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Exploring the Relationship between Academic Performances and Brain Dominances

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Abstract

Background/Objectives: This research study has been conducted in a scientific way to help the learners to find out their natural strengths and weakness. In spite, Thinking Style Assessment (TSA) was administered among 552 third year undergraduate engineering students. Methods/Statistical Analysis: Consequently this study also intended to identify the relationship between brain dominance's and academic results. Both academic performance analysis and brain dominance analysis have been done using rule based classification methods. Results/Findings: The outcome demographic analysis of the research appears to have both positive and morsel of inverse tendencies. Conclusion/Application: This research is to offer an inclusive model hypothetically both for an instructional activity and learning activity. Brain dominance analysis is an avenue to customize learning software's for self-paced learning activities too.

Keywords: Data Processing, Learning Management System (LMS), Theories Educational Research, Thinking Style Assessment (TSA), Rule Based Classification

1. Introduction

In the past decades several studies have been carried out on the cognitive functioning of brain. They all indicate that people vary significantly in their styles of thinking and learning. Identifying the thinking styles as an individual-difference variable has grabbed the attention of many educational researchers. There are three common terms are used in the role of interplay namely, cognitive styles, thinking styles and learning styles. The reason behind the successful personality in individual lies in alignment with their natural ability or intelligence towards an external event or activity[1]. Administering the TSA among undergraduate engineering students raised a level of self-awareness among learners[2].

Contact between cognitive and neuroscience is important for the better understanding of the cognitive functions of the human brain. Research studies indicates that brains' evolutionary model consists of three layered structure: (a) R-layer; containing the cerebellum and brainstem which are important in all spheres of human survival (b) limbic system; consisting of amygdala, hippocampus and hypothalamus that are responsible for emotions, behaviors and memory (c) neo-cortex; consisting of the two hemispheres of brain having four lobes; Occipital, Temporal, Frontal and Parietal, those are responsible for processing sensory information, psychomotor skills, logical thinking, decision making, planning, imagination, consciousness and language learning etc., Through the corpuscallosum all three layers are interconnected and dependent for survival[3]. One of the latest ongoing researches has reaffirmed the link between cognitive thinking and neurosciences named Benziger Thinking Style Assessment (BTSA). This psychological instrument was developed by Dr. Katherine Benziger based on Dr. Carl Gustav Jung's typology[4]. Table

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1 enlists the key functions and actions of four quadrants of brain namely Basal Left (BL), Basal Right (BR), Frontal Left (FL) and Frontal Right (FR). BTSA is a tool to understand the diverse thinking preferences of the 21st century students, to help them gear up their aspirations to learn and succeed in their lives.

Figure 1 shows the inter-alia conceptual model of learning behavior and the brain structure. The underpinning need of this figure states that, when an individuals' learning environment and their internal brain mechanism if it does not match; then that leads to a state of disequilibrium. This state of disequilibrium becomes the root cause for Prolonged Adaptation Stress Syndrome (PASS)[5] and Attention Deficit Hyperactivity Disorder (ADHD)[6].

Research reveals that the top factors that impede female students in academic achievements are due to fear of failure and lack of self-confidence[7]. The Study of Italian Universities states that for so many years engineering courses have been considered most difficult course among student community. Moreover, large numbers of students have decided to leave their courses before the completion of their final year. In order to overcome these problems, individualized adaptive system has been recommended[8]. Many researchers on academic studies accentuate on the context of understanding the characteristics of the learner in order to maximize their learning skills. Thinking style assessment model can be used to measure the individual's preferences in a way of thinking.

The prime objectives of this study are: (a) Identifying the brain dominances of the learner's (b) Classifying the learners based on their academic grade results (c) Exploring the relationship between brain dominances and academic grades (d) Hypothetically, proposing the set of learning and pedagogical activities.

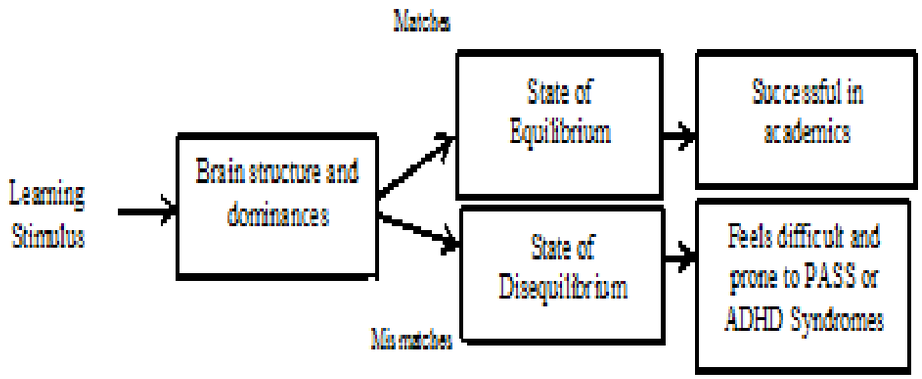

Figure 1. Concept map depiction of learning.

Table 1. Features and categories of brain dominances

Brain Dominance	Features
Basel Left (BL)	Stable foundations and routine, Seeks order, processes, procedures, systems, Sensing is dominant, realistic, grounded, practical
Basel Right (BR)	Peaceful, Seeks feelings, harmony, spirituality, emotional, subjective, takes things personally, closeness with people
Frontal Right (FR)	Adaption and internal imaging, Seeks meaning, expresses through images and metaphors, Intuition is dominant, uses hunches and speculations, Expressiveness
Frontal Left (FL)	Direction and decision-making, seeks clarity, criteria, standards, objective measures, benchmarks, thinking is dominant, analytical, logical, objective, critical

2. Materials and Methods

2.1 Survey Sample

The targeted sample of this study has been drawn from different streams of engineering education chiefly from third years. Non-probability sampling type and convenience sampling method was adopted during the survey.

2.2 Questionnaire Design

There are two types of cohort panel study has been conducted within a span of six months. Retrospective study is to learn the historical background of the educational psychology. The prospective study is to identify the possible inventories to be utilized in the research. Benziger Thinking Style inventory have been administered for brain dominance identification having 80 items with binary answer type. To empower the participant's responses questionnaire layout has been provided in bilingual along with an instructional page and navigational path.

2.3 Conduction of Survey

Sample size of 66 has been considered for the initial phase of cross sectional pilot survey. Consequently, Computer-assisted survey method was adopted using open source educational software named MOODLE. Design of digital questionnaire has been done using 'Notepad' text editor. To upload the questionnaire into LMS 'GIFT' file format has been used. In order to collate the data, additional efforts were taken in developing the software using JDK 1.1 - HSSF, Apache POI Packages and Net Beans 7.4 Integrated Development Environment.

2.4 Survey Errors and Remedies

Survey has been carried out with sufficient amount of explanations to the targeted audiences. Even then unavoidable errors were induced in the responses due to random sampling nature and the cognitive biases of respondents.

2.5 Academic Data Sources

Student's academic information and the participatory report of TSA were pulled out from LMS in order to collate and derive the inferences. Student's academic information consists of two different components: The first component is the kind of formative assessments in which set of objective type questions were adopted. There are about 45 sessions were planned for each courses. Whereas, the second component is a kind of summative assessments in which the kind of subjective type questions were adopted. There are four tests were planned for each of the courses. The number of participants and their course details were shown in Table 2.

Table 2. Demographic representation of academic data sources

Department	Number of Students (N)	Number of Courses (C)	Total Number of Formative Assessment (F)	Total Number of Summative Assessment (S)
Computer Science and Engineering	120	6	270	24
Electronics and Communication Engineering	120	6	270	24
Electrical and Electronics Engineering	120	6	270	24
Mechanical Engineering	192	6	270	24

2.6 Formulation of Hypothesis and Statistical Measures

Hypothesis: Brain dominance strongly influence the academic performances that, higher the brain dominance higher the grades.

3. Design of Algorithm

3.1 Survey Sample

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{Notations: μ1, μ2, μ2, μ4 represents number of 'Yes 'instances in each of the quadrant namely BL, BR, FR, FL

Assumption: Score value 15 and above represents the better brain dominance.

WBD: Whole Brain Dominance has strong in all the four quadrants of brain

TBD: Triple Brain Dominance has strong in any of three quadrants. For instance, T1: (BL, BR and FR), T2: (BR, FR and FL), T3: (FR, FL and BL)

DBD: Double Brain Dominance has strong in any of two quadrants. For instance DB: Double Basal (BL and BR), **DF:** Double Frontal (FR and FL), DR: Double Right (BR and FR), DL: Double Left (BL and FL)

PBD: Poor Brain Dominance is identified with the score value less than 15 in all the quadrants

FBD: Diagonally opposite quadrants would not be dominance that is a pair (BR, FL) and (BL, FR)

Single Brain Dominance (SBD)

BL: If (μ1>μ2,,μ3,μ4and μ1 > 15); BR: If (μ2>μ1,,μ3,μ4and μ2 > 15); **FR:** If (μ3>μ1,,μ2,μ4and μ3 > 15); **FL:** If (μ4>μ1,,μ2,μ3and μ4 > 15)

Double Brain Dominance (DBD)

DB: If ((μ1,μ2)>μ3,μ4and (μ1, μ2) >15); **DR:** If ((μ2,μ3)>μ1,μ4 and (μ2, μ3) > 15); DF: If ((μ3,,μ4)>μ1,μ2and (μ3, ,μ4) > 15); **DL:** If ((μ1, μ4)>μ2, μ3and (μ1, μ4) > 15)

Triple Brain Dominance (TBD)

T1: If(μ1,μ2,μ3)> 15; **T2:** If(μ2,,μ3,μ4)>15; **T3:** If(μ3,,μ4,μ1)>15

Whole Brain Dominance (WBD)

WBD: If (μ1and μ2and,μ3 and μ4) > 15

Poor Brain Dominance (PDB)

PBD: If (μ1 and μ2and,μ3 and μ4) < 15

Falsified Brain Dominance (FBD)

FBD: If ((μ1 and μ3) or (μ2and μ4) > 15

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[1]http://ekluvya.adithyatech.edu.in

3.2 Academic Learning (AL)

In the regular academic schedule, learners have the assessments namely formative and summative. Students were exercised to participate into an objective type questions at the end of every learning session. The outcome score of these assessments were named as Formative Assessment Quiz Marks (FAQM). Students were exercised to participate into a subjective type questions in four periodic. The outcome score of these assessments were named as Summative Assessment (IA). Since both of these assessments FAQM and IA are in different scales hence, it is mandatory to normalize to the scale value 10. The normalized variables are NFAQM and NIA. Minimum score of 5 is required to pass in both of these assessments.

3.3 Calculating NFAQM

There are 45 sessions have been planned for all the courses. For each session instructors were given freedom to set any number of objective type questions. In order to normalize the different scales across formative assessments the following algorithm has been developed.

Initialize $NFAQMc_{ij} = 0$;
Repeat for c = 1 to 6
Repeat for i =1 to N
Repeat for j = 1 to 45
Obtained $Scorec_{ij} = Sum(Quiz^{c}_{ij})$
NFAQMcij = (Obtained Scorecij / Total Score) * 10
Where, c represents the course index;
i represents the student index;
j represents the session index;
k represents the quiz index;
N represents the number of student;
M represents the number of quizzes;

3.4 Calculating NIA for each student

The following algorithm has been developed to normalize the score value of summative assessments.

Initialize $IA^{c}_{ij} = 0$;
Repeat for c = 1 to 6
Repeat for i =1 to N
Repeat for j = 1 to 4
Obtained $Score^{c}_{jk} = Sum\ (IA^{c}_{jk})$
Where, c represents the course index
i represents the student index;
j represents the IA index;

NIA^c_{ij} = (Obtained Score of IA^c_{ij}/Total Score) * 10

3.5 Statistical Average for NFAQM (ANFAQM) for each course

Initialize $ANFAQM^c_{ik} = 0$
Repeat for j =1 to 6
Repeat for i =1 to N
Repeat for k =1 to 45
$ANFAQM^c_{ik}$ = Sum ($NFAQM^c_{ik}$)/45;
Where, i represent the student index;
j represents the course index;
k represents the session index;

3.6 Statistical Average for NIA (ANIA) for each course

Initialize AIA = 0
Repeat for c =1 to 6
Repeat for i =1 to N
Repeat for k =1 to 4
$ANIAc_{ik}$ = Sum ($NIAc_{jk}$)/4;
Where, c represents the course index;
i represents the student index;
k represents the IA index;
j represents the AL index values continues from 1 to 6;

Once ANFAQM and ANIA are determined for each course AL representation is denoted by two dimensional data κ^c_{ij} ($ANFAQMc_{ij}$, $ANIAc_{ij}$).

3.7 Algorithm: Academic Grade Analysis

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Excellent (E): If (κ^c_{ij} Score point is between the range 8-10)
Good (G): If (κ^c_{ij} Score point is between the range 7-8)
Average (A): If (κ^c_{ij} Score point is between the range 6-7)
Below Average (B): If (κ^c_{ij} Score point is between the range 5-6)
Poor (P): If (κ^c_{ij} Score point is between less than 5)
}

3.8 Algorithm: Rule Based Classification

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Input: Data set having three attributes such as Name of the student, Label of brain dominance, and Grades
Output: Count Matrix having the instances of 6(Grades) versus 6(BD)
Method:
For each label of the class 'Grades' do
For each label of the class 'Brain Dominances' do
Repeat
Rule = If (Grades[i] and Brain Dominances [j])
Count_Matrix[i][j]=Count_Matrix[i][j] + 1;
End For
End For
Return Count_Matrix;
} End of Algorithm

4. Discussion

4.1 Analysis of Brain Dominances

Statistical counts of single brain dominance are shown in Table 3. The other brain dominances, SBD tweaks with the count of (145), likewise DBD (DB, DF, DR, DL) with (110), TBD (T1, T2, T3) with (110), WBD with (82), Falsified type FBD with (13), and PBD with (92) respectively.

Table 3. Instances of single brain dominance

BD	BL	BR	FR	FL
Count	164	283	49	56
%	29.7	51.3	8.9	10.1

4.2 Analysis of Academic Performances

Statistical counts of academic grades are as follows: Grade 'Excellent' tweaks with (71), likewise 'Good' tweaks with (136), 'Average' tweaks with (182), 'Below-average' tweaks with (121) and 'Poor' tweaks with (42) respectively.

4.3 Hypothesis Verification

Table 4 shows that the strong association between brain dominances and the academic grades as follows: (a) SBD possess highest percentage towards academic grade 'Average' (b) likewise DBD with 'Average' (c) TBD with 'Good' (d) WBD with 'Excellent' (e) FBD with 'Below Average' and 'Poor' finally, (f) PBD with 'Below Average'. The significance of this inference criti-

Table 4. Features and categories of brain dominances

BD / Grade	Excellent (%)	Good (%)	Average (%)	Below Average (%)	Poor (%)
SBD	0.0	27.6	35.2	33.8	3.4
DBD	7.3	28.2	50.9	8.2	5.5
TBD	20.0	42.7	17.3	10.0	10.0
WBD	50.0	20.7	26.8	2.4	0.0
FBD	0.0	0.0	23.1	38.5	38.5
PBD	0.0	1.1	33.7	48.9	16.3

cally shows that brain dominances highly influence the learning outcome. More the brain dominances better the academic records. Hence the formulated hypothesis has been accepted.

However, 18% of inverse tendencies appeared among brain dominances and academic grades. This might have arisen due to the behavioral and cognitive biases of the respective participants. Cognitive biases are important for this study because individual's perception and judgments are highly involved during the psychological assessments. The factors influence the biases are: (a) information-processing shortcuts (b) mental noise (c) mind's limited information processing (d) emotional and moral motivations and (e) social influence[9]. Cognitive biases influence some adverse effect during the psychological assessments which are, (a) Bandwagon effect-the tendency to do things because many other people do the same[10], (b) Choice-supportive bias–the tendency to remember one's choices as better than they actually were[11], (c) Conformation bias–the tendency to interpret information in a way of their own perception, (d) Egocentric bias–occurs when people claim more responsibility for themselves (e) Halo effect–the tendency to project themselves in others' perception (f) Herd instinct–a common tendency to adopt the opinions of the majority (g) Notational bias–a form of cultural bias (h) Consistency bias–the effect of unconscious assumptions (i) Cryptomnesia–memory is mistaken for imagination (j) Confabulation–remembering something that never actually happened and (k) Attentional bias–negligence of relevant data when making judgments[12].

5. Suggestions for an Inclusive Model

5.1 Impact of TPACK

Technology, Pedagogy and Content Knowledge (TPACK) model is one of the most influential conceptual frameworks of 21st century in facilitating the delivery of knowledge, skills, and dispositions. Numerous research outcomes made available to describe the use of TPACK framework, to design, develop, and deliver courses adaptively[13]. Several burgeoning area of research explores the cross fertilization of TPACK with the study of Arts, Social Sciences, Mathematics, Science, engineering, Technology and Literary Education. In the behavior of knowledge transfer and knowledge acquisition TPACK is the framework conceived and enacted for teachers, whereas, TLACK is the framework which is conceived and enacted for students learning activities[14]. Different directions to incorporate TPACK model and its logistics, collaboration and diffusion of an innovation in adults learning were discussed in[15]. Distinct learning activities of TPACK model in the behavior of knowledge building and knowledge expression. There are about 17 knowledge building activities; six convergent and 21 divergent learning activities in the behavior of knowledge-expressions have been discussed in[16]. TPACK framework model have been adopted

in a Singaporean primary school pre-service teacher's in a 12-week training module. Impacts of the training were discussed in[17].

5.2 Impact of Student-Centered Education System

Twelve different roles of teachers in terms of contextualizing the activities across different programmers and professional requirements have been discussed in[18]. A computer-assisted framework for an adaptive learning system has been discussed using theories of learning styles and multiple intelligences. In order to improve and overcome the factors of human interventions, an automatic detection and correction method was adopted. Particle Swarm Optimization (PSO) algorithm is used in the assortment of dynamic learning objects in order to afford the learning substances[19].

5.3 Impact of Educational Theories

Sensory Simulation Theory emphasize that, the stimulation through the senses are achieved through a greater variety of colors, volume levels, strong statements using digital technologies. Reinforcement Learning Theory emphasizes to create positive environment to repeat the desired behavior of the learner. Cognitive-Gestalt approach emphasizes to know the need and concerns of an individual at different times. Holistic Learning Theory emphasizes to have the intellect, emotions, the body impulse, intuition and imagination of learner that all require for activation[20]. Facilitation Theory emphasizes the basic premise that learning happens better when the educator acts as a facilitator[21].

5.4 Proposal of Hypothetical Model

To seize the learner's attention, hypothetically suggested instructional strategies, e-learning activities and classroom activities have been listed in Table 5.

6. Conclusion

This paper shows the adaptation of TSA and its impact with academic performances. The preliminary results of this study indicate that, increase in the brain dominance leads to better academic grades. Further, work is in progress to propose the hypothetical model based on brain dominances. Other outcome findings of this research study are (a) thinking styles are influenced by individual characteristics and learning environment (b) Students achieve better results if their thinking style matches with

Table 5. Inclusive model suitable to the brain dominances

Brain Dominance	Instructional Strategies	Classroom Activities	e-Learning Activities
Basel Left (BL)	Punctuated lectures, The Half class Lecture	Choral Response, Polar Opposite, Learning Reflection, Memory Matrix	Concept Map, Haiku, Bookmark Notes, Chart Activity
Basel Right (BR)	High interpersonal rapport is required	Instructor storytelling, Read Aloud, Group work evaluation, Online chat	Audio/Video Learning, Collaborative Discussion through Blogs and Forms
Frontal Right (FR)	Flipped Classroom[22]	Picture Prompt, Muddiest point of discussion, Brain storm, Role Playing, Fishbowl Discussions	Personal Journal Preparation, Industrial Visit, Pro and con grid
Frontal Left (FL)	Flipped Classroom	Think Break, Tournament, Simulation	Puzzle/Problem solving, Case-study

their learning strategy (c) Thinking styles are influenced by cultural settings and (d) In addition to thinking style, medium of instruction in their school background also plays a crucial role in academic achievements. To avoid the adverse inferences of the results, survey may be conducted with a smaller sample size. The view of cognitive anthropology indicates that human thinking and intelligence are influenced by their cultural settings. Hence the research inferences may vary for different ethnographic sectors.

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