International Journal of Mathematics and Statistics Studies
Vol.3, No.3, pp.1-15, .May 2015
Published by7 European Centre for Research Training and Development UK (www.eajournals.org)

STATISTICAL ANALYSIS OF THE LEARNING STYLES OF ACCOUNTING, STATISTICS AND ENGINEERING STUDENTS AND ITS IMPLICATION TO TEACHING IN THE HIGHER INSTITUTION

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ABSTRACT: *Tertiary Students' studying statistics usually process statistical information in different ways depending on their programme of study. Teaching methodologies for transmitting statistical information to students also vary considerably depending on the type of programme being taught, a trade-off between the two must be sought for, it is therefore necessary to determine what is most likely to trigger each student's concentration, and how to maintain it. The study examined the distribution of learning styles of accounting, statistics and engineering students among the four learning styles and its implication to teaching in higher institutions. Data for the study was collected using Solomon and Felder's ILS questionnaire. Purposive sampling technique was used to select the respondents; the responses from each person's questionnaire were entered into Felder's self-scoring web based instrument. The output was further analyzed via SPSS version 17. The results showed that there were remarkable differences in the distribution of the programme of study to the learning styles. Majority of the students belonged to the active, visual, sensing and sequential learners. There was sufficient evidence to believe that differences existed among the active-reflective learners and program of study. The multiple comparisons method gave pair-wise significance among the active-reflective group of learners. The pair business and statistics was pair-wise significant ($P = 0.016 < 0.05$), the pair Business and Engineering learners was not significant ($p = 0.197 > 0.05$) finally, the pair Engineering-Statistics Learners was highly significant ($p = 0.004 < 0.05$). For statistics to have practical relevance and provide the various categories of students with the opportunity to understand how the concepts can be applied in the world of work. It is highly recommended to lecturers to conduct need assessments to find the learning styles of their students and structure their teaching methods to satisfy the needs of the students.*

KEYWORDS: *learning styles, teaching methods, higher education, statistics*

INTRODUCTION

Learning styles by definition is the way in which each learner begins to concentrate on process, absorb and retain new and difficult information (Dunn and Dunn 1992, 1993, 1999). The authors indicate that the interaction of these elements occur differently in everyone, and it was therefore necessary to determine what was most likely to trigger each students concentration, how to maintain it and how to respond to his or her natural processing style to produce long term memory and retention, Accordingly, it was important to use a

ISSN 2053-2229 (Print), ISSN 2053-2210 (Online)

comprehensive model of learning styles that identifies each individuals strengths and preferences across the full spectrum of physiological, sociological, psychological, emotional and environmental elements(cited in Pashler et al, 2008). Proponents of learning styles assessment contend that optimal instruction requires diagnosing individuals learning styles and tailoring instructions accordingly (Pashler et al, 2008).

The learning style hypothesis contends that learning will not be effective if learners receive instructions that do not take into consideration their learning styles. This learning style hypothesis is what has come to be know as meshing hypothesis, the claim that presentation styles should mesh with learners own style of learning. Rowntree (1992) as cited in McLoughlin (1999) argues persuasively that developers need to take into account the research on learning styles and design materials for flexible, diversity and balance. Richardson (1994) as contained in McLoughlin (1999) also posits that higher education requires students to comprehend and not merely to reproduce ideas and acknowledges that different approaches to learning enables authentic tasks to be created which should be responsive to learners needs. An empirical research was conducted by the Canfield Learning Styles Inventory (which aims at educating instructors to present instructions in a clear, logical and organised manner) to identify the teaching styles of business instructors and the learning styles of their students, the research aimed at finding whether there was a match between the students learning styles and instructors teaching styles and to determine if there exists a relationship between style match and student success as indicated by the course grades and final exams score. It also aimed at finding out if there was a relationship between style match and students evaluation of instructors. The study revealed that 36% of the students preferred learning styles matched with instructors teaching methods, the study concluded that students preferred organized and meaningful course work that requires hands-on or performance situations, additionally, they liked interactions with the instructor and classmates involving activities closely related to real world experiences (Tucker, 1998).

The four Models of Learning Styles by Felder- Solomon

A number of learning style models have been developed, some popular learning style models include Dunn and Dunn learning style model(Dunn, 1990), Kolb's learning style model(1984,1985) and Felder-Silverman model (1988).Felder and Silverman reviewed the earlier models and developed a model that has come to be an accepted model for science education. In the current review of the Felder and Silverman's model (2002) they came out with four dimensions of learning styles namely; Sensing -Intuitive learners, Visual-Verbal Learners, Active-Reflective learners and Sequential - Global learners. The unique characteristics of each dimension are explained below:

Sensing and Intuitive learners

According to Felder and Silverman (1988) sensing involves observing and gathering data through the senses (concrete, practical, oriented towards procedures); while intuition involves

ISSN 2053-2229 (Print), ISSN 2053-2210 (Online)

indirect perception by way of the unconscious-speculation and imagination (conceptual, innovative, oriented towards theories and underlying meanings). To them everyone uses both faculties, but most people tend to favor one over the other. Sensors like facts and are good at memorizing them, they also like data, and experimentation; intuitive learners prefer principles and theories. Again, sensors like solving problems using standard methods while intuitors like innovation, and appreciate new concepts but dislike repetitions. Moreover, sensors are patient with details but do not like complications; while on the other hand intuitors are bored with details and welcome complications. The authors noted that these characteristics are tendencies of the two types, not behavior patterns.

Visual and Verbal learners

Visual learners remember best what they see: pictures, diagrams, flowcharts, time lines, films, demonstrations and so on. If they are told something they will probably forget it. On the other hand Verbal learners remember much of what they hear and more of what they hear and then say. They prefer verbal explanations to visual demonstrations and learn effectively by explaining things to others. Most people of higher education age and older are visual learners while most teaching in higher education is verbal-the information presented is predominantly through lecturing or visual representation of verbal information like mathematical symbols (Felder and Silverman, 1988).

Active and Reflective learners

The processes by which information is converted into knowledge can be categorized into two; Active experimentation and Reflective observation (Felder and Silverman, 1988). Active experimentation involves doing something in the real world with the information by discussing, questioning, arguing, brainstorming, explaining or testing it, these group of learners learn by trying things out, they enjoy working in groups, whereas reflective observation involves examining and manipulating the information., They learn by thinking things through, they prefer working alone or with one or two familiar partners Active learners are more comfortable with experiments and conversely so for reflective learners. Active and reflective learners are closely related respectively to the extrovert and introvert of Jung-Myers-Briggs model. Active learners do not learn much in situations that require them to be passive while reflective learners do not learn much in situations that provide no opportunity for them to ponder about the information being presented. Active learners work well in groups, reflective learners work well alone or with one other person.

Sequential and Global Learners

In most formal education, the teaching materials are presented in a logical sequence. After covering some portion of the materials, students are tested. The lecturer then moves on to the next stage, Sequential learners are comfortable with this system, they learn sequentially, mastering the material as they are presented, this group of learners can be described as linear thinkers who learn in incremental jumps. Global learners, however, cannot learn in this

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manner. They may be lost for some weeks unable to solve even the simplest of problems until after some time, thereafter they pick the material so well that they could apply them to problems that leave most of the sequential learners baffled, they can be described as holistic thinkers, they learn in large heaps. Sequential learners can work with the content materials when they understand it superficially but global learners may have great difficulty doing so. Sequential learners learn best when the content is presented in a steady progression of complexity and difficulty; global learners sometimes do better by jumping directly to more complex and difficult material (Felder and Silverman, 1988).

Reliability and Validity of the four Models of Learning Styles by Felder - Solomon

A study conducted by Litzinger et al (2007) on the Felder-Solomon Index of Learning Styles (ILS) to assess reliability, factor structure and construct validity showed that the ILS has internal consistency ranging from 0.55 to 0.77 across the four learning style scales. Again a test- retest correlation coefficient for all four scales of the instruments varied between 0.7 and 0.9 for an interval of four weeks between test administrations and between 0.5 and 0.8 for intervals of 7 months and 8 months, moreover all coefficients were significant at the 0.05 level of significance. Thus there is no doubt about the suitability of this scale in determining learner's preference to learning (Felder and Spurlin, 2005).

Acquisition of Knowledge by Learners

Students in general acquire knowledge through various means, some students learn by; observing, hearing, reading, practicing, reflecting, meditating, experimenting, drawing, memorizing, modeling, reasoning logically, visualizing, analyzing and so on, On the other hand teaching methodologies and assessment vary considerably ranging from lecturing, discussions, workshops, illustrations and demonstrations. While some lecturers emphasize application of theory, others focus on principles, while some encourage understanding others encourage memorizing. When it comes to assessment, many lecturers go by the status-quo, asking students to do computations.

If the teaching and assessment methods do not conform to the learning styles of the students there are bound to be problems; hostile classes will be developed, there will be poor attendance to lectures, there will be poor performance, there will be frustrations and eventually many drop outs, but if the teaching and assessment methodologies are tailored to suit majority of the learning styles of the students in the class, most of them will be comfortable and become appreciative of the mode of delivery of the instructional material. The purpose of this study therefore is to examine the distribution of the learning styles of Accounting, Statistics and Engineering students of Takoradi Polytechnic and discuss the implications of the findings to the teaching–learning community.

The objectives of the study are to:

- Ascertain the learning styles of students of Takoradi Polytechnic in general.

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- Find out if there are remarkable differences among the learning styles of Accounting, Statistics and Engineering students
- Conduct a statistical test to ascertain whether there is any difference among the learning styles of Accounting, Statistics and Engineering engineering students
- Discuss the implications of the findings to the teaching–learning community

METHODS

The population of interest was all Polytechnic students in Ghana; the accessible population was all students of Takoradi Polytechnic at the time the research was conducted. A forty–four closed-type Index of Learning Style questionnaire (ILS) (samples of the questions are presented in Table 1A to 1C) was downloaded from the website of Felder-Silverman, printed out and administered to Accounting, Statistics and Engineering students at different times while they were in their classrooms, the reason for the data collection exercise was explained to them, thereafter each student was asked to answer all questions carefully and thoughtfully, each student used approximately 12 minutes to answer the questionnaire. The ILS questionnaire was used because of the quantitative nature of the questions, its relevance to statistics and/or mathematics and science education and the fact that it covers four of the five cognitive styles of learning, namely; sensing-intuitive learners, visual-verbal learners, active-reflective learners and sequential-global learners. In addition to the 44 questions, the researcher also elicited information on gender, programme of study and geographical location. Purposive sampling technique was used to select the respondents. A total of 410 respondents representing 82 per cent of total questionnaire sent out were returned. The responses for each person's questionnaire were entered back into Felder- Silverman's self-scoring web based instrument and processed; the result for each person's analyzed questionnaire was printed out(a samples of the result is presented in Table 1D). The report consisted of odd number scores on a scale from 1 to 11. A score of 1-3 in either dichotomy of a dimension of learning style shows that the learning style is fairly balanced; a score of 5-7 in a dimension indicates a moderate preference in the associated dimension of learning style while a score from 9 to 11 in a dimension indicates a very strong preference for the associated dimension. The scores obtained for each student was coded accordingly and analyzed via SPSS 17 package. The data was explored using tables. It was further analyzed using Chi- Square and Analysis of Variance (ANOVA)

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Examples of questions in ILS Questionnaire

Table A.

ILS questionnaire
I understand something better after I
[ ](a) try it out
[ ](b) think through it

Table 1B

	ILS questionnaire
	If I were a teacher, I would rather teach a course
If I were	[ ](a) that deals with facts and real life situations
	[ ](b) that deals with ideas and theories

Table 1C

ILS questionnaire
When I work a mathematics problems
(a) I usually work my way to the solutions one step at a time
(b) I often just see the solution but then have to struggle to figure out the steps to get to them

Table1D : A Typical Learning Styles Result of a Student

						X							
ACTIVE	11	9	7	5	3	1	1	3	5	7	9	11	**REFECTIVE**
						<-- -->							

						X							
SENSING	11	9	7	5	3	1	1	3	5	7	9	11	**INTUITIVE**
						<-- -->							

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X
VISUAL 11 9 7 5 3 1 1 3 5 7 9 11 **VERBAL**
<-- -->

X
SEQUENTIAL 11 9 7 5 3 1 1 3 5 7 9 11 **GLOBAL**
<-- -->

RESULTS

From Table 2, it could be seen that 24.9 percent of the students were strictly sequential learners while only 7.5 percent were strictly global learners with the remaining 67.6 percent being balanced sequential-global learners, the scale tilts

Table 2: Distribution of Learners according to the Four Learning Styles

	Type of Learner	**Frequency**	**%**
Sequential Global	Strong Sequential learner	8	2.0
	Moderate Sequential	94	22.9
	Balanced Sequential-Global	277	67.6
	Moderate Global learner	30	7.3
	Strong Global learner	1	0.2
	Total	**410**	**100**
Verbal-Visual	Strong Visual learner	26	6.3
	Moderate Visual learner	112	27.3
	Balanced Visual-Verbal	247	60.2
	Moderate Verbal learner	25	6.1
	Strong Verbal learner	0	0.0
	Total	**410**	**100**
Sensing-Intuitive	Strong Sensing	22	5.4
	Moderate Sensing	116	28.3
	Balanced Sensing-Intuitive	247	60.2
	Moderate Intuitive	23	5.6
	Strong Intuitive learner	2	0.5
	Total	**410**	**100**

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Active -Reflective	Strong Active learner	6	1.5
	Moderate Active	58	14.1
	Balanced Active-Reflective	313	76.3
	Moderate Reflective	31	7.6
	Strong Reflective learner	2	0.5
	Total	**410**	**100**

towards the sequential learners, in other words majority of the learners were sequential learners. For the visual- verbal learners, it was realized that 33.6 percent of the students were strictly visual learners while only 6.1 percent were strictly verbal learners, with 60.2 percent being balanced visual-verbal learners, there again, the scale of the dimension was in favor of the visual learners. Considering the sensing-intuitive learners; 33.7 percent were strictly sensing learners, 6.1 percent were strictly intuitive learners while 60.2 percent were balanced sensing- intuitive learners, the scale favors the sensing learners. Finally, regarding the active–reflective learners only 15.6 percent of the students were strictly active learners while 8.1 percent were reflective learners, the remaining 76.3 percent were balanced active-intuitive learners, the scale of the dimension slightly favors the active learners.

The following was obtained with the distribution of programmes of study over the learning styles. For the active- reflective learners (Table 3), much of the Engineering students (26%) than Business students (16.8%) and Statistics students (11.4%) were strictly active learners. It also appears that much of the Statistics students (12%) were strictly reflective learners than either the Business students (5.9%) or the Engineering students (2.0%).With respect to the balanced active-reflective learners a greater proportion (77.2%) of them were Business students followed by Statistics students (76.7%) and Engineering students (72.0%).

Table 3: Distribution of Active (ACT) – Reflective (REF) Learners over Programme of Study

	PERCENTAGE OF ACTIVE-REFLECTIVE LEARNER WITHIN EACH PROGRAMME OF STUDY					
	Strong ACT	Moderate ACT	Balanced ACT-REF	Moderate REF	Strong REF	Total
Business	2.7%	14.1%	77.2%	5.4%	0.5%	100.0
Engineering	0.0%	26.0%	72.0%	2.0%	0.0%	100.0
Statistics	0.6%	10.8%	76.7%	11.4%	0.6%	100.0

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For the sensing-intuitive learners(Table 4), it appears that the Business students are more of sensing learners(36.9%) than the Statistics students (33%) who in turn are more than the Engineering students (22%), moreover, a greater proportion (7.6%) of the strictly intuitive learners were Business students when compared to Statistics (5.6%) and Engineering students(2.0%), furthermore it could be said that a greater percentage (76.0%) of the Engineering students were balanced between the sensing–intuitive learners, (60.8%) were Statistics students while (55.4%) were Business students

Table 4: Distribution of Sensing (SEN)-Intuitive (INT) Learners over Program of Study

	PERCENTAGE OF SENSING-INTUITIVE LEARNER WITHIN EACH PROGRAMME OF STUDY					
	Strong SEN	Moderate SEN	Balanced SEN-INT	Moderate INT	Strong INT	Total
Business	5.4%	31.5%	55.4%	7.6%	0.0%	100
Engineering	2.0%	20.0%	76.0%	2.0%	0.0%	100
Statistics	5.7%	27.3%	60.8%	4.5%	0.1%	100

From Table 5, in descending order of proportion of students who were strictly visual learners, we have Engineering student(38%),Business students(33.7%) and Statistics students(32.4%), moreover a greater percentage(7.6%) of Business students than Statistics(5.1%) or Engineering(4.0%) were strictly verbal students, also many more Statistics students(62.5%) than Business students(58.7%) or Engineering students(58%) were balanced visual-verbal learners.

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Table 5: Distribution of Visual (VIS)-Verbal (VER) Learners over Program of Study

	PERCENTAGE OF VISUAL-VERBAL LEARNER WITHIN EACH PROGRAMME OF STUDY					
	Strong VIS	Moderate VIS	Balanced VIS-VER	Moderate VER	Strong VER	Total
Business	5.4%	28.3%	58.7%	7.6%	0.0%	100
Engineering	8.0%	30.0%	58.0%	4.0%	0.0%	100
Statistics	6.8%	25.6%	62.5%	5.1%	0.0%	100

Table 6: Distribution of Sequential (SEQ)-Global (GLO) Learners over Program of Study

	PERCENTAGE OF SEQUENTIAL –GLOBAL LEARNER WITHIN EACH PROGRAMME OF STUDY					
	Strong SEQ	Moderate SEQ	Balanced SEQ-GLO	Moderate GLO	Strong GLO	Total
Business	1.6%	23.4%	67.4%	7.6%	0.0%	100
Engineering	0.0%	32.0%	62.0%	6.0%	0.0%	100
Statistics	2.8%	19.9%	69.3%	7.4%	0.6%	100

Regarding the distribution of students to the sequential-global learners (Table 6), it could be seen that a greater proportion of the Engineering students (32%) than either the Business(25%) or the Statistics students(22.7%) were strictly sequential learners while the order reverses as follows for the strictly global students; Statistics(8%), Business(7.6%) and Engineering students(6%). A lot more of the Statistics students(69.3%) than Business students(67.4%) or Engineering students(62.0%) were balanced sequential-global learners.From the Chi-square analysis performed on the program of study and active-reflective learning style (Table 7), the P-value (0.03) was less than 0.05; we therefore reject the null hypothesis and state that we have sufficient evidence to believe that there are differences among the active-reflective learning styles among the three programs. From Tables 8,9 and 10, the P-values of the Chi- square test in each of the remaining 3 styles of learning; sensing-intuitive, visual-verbal and sequential-global against program of study was

ISSN 2053-2229 (Print), ISSN 2053-2210 (Online)

greater than 0.05, we therefore conclude that we do not have enough evidence to reject each of the three null hypotheses.

The results of the ANOVA (Table 11) confirms the above test, in this test only the active-reflective learners against program of study assumed significance, the remaining 3 learning styles(that is sensing-intuitive, visual-verbal and sequential-global) on program of study (Accounting, Statistics and Engineering students) did not assume significance. The multiple comparisons based on the least significant difference (LSD) in ANOVA (Table 12) gave the pair wise significant programmes among the active-reflective group of learners. It could be seen from the table that the pair; Business and Statistics was pair wise significant (0.016) while the pair Business and Engineering was not significant (0.197). Again, the pair Engineering and Statistics was highly significant (0.004). This result from the LSD declares that the corresponding population parameters are different.

Table 7: Summary of Chi-Square Tests results of accounting, statistics and engineering students against active and reflective learners

	Value	*df*	*Sig.*
Pearson Chi-Square	16.969	8	.030
No. of valid cases	410		

Table 8: **Summary of Chi-Square Tests results of accounting, statistics and engineering students against sensing and intuitive learners**

	Value	*df*	*Sig.*
Pearson Chi-Square	12.644	10	.244
No. of valid cases	410		

Table 9: Summary of Chi-Square Tests results of accounting, statistics and engineering students against visual and verbal learners

	Value	*df*	*Sig.*
Pearson Chi-Square	2.500	6	.868
No. of valid cases	410		

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Table 10: Summary of Chi-Square Tests results of accounting, statistics and engineering students against sequential and global learners

	Value	*df*	*sig*
Pearson Chi-Square	6.088	8	0.637
No. of valid cases	410		

Table 11: **Summary of Analysis of Variance (ANOVA) results of accounting, statistics and engineering students and active and reflective learners**

	Sum of squares	***df***	***Mean square***	***F_o***	***Sig.***
Active and Reflective Learners Between groups	3.028	2	1.514	5.360	0.005
Within Groups	114.984	407	0.283		
Total	118.012	409			
Sensing and Intuitive Learners Between groups	0.651	2	0.352	0.692	0.501
Within Groups	191.205	407	0..470		
Total	191.856	409			
Sequential and Global Learner Between groups	0.312	2	0.156	0.439	0.645
Within Groups	144.849	407	0.356		
Total	145.161	409			
Visual and Verbal Learner Between groups	0.433	2	0.216	0.455	0.635
Within Groups	193.443	407	0.475		
Total	193.876	409			

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Table 12: Summary of Analysis of Variance (ANOVA- Multiple Comparisons) results of accounting, statistics and engineering students against active and reflective learners

Dependent Variable	*(I) Program of Study*	*(J)Program of Study*	*Std. Error*	*Sig.*
Active and Reflective Learners	**Business**	Engineering	.085	.197
		Statistics	.056	.016
	Engineering	Business	.085	.197
		Statistics	.085	.004
	Statistics	Business	.056	.016
		Engineering	.085	.004

IMPLICATION OF FINDINGS TO TEACHING IN HIGHER INSTITUTION

To begin with the ILS questionnaire is quantitative in nature and was designed for science and mathematics education. It also covers four of the five cognitive styles of learning which have already been discussed in this study. The wisdom behind the use of this kind of questionnaire was to provide a platform for mathematics and science teachers to appreciate how quantitative subjects like mathematics and statistics could be transmitted to these three categories of students-Accounting, Statistics and Engineering to achieve maximum results. From the results, majority of the students in the Polytechnic belonged to the Active; Sensing, Visual and Sequential dimensions of learning therefore the teaching methodology of the lecturers should be tailored to meet the needs of these groups of learners. The teaching style that will be appreciated by the active learners include but not limited to the following; team work, hands-on activities, discussions, question and answer sessions, brainstorming, arguing and real life problem analysis. The teaching style that will suit the sensing learners include the following; experimentation, solving problems using standard procedures, detailing the step by step approach to solving problems, encouraging memorization of facts and the use of concrete fact. The teaching method that suits the visual learners is the use of visual aids such as pictures, diagrams, sketches, flowcharts, graphs and demonstrations. Finally to satisfy the sequential learners the teaching material should be presented in a logical sequence without having to jump around topics, students should be giving some drills to offer them the opportunity to practice the principles they have been taught. It also came to light that the teaching methodology for the active- reflective learner suitable for Business students could to some extent be adopted for the Statistics students and vice versa but not to the Engineering

ISSN 2053-2229 (Print), ISSN 2053-2210 (Online)

students, similarly, the teaching methods applicable to the Engineering students could to a large extent be applied to the statistics students and vice versa.

CONCLUSIONS

The study revealed that majority of the students in the Polytechnic belonged to the Active, Sensing, Visual and Sequential dimension of learning. It also came to light that the Engineering students are more of visual (38%) than sequential (32%), than active(26%) an then sensing(22%), again, the Business students are more of sensing (36.9%) than visual (33.7%) than sequential (25%), than active (16.8%) while the statistics students were more inclined to sensing learning (33%) than visual(32.4%) than sequential (22.7%)and then active(11.4%). Majority of the three groups of students belonged to the balanced dimension of each learning styles. This supports the statement made by Felder-Silverman (1988) that "Everyone uses both faculties, but most people tend to favor one over the other". It was also established through a statistical test that there is a relation between programme of study and the active- reflective learning style dimension, moreover through the LSD multiple comparison for the active-reflective learners, it was leant that the teaching style that will suit the Business students will also suit the Statistics students and vice versa, but not the Engineering students, it was leant again that the teaching method which will be appreciated by the Engineering students will also be appreciated by the Statistics students and vice versa. As lecturers prepare their teaching methodology care must also be taken to satisfy the other dimension of learners (Reflective, Intuitive, Verbal and Global) a balanced methodology will go a long way to ease the tension that the subject matter of mathematics and statistics present. Lecturers are being called upon to develop new orientation in the teaching and learning of mathematics and statistics with the view to making it more relevant to the developmental needs of society. This could be achieved if lecturers conduct need assessments to find the learning styles of their students and structure their teaching methods to satisfy the needs of the students they teach. A mismatch between the teaching methods of the lecturer and the learning behaviors of students can lead to poor performance and negative attitudes towards the subject matter.

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