students Pursuing Engineering Education At The University Level Institution Are Participated In The Survey. The Psychometric Theories [12] Related Attributes Considered For This Research Are Shown Below:

Mai Components = {Dk,Pk,Ck,Pl,Ims,Cm,Ds,Ev,Kac,Rac}

Thinking Style= {Bl,Br, Fl, FI}

Learning Style= {Ae, Ac, Ro, Ce}

Multiple Intelligence= {Lin, Lo, Mu, Bo, Vi, Inter, Intra, Na}

Personality Traits= {F1, F2, F3, F4, F5}

B) Questionnaire And Assessment Of Mai:

Metacognition Awareness Inventory (Mai)[11] Consists Of 52 Questionnaire. Each Question Has Two Possible Answers Either True Or False. Participant Scores One Mark For Each True And Zero For Each False. Responses Are Collected From Students Using Google Form. To Find The Score Of Each Element In The Metacognitive Awareness Inventory Is As Shown In Table.1:

Subcomponents Of Mai	No. Of Items	The Questionnaire Used For Score Calculation
Declarative Knowledge(Dk)	8	Σ Value Of The Items 5,10,12,16,17,20,32, And 46
Procedural Knowledge(Pk)	4	Σ Value Of Items 3,14,27 And 33
Conditional Knowledge(Ck)	5	Σ Value Of The Items 15,18,26,29 And 35
Planning(Pl)	7	Σ Value Of The Items 4,6,8,22,23,42 And 45
Information Management Strategies(Ims)	10	Σ Value Of The Items 9,13,30,31,37,39,41,43,47 And 48
Comprehension Monitoring(Cm)	7	Σ Value Of The Items 1,2,11,21,28,34 And 49
Debugging Strategies(Ds)	5	Σ Value Of The Items 25,40,44, 51 And 52
Evaluation(Ev)	6	Σ Value Of The Items 7,18,24,36,38, And 49
	52	

Table 1: Components Of Mai And Its Questionnaire

C) Procedure:

The Mai Survey Is Set Up Using The Google Docs Application For Respondents To Access. The Google Docs Application Allows Researchers To Create An Online Survey Form And Email It To A Group Of People. Another Advantage Of Google Docs Is Its Ease Of Use And Convenience To The Survey Invitation In Google Classroom This Feature Is Used To Collect Data In The Current Study. All Responses Are Automatically Collected And Saved In A Google Docs Spreadsheet.

D) Descriptive Statistical Analysis:

A Descriptive Statistical Measure Of Each Element In The Metacognitive Awareness Inventory, Answers For Research Questions Through Statistics. Figure.1 Shows That Mean Value Of Knowledge About Cognition(Kac)(84.26) Is Less Compared To Regulation Of Cognition(Rac)(88.06).In Deep Analysis, Among The Subcomponents Of Kac, The Mean Value Of Procedural Knowledge(82.35) Is Comparatively Less Than To The Declarative Knowledge And Conditional Knowledge. In The Procedural Knowledge Questionnaire, Mean Value Is Less For The Question "I Try To Use Strategies That Have Worked In The Past". It Indicates That Learners Are Poor In Introspecting The Approach Or Strategy What They Followed Earlier And Making Changes In It. Among The Subcomponents Of Rac, The Mean Value Of Planning (86.33) Is Less Than The Remaining Subcomponents. The Planning Questionnaire, Mean Value Is Less For The Questionnaire," I Set Specific Goals Before I Begin A Task", " I Ask Myself Questions About The Material Before I Begin". It Indicates That Learners Are Lack Of Goal Setting, Choosing The Appropriate Material.

Mai Components	Number Of Participants	Mean	Standard Deviation
Kac	1145	84.259098	22.27629
Dk	1145	84.41048	20.346691
Pk	1145	82.358079	24.667956
Ck	1145	86.008734	21.456166
Rac	1145	88.06072	38.722514
Pl	1145	86.338116	19.647132
Ims	1145	87.283843	16.668633
Cm	1145	87.298815	16.525868
Ds	1145	92.541485	15.79768
Ev	1145	86.841339	19.650416

Table 2 : Descriptive statistics of MAI sub components

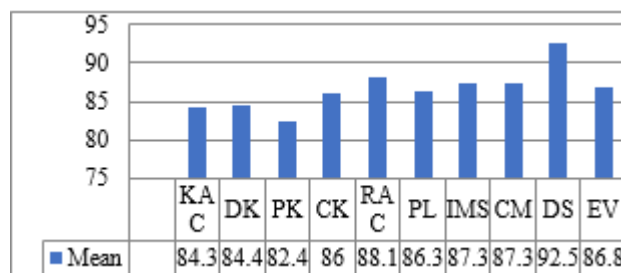


Figure 1: Mean Value Representation Of Mai Subcomponents

III. CORRELATION ANALYSIS OF MAI AND PSYCHOMETRIC ASSESSMENTS

Pearson Correlation Coefficient [13] Statistical Measures Are Used To Determine The Strength Of Relationship/Association Between Two Variables. The Correlation Coefficient Ranges Between -1.00 And 1.00. If The Value Is Negative, The Variables' Relationships Are Negatively Correlated. Otherwise, The Relationship Is Considered To Be Positive. There Is No Correlation Between The Variables If The Value Is Zero. Correlation Between Metacognitive Awareness And Python Programming Marks, Answers For Research Question1 And Question2 Through Correlation. Intra Correlation Analysis Is Performed By Following Pearson, Sperman, Kendall Between Metacognitive Awareness Inventory Components And Multiple Intelligence, Thinking Style, Learning Style, Personality Traits.

A) Intra Correlation Analysis Of Mai Components

As Shown In Table 3:Comparatively Strong Association Is Observed In Between (Dk,Ck) (Dk,Pl),(Dk,Cm)(Dk,Ev) (Pk,Cm)(Pk,Ev)(Ck,Dk)(Ck,Pl)(Ck,Cm)(Ck,Ev)(Pl,Cm)(Pl,Ev)(ImS,Ev)(Cm,Ev)

Correlation Test Among Metacognitive Components(Method=Pearson)								
	Dk	Pk	Ck	Pl	ImS	Cm	Ds	Ev
Dk	1	0.51	0.68	0.67	0.56	0.61	0.29	0.6
Pk	0.51	1	0.54	0.56	0.49	0.64	0.41	0.61
Ck	0.68	0.54	1	0.67	0.5	0.67	0.5	0.64
Pl	0.67	0.56	0.67	1	0.55	0.75	0.51	0.76
ImS	0.56	0.49	0.5	0.55	1	0.54	0.56	0.6
Cm	0.61	0.64	0.67	0.75	0.54	1	0.51	0.62
Ds	0.29	0.41	0.5	0.51	0.56	0.51	1	0.52
Ev	0.6	0.61	0.64	0.76	0.6	0.62	0.52	1

Table 3: Correlation Test among Mai Sub Components

B) Inter Correlation Analysis Of Mai And Multiple Intelligence

As Shown In Table.4 Positive Association Is Observed In Between (Dk,Lin),(Dk,Lo)(Dk,Vi)(Dk,Inter)(Dk,Intra)(Pk,Lo)(Pk,Inter)(Ck,Lo)(Ck,Inter)(Pl,Lo)(Pl,Inter)(Pl,Intra)(ImS,Lo)(ImS,Vi)(ImS,Inter)(Cm,Lin)(Cm,Inter)(Ds,Lo)(Ds,Inter)(Ev,Intra)

	Lin	Lo	Mu	Bo	Vi	Inter	Intra	Na
Dk	0.121	0.336	-0.016	-0.023	0.139	0.207	0.189	-0.005
Pk	-0.003	0.301	-0.018	-0.004	0.012	0.108	0.071	-0.005
Ck	0.029	0.606	-0.013	-0.006	-0.001	0.150	-0.001	0.034
Pl	0.017	0.211	-0.040	-0.005	-0.002	0.206	0.172	0.006
ImS	0.018	0.159	-0.009	-0.037	0.125	0.130	0.020	0.009
Cm	0.129	0.000	-0.036	0.007	-0.001	0.108	0.007	0.007
Ds	0.002	0.125	-0.011	0.016	-0.009	0.231	0.034	0.023
Ev	0.007	0.061	-0.025	-0.039	-0.028	0.002	0.124	0.004

Table 4: Correlation Test Between Mai Subcomponents And Multiple Intelligence

C) Inter Correlation Analysis Of Mai And Learning Style

As Shown In Table.5 Positive Association Is Observed Between (Dk,Ce)(Dk,Ro)(Pk,Ro)(Pk,Ac)(Pl,Ce)(Pl,Ae)(ImS,Ro)(ImS,Ac)(Ds,Ce)(Ds,Ac)(Ds,Ae)

D) Inter Correlation Analysis Of Mai And Thinking Style

As Shown In Table.5 Positive Association Is Observed Between (Dk,B1)(Dk,F1)(Pk,B1)(Ck,B1)(Ck,F1)(Pl,B1)(Pl,Fr)(Pl,F1)(Ims,Fr)

E) Inter Correlation Analysis Of Mai And Personality Traits

As Shown In Table.5 Strong Association Is Observed In Between (Dk,F1)(Dk,F3)(Dk,F5)(Pk,F1)(Pk,F3)(Pk,F5)(Ck,F3)(Ck,F5)(Pl,F1)(Pl,F3)(Pl,F4)(Pl,F5)(Ims,F3)(Ims,F5)(Cm,F3)(Ds,F3)(Ds,F5)

	Learning Styles				Thinking Styles				Personality Traits				
	Ce	Ro	Ac	Ae	B1	Br	Fr	F1	F1	F2	F3	F4	F5
Dk	0.122	0.126	-0.004	0.001	0.239	0.03	0.004	0.318	0.301	0.015	0.471	0.007	0.554
Pk	0.051	0.234	0.252	0.053	0.101	-0.024	0.215	0.207	0.004	0.008	0.28	-0.004	0.349
Ck	0.031	0.039	-0.009	0.024	0.447	0.016	0.017	0.248	0.019	0.028	0.201	0.007	0.241
Pl	0.131	0.03	0.016	0.21	0.225	0.019	0.207	0.145	0.214	0.018	0.429	0.133	0.58
Ims	0.024	0.3	0.206	0.022	0.028	0.015	0.206	0.026	0.008	0.042	0.302	-0.004	0.248
Cm	0.018	0.042	0.029	0.024	-0.022	0.019	-0.001	0.03	0.004	0.027	0.033	-0.001	-0.018
Ds	0.226	0.01	0.204	0.218	0.013	-0.022	0.006	0.013	0.009	0.035	0.116	0.003	0.114
Ev	0.044	0.018	0.011	0.006	-0.031	0.007	0	0.04	-0.006	0.039	0.025	-0.028	-0.002

Table 5: Correlation Test Between Mai Subcomponents With Learning Style, Thinking Style And Personality Traits

IV. ANALYSIS BETWEEN METACOGNITIVE ASSESSMENTS AND PROGRAMMING

To Perform Metacognition Awareness Among Learners, 52 Questionnaires Related To Metacognition Is Chosen And Along With Academic Progress In Python Programming. The Course Outcomes Of Python Programming Subject Pursuing By The Students In First Year Second Semester Are As Shown In Table.6:

1	Develop Python Programs With Conditionals And Loops
2	Create A Python Data Structure Using Lists, Tuples, And Dictionaries
3	Define Python Functions And Call Them
4	Perform Exception Handling Programs To Resolve Run-Time Errors
5	Implement File Handling Concepts In Python

Table 6: Course Outcomes Of Python Programming

Solo Category	Evaluation Criteria In Programming
Prestructural	Irrelevant Or Very Slightly Relevant Answer To The Question. No Proper Knowledge In Terms Of Programming Structures.
Unistructural	Partial Code Is Relevant To The Question.
Multistructural	Most Of The Code Is Relevant But Minor Mistakes Identified
Relational	Purpose And Function Of The Program Code Is Reached. Good Understanding Of Applying Relevant Programming Concepts To The Problem
Extended Abstract	Reached The Level Of Learning And Applying The Programing Skills For The New Problems Or Technology

Table 7: Solo Taxonomy Adopted For Programming Course

Python Programming[14] Assessment Is Conducted On Features Of Python, Execution Of Python, Data Types In Python, Variables, Operators, Control Statements, Arrays Using Numpy, Functions, Exceptions In Python. An Assessment Is Conducted For 40 Marks Followed By Classifying The Student Level Of Understanding Solo Taxonomy As Shown In Table.7. Table.8 Shows The Correlation Between Mai Components And Python Programming

	Dk	Pk	Ck	Pl	Ims	Cm	Ds	Ev
Python Programming Marks	0.205	-0.022	-0.012	0.334	0.314	-0.028	0.301	0.370

Table 8: Correlation Test between Mai Subcomponents And Python Programming

V. METACOGNITION MODELLING

Teaching Students To Use Metacognition To Understand How They Are Thinking About Their Programming Course Provides An Important Step On The Path To Thinking And Learning. Metacognition Model Include Preassessment, Teaching, Activity, Identifying Misconceptions, Post Assessment And Retrospection. Pre-Assessment Phase Helps The

Students To Question Themselves And Understand About, “What Does Him/Her Already Aware About This Topic That Could Guide Him/Her For Further Learning?” Self-Questionnaire To Promote Student Metacognition Is Shown In Table.9,10 And How To Integrate Metacognition In Pedagogy While Delivering The Course Is Shown In Figure.2.



Figure 2: Metacognitive Modeling

	Classroom Teaching	Activity Time	Case Studies/Assessment/Assignment
Planning	How To Prepare For The Classroom Teaching Session? Where I Have To Sit In The Class To Maximize My Learning? What Are The Confusions I Have In Prerequisites? What Subtopics Of Today’s Session That I Want To Focus Out More About?	What Is The Teaching Faculty Instructed Me To Perform? How Can I Complete It Successfully? What Materials Will I Require To Complete The Task? How Long Does It Take To Complete The Task? How Could I Do My Task Better, If Once I Have Done Before?	How Long Does The Task Take To Complete? How Could I Do My Job Better If I’ve Already Done It? What Research Methods Will I Use? How Much Time Should I Allot To Studying?
Monitoring	What Questions Are Being Raised During The Class? Am I Taking Notes In A Book? Is This Something I’m Interested In? What Is Your Reasoning? How Can I Make This Information More Relevant? Can I Tell The Difference Between Important Information And Minor Details? If Not, How Could I Possibly Do It?	What Learning Strategies Are Effective? What Additional Resources Were Needed To Complete This Task? Which Aspect Of This Task Is The Most Difficult For Me? The Most Perplexing?	Am I Studying All Of The Exam Material In A Systematic Manner? Is It Possible That I Am Lacking Motivation To Study? If So, Do I Recall Why I’m Taking This Class? Which Misunderstandings Have I Dispelled? How Did I Manage To Clarify Them? Which Misunderstandings Necessitated Hands-On Practice To Clarify?
Evaluation	How Could I Connect The Topics Of Today’s Class Session To Previous Class Learning? What Did I Find Most Intriguing About Today’s Class?	Did I Successfully Accomplish The Goals Of The Task? Did I Use Resources Available To Me? If I Were The Teaching Faculty Of This Course, What Would I Identify As Strengths Of My Work And Flaws In My Work?	What Aspects Of My Exam Preparation Went Well That I Should Remember For The Next Time? What Didn’t Work So Well That I Shouldn’t Do Again Or Should Change? What Questions Did I Not Correctly Answer? Why? How Did My Response Compare To The Suggested Correct Response? What Questions Did I Not Correctly Answer? Why? What Ambiguities Do I Still Need To Clear Up?

Table 9: Self-Questionnaire To Promote Metacognition In Learning During Classroom

Discussion	Activity/Assignments	Assessments
What Is Your Interpretation Of The Question? What Was Your Main Reason For Selecting This Answer? How Did Your Ideas Stack Up Against Those Of Your Peers? What Was The Most Perplexing Aspect Of This Question For You? How Certain Are You Of Your Response? Why? What Else Would You Need To Know To Boost Your Self-Esteem?	Ask Three Questions About The Concepts You Noticed In Your Task. List Two Ideas From This Assignment That You Found Perplexing. "I Did A Lot Of Research While Working On This Task." To What Extent Do You Concur? Disagree? What Was The Procedure You Used To Respond To It? What Advice Would You Give Yourself If You Were Starting This Task Again?	How Do You Intend To Study For The Upcoming Exam? Why? What Resources Are There To Help You? Why Do You Make It A Point To Use These? How Does Your Exam Preparation Strategy Compare To At Least Three Other Students In Your Lab Section? What Concepts Have You Found The Most Difficult To Grasp Thus Far? What Ideas Have Stood Out The Most? Given This, How Should You Devote Your Study Time To Studying For The Exam? Prepare A Letter To Yourself With Advice On How To Prepare For The Next Exam Based On Your Performance On The First Exam.

Table 10: Questionnaire To Promote Metacognition

VI. MULTIPLE CRITERIA DECISION MAKING ALGORITHM: TOPSIS

Technique For Order Performance By Similarity To Ideal Solution (Topsis)[15], Helps In Prioritizing Multi-Criteria And Multi-Attribute. A Decision-Making Method Based On The Idea That The Chosen Alternative Should Have The Shortest Geometric Distance To The Positive Ideal Solution (Pis) And The Longest Geometric Distance From The Negative Ideal Solution (Nis).In This Paper, Total 29 Attributes ,Taken From 1145 Students .The Following Are The Sequence Of Steps To Be Followed For Topsis Method. The Evaluated Hierarchical Scores Of Attributes Are Shown In Table.11.A Sample

Data About Priority And Rankings Of Students Are As Show In Table.12.Solving Mcdm Problem Using Topsis Method Is As Follows:

1. Calculate Normalized Matrix

$$\bar{X}_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^n X_{ij}^2}}$$

2. Calculate Weighted Normalized Matrix

$$V_{ij} = \bar{X}_{ij} \times W_j$$

3. Determine The Ideal Best And Ideal Worst Value

4. Calculate The Euclidean Distance From The Ideal Best

$$S_i^+ = \left[\sum_{j=1}^m (V_{ij} - V_j^+)^2 \right]^{0.5}$$

5. Calculate The Euclidean Distance From The Ideal Worst

$$S_i^- = \left[\sum_{j=1}^m (V_{ij} - V_j^-)^2 \right]^{0.5}$$

6. Calculate Performance Score

$$P_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Attributes	Priority	Rank	Attributes	Priority	Rank	Attributes	Priority	Rank	Attributes	Priority	Rank
Fl	10.03%	1	Ims	5.83%	8	Vi	3.13%	15	Br	0.90%	22
Lo	6.13%	2	Ev	5.82%	9	Ro	3.09%	16	F5	0.84%	23
Pk	6.03%	3	Ds	5.52%	10	Ac	2.60%	17	F1	0.73%	24
Dk	5.97%	4	F3	4.55%	11	Lin	2.41%	18	Mu	0.67%	25
Pl	5.85%	5	Intra	4.33%	12	Ce	1.71%	19	F4	0.61%	26
Ck	5.85%	6	Inter	4.22%	13	Fr	1.58%	20	Bo	0.53%	27
Cm	5.83%	7	Ae	3.45%	14	F2	1.19%	21	Na	0.44%	28
									B1	0.09%	29

Table 11: The Hierarchical Scores Of Attributes:

Student Id	Priority	Rank	Student Id	Priority	Rank
S162	0.503231	1	Lower Rank
S36	0.503118	2	S647	0.455326	1140
S325	0.501242	3	S1046	0.454915	1141
S778	0.500706	4	S188	0.449987	1142
S655	0.500263	5	S237	0.449578	1143
S123	0.499308	6	S133	0.443841	1144
S163	0.498991	7	S530	0.438756	1145

Table 12: Priority And Rank Order Of Students

VII. METACOGNITIVE AIDED TPACK FRAMEWORK

As Shown In Figure.3, Metacognition Aided Technological Pedagogical Content Knowledge (Tpack) Is A New Framework For Integration Of Technology With Pedagogy And Course Content By Understanding The Levels Of Student Metacognition. Teaching The Programming Course By Integrating Metacognition As Part Of Curriculum Results Positive Development In Student Thought Process.

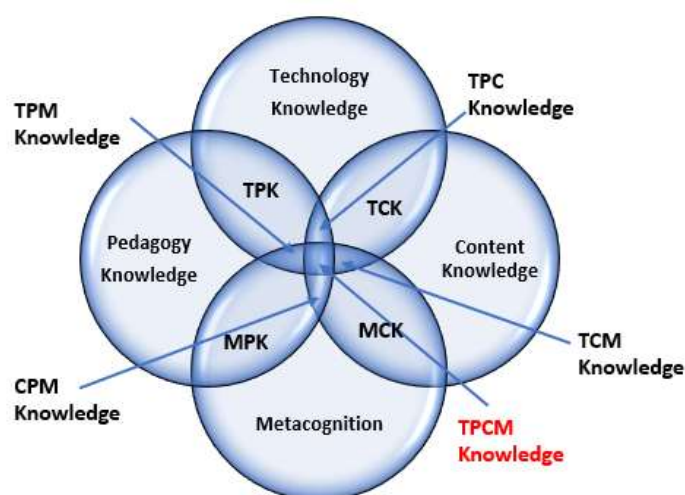


Figure 3: Metacognition Aided Tpack Framework (M-Tpack)

Tpcm: Technological Pedagogical Content Knowledge Aided With Metacognition

Tpk: Technological Pedagogical Knowledge

Tck: Technological Content Knowledge

Tcm: Technological Content With Metacognition Knowledge

Mck: Metacognition Based Content Knowledge

Cpm: Content Pedagogical Metacognitive Knowledge

Mpk: Metacognitive Pedagogical Knowledge

Tpm: Technological Pedagogical Metacognitive Knowledge

Tpc: Technological Pedagogical Content Knowledge

VIII. CONCLUSION

The Metacognitive Awareness Inventory (Mai) Was Used By 1145 First-Year Engineering Students In This Study To See How It Correlated With Their Performance In A Python Programming Course. The Results Of The Correlation Tests Revealed That Of The Declarative, Procedural, And Conditional Knowledge Subcomponents Of Knowledge About Cognition, There Is A Significant Association With Declarative Knowledge (0.205) In The Students' Positive Performance In Python Programming. The Findings Also Revealed A Positive Relationship Between Learning Python Programming Performance And Planning (0.334), Information Management System (0.314), Debugging Strategies (0.301), And Evaluation (0.37). This Analysis Shows That Learners Are Capable To Use Critical Thinking And Intellectual Resources. Learners Easily Obtain Knowledge Through Presentations, Demonstration, And Problem Solving. Since Components Of Mai, Is Positively Correlated With Prime Two Intelligences Such As Logical Intelligence And Interpersonal. It Inferences That Students Pursuing Computer Programming, Engineering, Mathematics Courses Get Befitted By Including Metacognition In Teaching And Learning Pedagogy. Results Have Also Shown That Components Of Knowledge Of Cognition Are Positively Correlated With Frontal Left And Basal Left Lobes Of The Brain. It Inferences That Including Metacognitive In Curriculum Teaching Helps To Develop Good Analytical Skills And Critical Analysis Among Students. It Helps To Do Excellence In Engineering And Programming Courses. The Descriptive Statistics For The Metacognitive Awareness Inventory Subcomponents Are Also Discussed In This Paper. This Study Strongly Suggests Incorporating Metacognition Into Classroom Sessions, Activities, And Assessment. It Assists Students In Better Understanding, Comparing, And Analyzing The Technical And Programming Concepts. The Hierarchical Scores Of Attributes And Ranking Scores Of Students' Inferences That Students With Low Ranking Are The Best Performers In Programming Courses, Whereas High Ranking Students Are The Slow Learners Of Programming Course. This Study Helps Students In Taking Admission Engineering Courses, Academicians Teaching Programming, Identifying The Students For Placements Proportionate To The Requirement. To Improve The Programming Skills Among All The Students, Adaptive Tutoring System Is Being Proposed Using Metacognition Aided Tpack (M-Tpack) Framework For Learning Programming.

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