**D E C L A R A T I O N**

I, **RASHIDA BANU. M** do hereby declare that this dissertation, **RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS OF SECONDARY SCHOOL STUDENTS** has not been submitted by me for the award of a Degree, Diploma, Title or Recognition before.

Farook Training College

08.08.2006. **RASHIDA BANU. M**

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**C E R T I F I C A T E**

I, FAZILUDDIN, do hereby certify that this dissertation, **RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS OF SECONDARY SCHOOL STUDENTS** is a record of bonafide study and research carried out by **RASHIDA BANU. M** under my supervision and guidance. The report has not been submitted by her for the award of a Degree, Diploma, Title or Recognition before.

Farook Training College,  **A. FAZILUDDIN**

08.08.2006. (Supervising Teacher)

*ACKNOWLEDGEMENT*

*The investigator with deep felt gratitude expresses her indebtedness to* ***Mr.Faziluddin, A.,*** *Lecturer (Selection Grade), Farook Training College, Calicut, who has supervised this research work. His deep insight and profound knowledge in Science Education and his foresightedness on research in Science Education combined with his expert criticism and constant encouragement helped the investigator in the successful completion of this work.*

*The investigator is extremely thankful to* ***Dr. S.Nirmala Devi****, Principal of Farook Training College, and Former Principal* ***Prof. C. Abdusalam*** *and all the members of teaching staff, Librarian Farook Training College, Calicut who has helped the investigator in every possible way.*

*The investigator places on record her sincere gratitude to* ***Dr.Sudheesh Kumar*** *(Reader in Education, Calicut University) for permitting to use the tools developed and standardised by him, which have been an immense help in the present study. Thanks are also due to all the faculty members of Farook Training College, for providing valuable suggestions during the investigation.*

The investigator is highly thankful to **Dr. Manikandan,** Lecturer in the Department of Psychology, Farook College, for helping to do the analysis needed for study.

*The investigator would also like to express her gratitude to the Heads, teachers and the students of various schools and friends who have whole- heartedly co-operated with the study.*

Farook TrainingCollege,

8.08.2006 RASHIDA BANU.M

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# INTRODUCTION

Science is an endless voyage of discovery, a continued venture into the unknown, a quest to know and understand the world in which we live. It is an active field, constantly demanding willingness to make new observations,to repeat experiments, to consider new facts, and to challenge earlier conclusions.Science is far from finished subjects; in fact, it is likely that science is only in beginnings.New ideas are being added and old ideas revised as a result of continous study. The current innovations in schools emphasize the processes of science, the way in which scientists advance their knowledge and solve problems. This would require meaningful attainment of knowledge, development of attitudes and value systems as well as mastery of skills required to effectively involve in scientific activities. This warrants a new outlook towards science education.

Traditionally science education has been dominated by the transmission of knowledge as the principal component of teaching and was mostly content oriented. It is now increasingly finding a base on constructivist, cognitive and social learning theories which consider human being as an active constructor of knowledge based on his or her knowledge rather than as being passive recipient of environment stimuli. Science education should aim at developing scientific values such as accepting truth, respect for evidence, seeking clarification, open mindedness and being objective in interpretation. To achieve these expected learning outcomes, the teacher has to allow students to construct their own concept, to work at their own pace and to provide all students with opportunities to engage in learning tasks. The new guidelines suggested by the new trends adopted that various aspects of science education have to be innovated in tune with these trends. This demands changes in the various aspects of instructional methods.

Since science education is viewed seriously, the student's ability of process outcomes in science is likely to be of very high profile. Educational outcomes in science treated, as mastery over the process of science is relatively new development in the history of science education. Thus science has both process and product approaches. Process denotes the learning experiences given to the learner, which results in product that denotes the learning outcomes. In order to make the teaching of science effective and efficient, a new objective based curriculum should be framed and the teachers should adopt that new methods and techniques of teaching. As science education is process oriented, emphasis on process outcomes has found its way into every level of education from the elementary school to the university. In order to understand science, the students must not only have some understanding of the concepts, theories, principles and laws of the particular discipline, but must also be able to appreciate how this knowledge is obtained and how it is organized into a logical framework. This has developed a process approach to science learning. The process skills required for learning science and understanding its process, which are present in the students can be made explicit through the evaluation of their Process Outcomes.

In schools, students are all instructed the same way in the classroom, yet the way they process and learn new information is as unique as their potentialities. Specifically biological science students may show unique learning style preferences. The subject offer or demand drawing skills and other related activities. Therefore teaching style complementary to student's learning style open door for an easy understanding of the learning material. Optimising learning for all students in classrooms can be achieved through creating multiple learning opportunities and style shifts for all students as their differences are valued and celebrated (Sulaiman, 1996). It is hypothesized that learner characteristics and individual differences have considerable bearing upon the learning process and learning outcomes. An awareness of Learning Styles of pupils having high Process Outcomes will facilitate in the development of an appropriate framework, within which teaching should be carried out to optimize effectiveness in process skills.

"Education is training of intellect, refinement of heart and discipline of the spirit" (Radhakrishnan). We use all our intelligences to make our sense of the world. As the early concept of intelligence has changed, it is now reflecting in teaching learning process. Howard Gardner argued that we do not have one underlying general intelligence, but instead have Multiple Intelligences each being controlled by an independent system in the brain. Since, Howard Gardner first published 'Frames of mind', the theory of Multiple Intelligences in 1983, educators began to apply this in the classroom. Multiple intelligences theory identifies eight ways in which students can be 'smart'. It provides educators with an expanded framework to use when assessing the student's strengths and potentialities. He could see way in which students learned more easily, enjoyably and efficiently and assumed that they corresponded with student’s strongest intelligences, which promote Process Outcomes. The present study aims to explore the relation of Learning Style and Multiple Intelligences with Process Outcomes in Biology.

**A. NEED AND SIGNIFICANCE OF THE STUDY**

We are living in the age of science and all our activities are controlled and governed by science. It is a creative process. Science, which has so much of importance in life, cannot be denied an important place in the school curriculum. Quality of science learning depends upon many interrelated factors like identifying and development of appropriate curriculum, provision for suitable learning experience in a particular conducive learning context and varied teaching and evaluating techniques. It should emphasize on understanding of scientific processes like recognizing and defining the problem, formulating hypotheses, collecting data, interpreting data etc. Hence both the objectives and the curriculum are being redefined to make them more oriented towards process outcomes. It helps the teachers to improve their teaching skills to develop Process Outcomes in students and to identify the specific components to maximize the Process Outcomes.

In our present method of teaching science, the process of science is given more importance than the product but the Process Outcomes is not evaluated to a great extent. This could be perhaps due to the lack of emphasis given by curriculum designers on the process-oriented methodology of teaching science. To improve creativity and divergent thinking training in process skills is necessary. The process skills exhibited by the students can be measured through their Process Outcomes.

Effective and less effective learners can be differentiated in terms of their learning strategies and less effective student can be assisted in developing skill at strategy use through instruction. Knowledge about the Learning Styles and brain behaviour is a fundamental tool at the service of teachers and schools. It will facilitate in the development of an appropriate framework within which a sound theory and practice of learning and instruction may be built. The way individuals learn is the key to educational improvement. Students can learn to capitalize on their learning style strengths when they concentrate on new and difficult information. Educators will get an opportunity to individualize education by identifying student's styles and systematically prescribing programmes which are complimentary to their learning needs.

Once Learning Style have been identified, instructors can estimate the approach(s), method(s) and sequence(s) that are likely to make learning relatively comfortable for each person. The personal preference by which one perceives and processes new method determines his or her unique Learning Style. It plays a crucial role in how effectively students learn. Learning styles responsive instruction will increase the achievement or improve the attitude towards learning. The potential utility lies in providing learning styles suitable for developing process skills for successful learning outcomes.

For improving the present classroom practices it is important that we recognize and nurture all the varied type of human intelligences and all of the combination of intelligences. Gardner believed that the components of Multiple Intelligences could be developed through training and practice. As the early concept about intelligence has changed, it is reflecting in teaching learning process. Since Howard Gardner first published 'Frames of mind', the theory of Multiple Intelligences in 1983, educators began to apply this in classroom. Intelligences used for science processes have to be identified and teacher should provide learning activities to enhance the student's ability. The students should develop the competency to apply his knowledge to the solution of the problems around him. As Multiple Intelligences theory widely discussed among the educational practitioners, many researches have been conducted to improve the existing style of instructions. The studies related to this helps to know the students type of intelligence, which is used for scientific processing, and improve their problem solving skill.

Science should be taught scientifically, one dimension of such teaching is to be aware of the general nature of the growing children and young pupil that we teach and to gain some notion of how we can study the individual differences that occur among students. Educational researchers in India have not adequately dealt with Process Outcomes in science, especially the relation of Process Outcomes with other factors like Learning Style and Multiple Intelligences. Such studies are needed so as to help the teacher in guiding the pupils along proper lines in their attempts to acquire process skills. This will help in developing a better understanding in the way in which process skills can be acquired or even taught to pupils. An initial review of related literature revealed that the number of studies conducted in this area found to be few. So the investigator selected this area for her research. The present study has its objective to find out whether there is any relation and if so, the extent of this relation of Learning Style and Multiple Intelligences on 'Process Outcomes in Biology'.

**B. STATEMENT OF THE PROBLEM**

The present study is entitled as "**RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS OF SECONDARY SCHOOL STUDENTS."**

**C. DEFINITION OF KEY TERMS**

**1. Relation**

Relation refers to the existence or effect of a connection, of Process Outcomes in Biology with Learning Style and Multiple Intelligences.

**2. Learning Style**

Eysenck (1994) defined Learning Style as the general tendency to adopt similar set of strategies consistently across different tasks and settings.

**3. Process Outcomes in Biology**

Process Outcomes in Biology refers to behavioural evidences which shows mastery over the accepted scientific processes like recognizing and defining the problem, formulating hypotheses, collecting data, interpreting data, evaluating hypotheses and formulating generalizations in Biology.

**4. Multiple Intelligences**

Human beings possess a number of distinct intelligences that manifest themselves in different skills and abilities. All human beings apply these intelligences to solve problems, invent process and create things. According to Gardner each person has a unique profile of these intelligences, with strengths in some areas and weakness in others.

**5. Secondary School Students**

The term refers to the students studying in class VIII, IX andX. In this study only standard IX students are taken as the accessible population of the study.

### D. OBJECTIVES

1. To estimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. To estimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

Boys

1. Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

3. To find out the relationship between different Multiple Intelligence groups and their Process Outcomes.

4. To identify the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

### E. HYPOTHESES

1. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the total sample.

2. There exists significant relation between Process Outcomes in Biology and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

**F. METHODOLOGY**

**a. Sample**

The study was conducted on a representative sample of 700 students of standard IX drawn from 12 schools of kozhikode district of kerala. The sample was selected using stratified sampling technique giving due representation to factors like Gender of the subjects, Locale of schools and Management categories of the schools.

**b. Variables**

The study is designed with 'Process Outcomes in Biology' as the dependent variable and 'Learning Style' and 'Multiple Intelligences' as the two independent variables.

**c. Tools**

The investigator used the following standardized tools of satisfactory reliability and validity for measurement of the variables.

1. Learning Style Inventory developed by Kumar, P.K.S *et al*., (1996)

2. Multiple Intelligences Inventory (developed and standardized by  
 Kumar *et al*.)

3. Test of Process Outcomes in Biology (developed and standardized by the Rashida Banu and A. Faziluddin, 2006).

**d. Statistical Techniques Used**

The data was analyzed and results were discussed using the following statistical techniques.

1 Preliminary Analysis.

2. Pearson's Product Moment Coefficient Of Correlation.

3. Multiple Regression -Stepwise Analysis were used by SPSS (Statistical Package for Social Sciences) Method.

#### G. SCOPE AND LIMITATIONS

The aim of present study is to know whether any relation exists between Learning Style and Multiple Intelligences on 'Process Outcomes in Biology' and if so, whether the relation is significant or not.

The investigator selected a representative sample of 700 students from 12 secondary schools of Kozhikode district. While selecting the sample due representation was given to factors like Gender of subjects, School Locale and Type of management of the schools. The study was restricted to one representative group of secondary school students attending standard IX. Standardized tools of accepted reliability and validity were used for data collection. This study helps to find out whether students with high process outcomes have specifically selected or preferred Learning Style Area and type of Multiple Intelligences. It also helps the teachers to modify their instruction according to the student's preference. The present study serves the purpose of finding the extent of relationship between them. Therefore, it is hoped that the findings of the study will be valid to a great extent.

Even though considerable efforts were made to make the study precise and scientific, the investigator could identify the following limitations also. Some of these are;

1. The sample of the present study was limited to one educational level, i.e; standard IX only due to practical reasons. This was done with the notion that standard IX will reasonably represent standard VIII, IX and X of the secondary schools.

2. The study was conducted on a sample selected from students of standard IX of Kozhikode district, due to constraints of time, effort economy and traveling difficulty. However, more generalisable results could have been obtained from the study, if stratified sample from the whole state was used.

3. The study was limited to Biology only.

In spite of these limitations, the investigator hopes that the study will provide dependable findings.

**H. ORGANISATION OF THE REPORT**

The report has been organized into 5 chapters:

**Chapter I** present a brief introduction of the problem, need and significance of the study, statement of the problem, definition of key terms, objectives, hypotheses, methodology, scope and limitations of the study.

**Chapter II** deals with a review of related literature.

**Chapter III** describes the methodology of study. This chapter contains details like variables, tools, sample, data collection procedure, scoring and statistical techniques used for the study.

**Chapter IV** contains the details of the statistical analysis and interpretations based on the results.

**Chapter V** presents a summary of the study, major findings, educational implications of the study and suggestions for further research in this area.

**REVIEW OF RELATED LITERATURE**

It is essential for an educational research worker to possess up-to-date information about what has already been thought and done in the field from which he or she intends to take up a problem. The literature in any field forms the foundation upon which all future work will be built.

In the words of Good,"The key to the vast store house of published literature may open doors to sources of significant problems and explanatory hypotheses, and provide helpful orientation for definition of the problem, background for selection of procedure, and comparitive data for interpretation of results. In order to be truly creative and original, one must read extensively and critically as a stimulus to thinking".

**PURPOSE OF THE REVIEW**

Review of related literature, besides, allowing to acquainting himself with current knowledge in the field or area in which he or she is going to conduct his or her research, serves the following specific purposes.

1. To provide ideas, theories, explanations or hypotheses valuable in formulating the problem.

2. To avoid risk of duplicating the same study already undertaken.

3. To define the limits of his field. It helps the researcher to delimit and define his problem. .

4. To avoid unfruitful and useless problem areas.

5. To understand the research methodology which refers to the way the study is to be conducted.

6. To know about the recommendations of previous researches listed in their studies for further research.

**A. THEORETICAL OVERVIEW OF SCIENCE AS A PROCESS**

Science is a way of describing and explaining some aspects of the world around us. It is also a package of processes by which we can increase our knowledge of external world. The current innovations in schools emphasize the processes of science, the ways in which scientists advance their knowledge and solve problems.

The term 'Process Outcomes' stands for the intellectual skills needed for scientific investigations attained by the student as a result or consequences of learning science.'Science A Process Approach' focuses on the processes rather than on the content of science. In the last decades of 20th century, the process approach began to acquire prominence in science teaching. Process Approach is a middle ground between content approach and creativity approach by drawing content from the scientific disciplines and use them to illustrate the capability through Process oriented Inquiry model. The shift from product to process has wide implication for all aspects of the curriculum planning, instruction and evaluation.

The American Association for Advancement of Science (AAAS) in 1962-1968 stressed on this new development in science teaching in the curriculum, through its project-'Science A Process Approach'. Thus there has been a shift from mastery of subject through recall of content matter and processed information to the acquisition of skills in the process to how knowledge is attained. Hence learning outcomes in science is referred to as process outcomes.

A knowledge of methods of science lead to the development of a logical mind, critical judgement, and capacity for systematic organization which are essential for the proper solution of the problems of life. For attaining these, the children should have a better and vast knowledge about science and its implications. Only through the process of science children can acquire rational powers, which will help them to acquire and there by they can solve their everyday problems. Learning how to use processes of science is one of our important goals for solving daily problems skillfully.

**B. STUDIES RELATED TO PROCESS BASED EDUCATIONAL OUTCOMES IN SCIENCE**

Andrew (1980) evaluated the Skills in Scientific Process of secondary school pupils of Kerala and noticed that girls to be superior over boys in scientific process skills.

Padilla et al., (1983) conducted a study on the relationship between Process Skill and formal thinking abilities of Middle or High school students. Results indicate that science process skills ability is strongly associated with logical thinking, suggesting the process skill teaching may influence formal thinking ability.

Rowland (1987) conducted a study on In-service Training of Elementary Teachers to enhance Science Process Skill Development and Instruction. Overall evaluations indicate that the model for delivery of in-service workshops using elementary teachers as surrogates for science educators can be effective.

Yap and Yeany (1988) found that there exists some form of hierarchical link between the Piagetian cognitive nodes and integrated science process skills.

Varghese's (1989) study showed significant correlation between Process Outcomes in Biology and certain affective variables such as attitude towards problem solving, science interest and achievement motivation for a sample of standard IX pupils.

Haridasan (1989) conducted a study on the Problem Solving Ability in Biological Science of high, average and low biological achievers sample and some of the selected relevant sub samples.

Mini (1989) reported significant and high mean difference for Process Outcomes in Biology between equated groups of Boys and Girls of equating age, intelligence, socio-economic status and locale.

Noushad (1989) found significant main effect of sex and attitude towards Problem Solving on Process Outcome in Biology.

Wilson and Neubauer (1990) compared the teacher roles in three exemplary hands-Science A Process Approach (SAPA), Elementary science study (ESS) and Science Curriculum Improvement Study (SCIS) on elementary science programs. The study revealed that with SAPA studies scored highest gain (36 %).

Geetha (1991) studied the comparison between Attitude towards Science and Process Outcomes in Biology and found a significant positive relationship between the two variables for the total sample and sub samples.

Suresh's (1991) study reported significant relationship between Process Outcomes in Biology and certain Sociological, Cognitive and Environmental variables.

Sujatha (1994) study on the relationship between Adjustment and Process Outcomes in Biology is significant at .01 levels for personal adjustment, social adjustment and total adjustment separating with Process Outcomes in Biology.

Paulose (1996) study on the influence of Scientific Attitude of University entrants on their Process Outcomes in physics found that the three independent variables viz., Scientific Attitude, sex and residence exerted a significant influence on the dependent variable viz., Process Outcome in Physics scores.

Lovoic and Derrick (1999) conducted a study on Effect of Emphasizing Hypothetical-Predictive reasoning within Science Learning Cycle on High School Students Process Skills and Conceptual Understanding in Biology and found out that the instructional innovation produced significant gains relative to the use of Process Skill, Logical thinking skill, Science concepts and Scientific Attitude.

Vineetha's (2000) study on relationship between Science Studying Approach and Attitude towards Science with Process Outcomes in Physical science of secondary school pupils revealed the existence of significant relationship between the Process Outcomes in Physical Science and each of the independent variables.

Joshy (2002) conducted a study on Environmental Awareness in relation to Process Outcomes in Science of secondary school pupils of Thrissur district. The study was conducted on 450 secondary school pupils of standard IX. He found that there exist significant substantial positive correlation between Environmental Awareness and Process Outcomes in Science.

Baby Reema (2002) study on Process Outcomes in Science and Classroom Climate of secondary school pupils of Kerala revealed that the relationship between Process Outcomes in Science and Classroom Climate is positive and significant at .01 levels for total sample and six subsamples studied.

Sreena (2003) conducted a study on relation of Classroom Climate and Science Studying Approach with Process Outcomes in Biology of secondary school students, which reveals that the Organized Vs Disorganized Methods has negligible relationship while Deep Vs Surface Approach has a low correlation with the 'Process Outcomes in Biology'.

Shabana (2003) conducted a study on Process Outcomes in Science in relation to Creativity and Socio-economic Status of secondary school pupils of Malappuram district. She found out that Creativity and Socio-economic Status have significant effect on Process Outcomes in Science of secondary school pupils.

**C. THEORETICAL OVERVIEW OF LEARNING STYLE**

According to R. Dunn and K. Dunn (1993), Learning Style is the way that the students begin to concentrate on process, internalize and remember new and difficult academic information. "Many people can learn things that are easy for them without using their Learning Styles, but all people can learn new and difficult information better when they capitalize on their styles.

Learning Style is composed of biological and developmental characteristics that make the identical instructional environments, methods and resources effective for some learners and ineffective for others. Several reliable and valid assessments that identify individual learning style preferences have been developed. Some of the important tools for measuring learning style are the following.

1. Kolb and Fry's Learning Style Inventory (1975)

2. Park's Learning Style Inventory (1976)

3. Kolb's Revised Learning Style Inventory

4. Torrance's Inventory (1988)

5. Dunn, R Dunn, K. and Price Learning Style Inventory.

Kumar et al developed another Learning Style Inventory based on theoretical construct proposed by Dunn and Dunn. This includes four major style areas namely Environmental, Emotional, Sociological and Physical with their associated elements. In this Inventory physiological area of Dunn and Dunn model is excluded on the assumption that the processing styles are not tapped directly through items in Inventory.

A lot of recent works on learning skills has stressed the element of personal choice about Learning Style and methods (Main, 1985). The concept personal stances in learning give paramount importance to the personal position of learners. A survey about obtained literature revealed that a number of investigators have developed and used instruments to measure Learning Style Preference, Learning Strategies and similar psychological construct. A few studies related to Learning Styles are given below.

**D. STUDIES RELATED TO LEARNING STYLE**

Charkins (1985) reported about a study on Linking Teaching and Student's Learning Style with Student's Achievement and Attitudes. Findings disclosed that student's Achievement and Attitude at college level might be improved by a better match between teaching style of instructors and the learning style of students.

Smith and Holliday (1986) investigated the differences in Learning Styles as measured by the Learning Style Inventory (LSI). The subjects for the study were a sample of fourth, fifth and sixth graders in a Mid-western elementary school. The findings were that the students do manifest significant variations in how they prefer to learn in a classroom setting. The average achievers did not display a significant performance for a particular Learning Style, while the high and low achievers did.

Hanpole (1987) found no statistically significant relationship between Learning Style and Achievement of 74 Thai University students.

Atchison (1988) conducted a study to determine the relationship of Learning Style and Reading Achievement of sixth grade students and found statistically significant relationship between Learning Style and Total Reading Achievement Scores.

Cooper and Millar (1992) assessed Learning Style of 113 students and Teaching Style of 16 faculties within a college of business using Myers-Briggs Type Indicator (MBTI) and found that Learning Style-Teaching Style congruency was related to Academic performance.

Carthey (1993) studied the relationship between Learning Style and Academic Achievement on 64-second year Iowa community college students. Findings suggested that instructors should consider testing their students to determine their Learning Styles so as to increase Academic Achievement.

O'Brien (1994) assessed Cognitive Learning Style and Academic Achievement in secondary school and confirmed concrete-sequential students having highest grade point averages out performing male.

Allred and Holliday (1995) studied a brain-based approach to helping students reach their full potential in a South Carolina school. Examination of faculty Teaching Style and Student Learning Style revealed that only high achiever's Learning Style matched their Teacher's fact-based approaches.

Verma (1995) studied the relationship between Learning Style and Achievement Motivation of 51 class IX students and found Learning Style to be independent of Achievement Motivation.

Lindvall (1995) described a programme employing the theory of Multiple Intelligences and Individual Learning Style in order to make learning active.17 Third Grade Students targeted classroom of an elementary school were surveyed. The results indicated that analyzing student's needs and preferences and making accommodations to conform to those needs in the classroom, encouraged students to become increasingly engaged in their learning.

Preetha (1996) found that significant Sex Differences exist in Learning Style. High mean scores for Girls over Boys were noticed. In Learning Style revealed the superiority of girls over boys.

Rehna (1996) reveals the existence of Sex Differences in Learning Style.

Sathy (1996) found that there exists a satisfactory significant relationship between Achievement in Hindi and Learning Style for Boys and Girls.

Hall and Hale (1996) examined the relationship between Achievement and Learning Style of middle school students. Subjects were chosen from one urban middle school. Analysis of data revealed that traditional classroom settings may not provide sufficient environmental options to enable students to recognize their Learning Style Preference.

Kumar (1997) investigated the effect of Learning Style on Achievement in Secondary School Biology on 650 students. Analysis of the data indicated that Learning Style has significant main effect on Achievement in Biology.

Balas and Mascazine (1998) reported a study on General Biology students (N=24) in a college environment in the Columbus Ohio area. Comparisons are made between student's Learning Style and Perceptual modalities. The results revealed that student's achievement increased with choice and the use of a variety of teaching techniques is beneficial to college science teaching.

Gopalan (1999) conducted a study on Sex and Locale Difference in Learning Style of secondary school pupils reveals that there is no significant difference between Urban, Boys and Girls for Environmental and Emotional components where as in Sociological and Physical components of Learning Style there exists significant difference between the Urban, Boys and Girls.

Suchitra (1999) in her study found significant and positive correlation between 'Learning Style' and 'Classroom Climate' on 'Achievement in Physical science of secondary school pupils'.

Biju (1999) conducted study on Interaction of Intelligence and Cognitive Style on Learning Style of secondary school pupils. He found out that the main effect and interaction of intelligence and cognitive style on learning style of secondary school pupils for the total and subsamples are significant.

Warner (1999) investigated the effects of faculty Learning Style on student's grades in five different class sections at the University of Central Florida. Results from two of the five classes indicated that students with a Learning Style matching that of the instructor tended to have higher-grade averages.

Wingenbach (2000) in a study found that students with a field independent Learning Style scored significantly higher than field-dependent students.

Mc Shannon (2001) studied the effects of a faculty development programme offered to increase positive interactions between students and faculty and the effects of these interactions on student achievement and retention. Students enrolled in eight engineering classes (N=677) completed an interactive learning style instrument to show their preferred learning style. Results reported an average learning style is important because they are education-relevant expression of the uniqueness of the individual (Joyce, et a1, 1992).

Drysdale, *et al.* (2001) investigated the effects of Cognitive Learning Style on first year Academic Performance in 19 University courses. Results revealed that Academic Performance based on Learning Style was significant in 11 courses. All Learning Style excelled in liberal arts and social sciences.

Doss and Muthiah (2002) conducted a study to find out the types of Learning Style prevalent among college students and to correlate Styles of Learning with Academic Performance on 925 college students in Tamil Nadu. The results revealed that the predominant styles of learning among the college students are collaborative styles and their academic performance is related to their learning styles.

Hassan Koya (2002) conducted a study on influence of Learning Style Approaches to Studying and Achievement Motivation in Biology of secondary school pupils. The study revealed that the main effect of Approaches to Studying on Achievement in Biology is significant to a certain extent and the present study indicates that students differ in their approaches and is reflected in their achievement.

**E. THEORETICAL OVERVIEW OF MULTIPLE INTELLIGENCES**

The theory of Multiple Intelligences is biologically influenced and assumes, like other modular theories, the existence of independently working brain organizations. Dr. Howard Gardner assumes the intelligences to be independent in the sense that the level of performance achieved by the one intelligence is not related to the level achieved by the other intelligences. Brain has equally important type of intelligences but people differ in the strength and combinations of intelligences.

Gardner (1993) posited a theory of Multiple Intelligences, which proposes distinct areas of skill that each individual possesses to a different degree. His original theory comprised seven areas of intelligences viz; Linguistic, Logical, Spatial, Musical, Bodily, Intrapersonal and Interpersonal Intelligences. More recently, Gardner (1999) added three Intelligences to the previously identified seven i.e., Naturalistic, Existentialistic and Scientific Intelligence. However, the majority of existing empirical research and available measurement tools are based on his original theory of seven Multiple Intelligences. Gardner and Hatch (1990) demonstrated that children perform differently on activities that require the use of different intelligences, suggesting that they have strengths and weakness in different areas and distinct profiles.

Recently some schools have applied Multiple Intelligences theory in their curricula and have reported success in improving performance on achievement tests (Geimer, Getz, Pochert and Pullam, (2000). Applying Multiple Intelligences theory was different it did not mean that we abandon activities that are important to us and to our students. It means we enhance them to think differently.

Gardner has identified eleven intelligences although he has also been considering the possibility of a Spiritual Intelligence. The later when brought up under the content of spiritual feeling or a gift for religions, mysticism or the transcendent usually generates a great deal of controversy with the science. The eleven intelligences are human beings possess and their primary distinguishing characteristics are as follows.

**1. Verbal /Linguistic Intelligence:**

The capacity to use language and perhaps other languages to express what's on one's mind and understand other people. Poets really specialize in Linguistic Intelligence but any kind of writer, or an orator, speaker, lawyer or other person for whom language is important stock in trade, which highlights Linguistic Intelligence.

**2. Logical/Mathematical Intelligence:**

The ability to understand the underlying principles of some kind of a causal system-the way a scientist or a logician does, or can manipulate numbers, quantities and operations-the way a mathematician does.

**3. Visual/Spatial Intelligence:**

The ability to present the spatial world intimacy (in your mind)-The way a sailor or airplane pilot navigates the large spatial world, or the way a chess player or sculptor represents a more circumscribed spatial world.

**4. Musical/Rhythmic Intelligence:**

The capacity to think in music, to be able to hear pattern, recognize them or perhaps manipulate them.

**5. Bodily/Kinesthetic Intelligence:**

The capacity to usewhole body or parts of your body (hands, fingers, arms) to solve a problem, make something or put on some kind of production.

**6. Naturalistic Intelligence:**

The human ability to discriminate amonglivingthings**,** (plants and animals**)** as well as sensitivity to other features of the natural world (clouds, rocks, configuration).

**7. Intrapersonal Intelligence:**

Having an understanding of one self of knowing who am I, what I can do, what I want to do, how I react to things, which things to avoid and which things to gravitate toward.

**8. Interpersonal Intelligence:**

A person's capacity to understand the intentions, motivations and desires of other people and consequently, to work efficiently with others.

**9. Spiritual Intelligence:**

Ability to deal with spiritual matters and engage in spiritual activities.

**10. Existential Intelligence:**

The productivity to pose (and ponder) questions about life, death and ultimate realities.

**11. Scientific Intelligence:**

Multiple Intelligences theory is a psychological and educational theory espousing that seven kinds of "intelligences" exist in human, each relating to a different sphere of human life and activity. Educators, the theory states, can reach all of their students only by adapting their teaching program to meet all the type of intelligence that the target audiences possess.

**F. STUDIES RELATED TO MULTIPLE INTELLIGENCES**

Gardner (1983) reported about the apprenticeship programs that were given at the key school in Indianapolis which is the first Multiple Intelligences School in the U.S. Teachers, parents and community members mentor students in 17 crafts. Each student attends a craft of his or her four times a week to work on material related to one or more intelligences. The crafts include architecture, cooking, gardening and many others. Programs such as this offer students powerful oppurtunities to work with those who have achieved competence in a discipline or craft and studies shows that when they are immersed in real world tasks, these students who are worked in apprenticeship programs found to be more successful.

Ferrety and Butterfield (1992) studied the intelligence related difference in the learning, maintenance, and transfer of problem solving strategies.

The relationship of intelligence to strategy training, maintenance and transfer was studied for six intellectually gifted, six average and six mentally retarded children taught a balance scale problem strategy. Implications of the finding that the mentally retarded needed more training and were poorer at maintenance.

Jasmine (1996) reported that the use of the theory of Multiple Intelligences in education depends on the recognition of and respect for, each learners as well as each learner's special interests and talents and if education is given according to their interests and way of learning it is sure to be fruitful.

Campbell (1996) reported that Multiple Intelligences school students are proud of their work and are eager to share it with others. Their academic achievement gains have been documented through standardized test at Cascade elementary school in Marysville, Washington, the key school in Indianapolis and the New City school in St. Louis.

Campbell (1997) reported that through Multiple Intelligences based projects students learn to ask researchable questions, identified varied resources, create realistic time lines, initiates, implement and bring closure to a learning activity. These projects make use of numerous intelligences. As a result, intelligences were developed and in students self-directed learning takes place. It prepares students for their adult lives.

Constanzo and Paxton (1999) suggested that identification of personal strengths Multiple Intelligences theory based activities can give students a successful experience and builds their confidence as learners.

Paxton (1999) created a Multiple Intelligences assessment survey containing eight sceneries, each containing statements specific to certain intelligences and are administered to ABE and GED students. After making the responses discussions were held at. At the conclusion of the class, they took the survey again and found that significant positive change had occurred in their profiles.

Linda Campbell and Bruce Campbell (1999) in their recent publication 'Multiple Intelligences and student achievement, success stories from six schools' summarize the result of using different approaches to implementing the theory of multiple intelligences. They examine six schools at different levels. Comparisons were made between Multiple Intelligences School and Non Multiple Intelligences Schools. Multiple Intelligences schools showed better performance.

Karen Allard (2001) a nationally certified Kagan Trainer shared the result of her recent studies on Cooperative Learning and Multiple Intelligences structures as the strategy helped students to achieve high scores and help them study to quizzes, review information and concept about reading, writing and social studies.

Kallanbach, et al. (2001) conducted a study to inquire how Multiple Intelligences theory can support instruction and assessment in adult educators showed that awareness of their own intelligences help students to become more independent learners, help them to reduce learning disabilities and attention deficit disorder help them in their career decision making process, enhance a multi-sensory approach to the teaching of writing and readings.

Chris Hanley, Carmen Hermiz, Peddy Lagioia, Jennifer, Albuck Levine, Valerie (2002) conducted a study on Improving Student Interest and Achievement in Social Studies using a Multiple Intelligence Approach showed an increase in student achievement and interest, by participating in Multiple Intelligent activities.

Jugunu (2003) conducted a study on Effectiveness of Teaching Methods in the Development of Multiple Intelligences of standard VIII pupils, reveals that there is no significant difference between the experimental and control groups in mean pretest scores, mean posttest scores and in mean gain scores for the total sample and subsamples based on sex.

Rose Mary Antony (2003) conducted a study on Effect of Learning Strategies and Multiple Intelligences on Achievement in Biology of secondary school pupils, revealed that Learning Strategies are significant factors influencing Achievement in Biology. But Multiple Intelligences do not effect the achievement in biology of secondary school pupils.

Jennifer Reidel, Tracey Tomaszewski and Darla Weever (2004) conducted a study on Improving Student Academic Reading Achievement through the use of Multiple Intelligence Teaching Strategies showed a marked improvement in reading comprehension, motivation and student engagement.

Ethan Elliot Hodge (2005) conducted a study on a Best-Evidence synthesis of the Relationship of Multiple Intelligence Instructional Approaches and Student Achievement indicators in secondary school classrooms showing that multiple intelligences theory contributes positively to student learning and development.

**CONCLUSION**

Even though sufficient number of studies were conducted and reported on Achievement and Process Outcomes in Biology, Physics and Chemistry, the investigator found very few studies relating Process Outcomes in Biology with both the variables Learning Style and Multiple Intelligences. So the investigator selected this area.

From the review, the investigator found that the variable Multiple Intelligences and the Learning Style are related to Process Outcomes in Biology. The number of studies relating to 'Process Outcomes in Biology' and these independent variables are rare. The investigator could not therefore reach a conclusion on the relation of the variables based on the review.

**METHODOLOGY**

This chapter deals with the methodology of the study under the following heads viz;

A. Variables

B. Objectives

C. Hypotheses

D. Tools used for Data Collection

E. Sample for the Study

F. Data Collection Procedure

G. Scoring and Consolidation of Data

H. Statistical Techniques Used

Description of each of the above follows:

**A. VARIABLES**

The present study is entitled as "RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS OF SECONDARY SCHOOL STUDENTS."

The title of the study suggests that it involves two types of variables namely dependent and independent variables.

**Dependent Variable**

The statement of the study itself suggests that "Process Outcomes in Biology" is the dependent variable.

**Independent Variable**

The independent variables of the present study are two in number namely, 'Learning Style' and 'Multiple Intelligences'.

**B. OBJECTIVES**

Objectives set for the present study are the following:

1. To estimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. To estimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

a) Gender

Rural

b) Locale

Urban

Private

c) Management

Government

3. To find out the relationship between different Multiple Intelligence groups and their Process Outcomes.

4. To identify the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

**C. HYPOTHESES**

1. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the total sample.

2. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the relevant subsamples viz;

a) Gender

b) Locale

c) Management

**D. TOOLS USED FOR DATA COLLECTION**

The investigator used the following standardized tools for the collection of data.

1. Learning Style Inventory developed by Kumar, P.K.S. *et al*, (1996).

2. Multiple Intelligences Inventory (developed and standardized by Kumar *et al*.).

3. Test of Process Outcomes in Biology (developed and standardized by Rashida Banu and A. Faziluddin, 2006).

The tools are described below for content, nature and other psychometric details.

**1. Learning Style Inventory (1996)**

Kumar et al. developed Learning Style Inventory, in 1996. The theoretical formulation of Dunn and Dunn model of Learning Style (Dunn *et al,* 1989) was the basis of the Learning Style Inventory. According to this, Learning Style is multidimensional rather than bipolar. The style areas included in the inventory are Environmental, Emotional, Sociological and Physical. The style elements included in each of the four style areas of Learning Style Inventory are given below.

**i) Environmental**

Environmental Style area comprises of four style elements namely Noise level, Light, Temperature and Design. Eleven items are included in this dimension (Items 1 to 11 in the Inventory).

Two illustrative items are:

a) I feel lazy in studying during cold seasons.

b) I prefer studying is an open place, rather than in an enclosed room during daytime.

**ii) Emotional**

Emotional Style area comprises of persistence, responsibility and structure. Twelve items are included in this dimension (items 12 to 23).

Two illustrative items are:

a) I find it difficult to complete my studies at a stretch.

b) I strictly abide by the instructions of my teachers in study matters.

**iii) Sociological**

Sociological Style area comprises of style elements peers, authority, and several ways. Eight items are included in this dimension (items 24 to 31). Two illustrative items are:

a) When I study in the company of my friends, I understand the defects in my study process.

b) The study methods of toppers influence me.

**iv) Physical**

Physical style area comprises of style elements such as Auditory, Visual, Tactile, Kinesthetic, Intake, Evening/Morning, Late morning, Afternoon and Mobility.

Two illustrative items are:

a) Taking rest for sometime during studies is found to be effective for my studies.

b) I can study for long, if I am not haunted by hunger.

**Scoring**

There are 45 items in the inventory. All the items are prepared in three-point scale. The respondent has to respond to the statements by choosing any one of the three alternatives - 'Always', 'Sometimes,' 'Never'. The scoring is 2, 1, and 0 for the alternatives - 'Always,' 'Sometimes,' 'Never' respectively. In the case of negative items the scoring pattern is reversed. Thirteen items numbered 1, 5, 7, 13, 17, 19, 21, 22, 25, 31, 33, 37 and 45 are negative items. Copy of the Learning Style Inventory and the response sheet are provided as Appendix VII and VIII.

**Validity and Reliability of the Tool**

Validity of Learning Style Inventory was estimated by correlating the scores of Learning Style against the scores of Science Studying Approach as an external criterion for a sample of 50 students. Validity coefficient estimated using Pearson's 'r' was reported to be 0.62.

Reliability of the Inventory was established through test-retest method. Reliability index was 0.64 (N=50). Further internal consistency of the tool was established by estimating inter correlations of the scores of the four style areas with the total score of the Learning Style Inventory for a sample of 700 secondary school students. The obtained Pearson's 'r' range from 0.601-0.766.

**2. Multiple Intelligences Inventory**

For this present study the independent variable, Multiple Intelligences is measured using Multiple Intelligences Inventory developed and standardized by Kumar *et al*, (2003).

The inventory consists of eight subsets. They are Verbal/Linguistic Intelligence, Logical/Mathematical Intelligence, Spatial Intelligence, Bodily/Kinesthetic Intelligence, Naturalistic Intelligence, Musical Intelligence, Interpersonal Intelligence and Intrapersonal Intelligence. The test was constructed on the basis of Gardner's Theory of Multiple Intelligences.

**Scoring**

There are 40 items in the Inventory, each set of the questions are meant to measure the eight types of Intelligences. For each question there are three answers given and the student can mark his choice in the score sheet. The final score can be calculated by adding the total scores to get the Total Multiple Intelligences Score. Copy of the Multiple Intelligences Inventory and the response sheet are provided as Appendix IX and X.

**Validity and Reliability of the Test**

The Validity of the Test obtained was 0.85. The validity of the present test is established using criterion related technique. The criterion used for this was invented by Christison (1996).

Reliability of the test was established using the split-half method. The Reliability of the test obtained was 0.84.

**3. Test of Process Outcomes in Biology**

The investigator in consultation with her supervising teacher developed the Test of 'Process Outcomes in Biology' for standard IX.

**Theoretical Constructs of Process Outcomes**

The term science (scientia) is 'etymologically synonymous with knowledge.' The description of science as a body of systematized knowledge is also inadequate because the extensions of the definition, customarily and legitimately made, embrace the practices of finding out and using what becomes known, together with the human skills necessary for or acquired in the process.' This process involves how a problem is felt, how it is observed, experimented upon, how a hypothesis is developed and tested, how inferences are drawn, conclusions are generalized and these generalizations are applied to new situations. It is these skills which together help in the formation of the product of science.

Nay *et al,* (1971) defines scientific process as "a series of activities or operations performed by the scientists in his attempt to understand nature."

Process Outcomes in Science stands for the intellectual skills needed for scientific investigation and which students as a result of learning science attain. Process skills are assessed by outcomes. Therefore, here an outcome means the ability for process in science.

'Process Outcomes' were operationalized on the basis of theoretical models developed by Obourn (1960) and Klopfer (1971) on the basis of these models many investigators classified the abilities of Process Outcomes in Science into six skills namely,

i) Recognizing and defining a problem

ii) Formulating hypotheses.

iii) Collecting data

iv) Interpreting data

v) Evaluating hypotheses

vi) Formulating generalizations.

The test measured all the six above mentioned process skills in the case of standard IX pupils.

**Planning of the Test**

The objectives and content of the secondary school syllabus of Biology were carefully studied. It was decided that the content of the Test of Process Outcomes includes the basic concepts of Biology, which students studied in standard IX. It was decided to prepare a test of 60 items, from Biology of standard IX, which students can take within duration of 45 minutes. Only objective type multiple-choice items were included. The area chosen were:-

1. Nutrition in Plants.

2. Nutrition in Animals.

3. Respiratory Process in Organisms.

4. Skeletal and Muscular System.

**Item Writing**

On the basis of classification of the objectives given by Obourn (1960) and Klopfer (1971) the investigator prepared a draft test under the guidance of the supervising teacher. Different sources were used for item development including reference books, textbooks, teacher’s guide and question banks.

The explanations of the six components of Test of Process Outcomes in Biology along with illustrative questions are given below.

**1. Recognizing and defining the problem**

These test items include problematic situations. The recognition of a problem may pass through several stages and pupil's recognition ranges from awareness of the problem area to identification of a specific problem. The correct response chosen would indicate the pupil's behaviour. This sub-test includes ten items. Given below is an example of the item.

**EXAMPLE**

Doctors usually suggest that consumption of green leafy vegetables is good for eyes. Here the problem is

A. Whether leafy vegetables are available in plenty.

B. How leafy vegetables influence eye diseases.

C. Whether leafy vegetables are nutritious.

D. Which are the diseases affected to eyes.

**2. Formulating Hypotheses**

The best items in this section contain possible solutions to the problem posed. The pupil has to judge whether the specific problem can be investigated or not. The pupil has to select the most appropriate hypothesis from among the given hypotheses. Ten items were included in this sub-test. An example of the test item is given below.

**EXAMPLE**

Vitamin K is essential for blood clotting. The probable assumption here is ,

A. It helps to produce Prothrombin.

B. It helps to produce Insulin.

C. It helps to produce Heparin.

D. It helps to produce Ptyalin.

**3. Collecting Data**

The items in this category include experiments that form a valid test of the given hypotheses. These items test the student's observation, use of appropriate instruments and designing of the experimental procedure. There are ten items in this sub-test. Given below is an example of the item.

**EXAMPLE**

Which experiment can you do to prove the idea of Osmosis?

A. Observe dilute salt solution.

B. Observe mixed solution of concentrated salt solution.

C. Observe a mango dipped in concentrated salt solution.

D. Experiment by pouring a drop of ink in fresh water.

**4. Interpreting Data**

In this category an experiment is given and the student is required to analyze the results of the given experiment. This includes the student's behaviours of organizing, manipulating and adjusting his observations and measurements. There are ten items in this sub-test.

**EXAMPLE**

Blood is colourless in insects. The most suitable explanation for this is.

A. Due to the lack of W.B.C. in the blood.

B. Due to the higher quantity of oxygen in the blood.

C. Due to the lack of oxygen carrying heamoglobin in the blood.

D. Due to the lesser quantity of carbondioxide in the blood.

**5. Evaluating Hypotheses**

In this section a number hypotheses are stated to a given problem, which are based on the data contained in the problem. The pupil has to evaluate and select the hypothesis most suitable for the problem situation. It is a process of judging and predicting. It is forecasting the consequence if a solution is tried. There are ten items in this sub-test.

**EXAMPLE**

The leaf of plant grown in darkroom does not indicate blue colour after starch test. Which of the following is the best conclusion for this?

A. Chlorophyll is essential for starch synthesis.

B. Water is essential for starch synthesis.

C. Sunlight is essential for starch synthesis.

D. Carbondioxide is essential for starch synthesis.

**6. Formulating Generalizations**

Here the pupil has to consider the results of the given experiment with other similar enquiries. If the original findings are corroborated with others, he is justified in formulating an empirical generalization. This sub-test includes ten items. An example is given.

**EXAMPLE**

Blue colour appears when iodine is added to rice. The general reason for this:

A. Rice contains Protein.

B. Rice contains Fat.

C. Rice contains Vitamins.

D. Rice contains Starch.

**SCORING**

The scoring scheme of the test is to give one score for each correct response and no score for wrong response.

**Pilot Testing**

The draft test prepared incorporating 60 items was administered to 38 students of standard IX of Farook High School to ascertain the appropriateness of the phraseology used in the stem and options of the test items and corresponding changes were made.

**Tryout of the Draft Test**

The draft test was tried out on a sample of 380 pupils of standard IX. In selecting the sample care was taken to give due representation to Gender of pupils, School Locale and Management category of schools.

From the 380 score sheets after discarding the incomplete score sheets the investigator did item analysis with 370 score sheets selected at random.

**Item Analysis**

The item analysis was done as per the procedure suggested by Ebel in 1972. The answer sheets were arranged in the ascending order of their total scores. The top 100 (27%) and the bottom 100 answer sheets were separated which form the Upper group (U) and Lower group (L).

The number of correct responses for each item of the Upper and Lower groups was recorded separately. The difficulty level and discriminating power for each item were calculated.

**Difficulty Level/Index**

The difficulty of an item is inversely proportional to the difficulty level or index of that item. It was calculated using the formula.

U + L

D.I = ---------

2N

Where, U - Number of correct responses in the Upper group.

L - Number of correct responses in the Lower group.

N - Number of pupils in any of the group.

**Discriminating Power**

A test item possesses adequate discrimination power when it is capable of differentiating between superior and inferior students in the measured ability. It was calculated using the formula.

U - L

D.P = ---------

N

Where, U - Number of correct responses in the Upper group.

L - Number of correct responses in the Lower group.

N - Number of pupils in any of the group.

The item analysis data is presented in Table 3.1.

TABLE 3.1  
**Item Analysis Data of Test of Process Outcomes in Biology**

| Item No. | Upper | Lower | D.I | D.P | Remarks |
| --- | --- | --- | --- | --- | --- |
| 1. | 99 | 96 | 0.98 | 0.03 | Rejected |
| 2. | 97 | 65 | 0.81 | 0.32 | Rejected |
| 3. | 43 | 17 | 0.30 | 0.26 | Rejected |
| 4. | 78 | 32 | 0.55 | 0.46 | Selected |
| 5. | 95 | 58 | 0.76 | 0.37 | Selected |
| 6. | 61 | 25 | 0.46 | 0.36 | Selected |
| 7. | 25 | 17 | 0.21 | 0.08 | Rejected |
| 8. | 74 | 36 | 0.55 | 0.38 | Selected |
| 9. | 43 | 33 | 0.38 | 0.10 | Rejected |
| 10. | 96 | 58 | 0.77 | 0.38 | Selected |
| 11. | 48 | 9 | 0.29 | 0.39 | Selected |
| 12. | 85 | 46 | 0.65 | 0.39 | Selected |
| 13. | 76 | 42 | 0.59 | 0.34 | Rejected |
| 14. | 69 | 33 | 0.51 | 0.36 | Rejected |
| 15. | 79 | 25 | 0.52 | 0.54 | Selected |
| 16. | 89 | 36 | 0.63 | 0.53 | Selected |
| 17. | 52 | 26 | 0.39 | 0.26 | Rejected |
| 18. | 51 | 28 | 0.39 | 0.23 | Rejected |
| 19. | 91 | 54 | 0.73 | 0.37 | Selected |
| 20. | 63 | 44 | 0.54 | 0.19 | Rejected |
| 21. | 69 | 28 | 0.49 | 0.41 | Selected |
| 22. | 87 | 43 | 0.65 | 0.44 | Selected |
| 23. | 99 | 67 | 0.83 | 0.32 | Rejected |
| 24. | 49 | 32 | 0.41 | 0.17 | Rejected |
| 25. | 49 | 16 | 0.33 | 0.33 | Rejected |
| 26. | 82 | 35 | 0.59 | 0.47 | Selected |
| 27. | 88 | 48 | 0.68 | 0.40 | Selected |
| 28. | 70 | 28 | 0.49 | 0.42 | Selected |
| 29. | 79 | 46 | 0.63 | 0.33 | Rejected |
| 30. | 32 | 31 | 0.32 | 0.01 | Rejected |
| 31. | 79 | 59 | 0.69 | 0.20 | Rejected |
| 32. | 87 | 45 | 0.66 | 0.42 | Selected |
| 33. | 81 | 41 | 0.61 | 0.40 | Selected |
| 34. | 58 | 26 | 0.42 | 0.32 | Rejected |
| 35. | 65 | 27 | 0.46 | 0.38 | Selected |
| 36. | 52 | 30 | 0.41 | 0.22 | Rejected |
| 37. | 64 | 23 | 0.44 | 0.41 | Selected |
| 38. | 17 | 19 | 0.18 | 0.02 | Rejected |
| 39. | 65 | 20 | 0.43 | 0.45 | Selected |
| 40. | 54 | 42 | 0.48 | 0.12 | Rejected |
| 41. | 35 | 30 | 0.33 | 0.05 | Rejected |
| 42. | 88 | 45 | 0.67 | 0.43 | Selected |
| 43. | 86 | 24 | 0.55 | 0.62 | Selected |
| 44. | 87 | 31 | 0.59 | 0.56 | Selected |
| 45. | 35 | 24 | 0.29 | 0.11 | Rejected |
| 46. | 86 | 41 | 0.64 | 0.45 | Selected |
| 47. | 97 | 42 | 0.69 | 0.55 | Selected |
| 48. | 66 | 35 | 0.51 | 0.31 | Rejected |
| 49. | 49 | 25 | 0.37 | 0.24 | Rejected |
| 50. | 54 | 27 | 0.41 | 0.27 | Rejected |
| 51. | 67 | 27 | 0.47 | 0.40 | Selected |
| 52. | 49 | 39 | 0.44 | 0.10 | Rejected |
| 53. | 47 | 29 | 0.38 | 0.18 | Rejected |
| 54. | 75 | 27 | 0.51 | 0.48 | Selected |
| 55. | 83 | 44 | 0.64 | 0.39 | Selected |
| 56. | 62 | 29 | 0.46 | 0.33 | Rejected |
| 57. | 58 | 31 | 0.45 | 0.27 | Rejected |
| 58. | 42 | 18 | 0.30 | 0.24 | Rejected |
| 59. | 95 | 53 | 0.74 | 0.42 | Selected |
| 60. | 64 | 27 | 0.46 | 0.37 | Selected |

**Selection of Items and Preparation of the Final Test**

Item with discrimination power 0.36 and above were readily selected. A total number of 30 items - five items from recognizing and defining the problem, five items from formulating hypotheses, five items from collecting data, five items from interpreting data, five items from evaluating hypotheses, and five items from formulating generalizations - were selected for the final test. The items were combined together in sequence to make it a test of Process Outcomes in Biology. The draft test in Malayalam, Score Sheet (Draft), Scoring Key (Draft), Final test in Malayalam, Scoring Key (Final), its English version are given as Appendices I, II, III, IV, V and VI.

**Reliability and Validity of the Test**

Precision, consistency or stability of scores is different aspects of what is called test reliability. This is one of the desired fundamental characteristics of a standardized test.

The reliability of the present test is assessed using the scores of the final test. In estimating reliability test-retest method was used. This method requires administration and readministration of the test within a time interval for the same group of students. Hence a class of 32 students were tested twice, the interval of time separating the two administration being two weeks.

The obtained scores were correlated using Pearson's Product Moment Coefficient of Correlation. The co-efficient of correlation was found to be 0.590. This shows that the test is reliable to measure the Process Outcomes in Biology of standard IX pupils.

Validity was estimated by finding the correlation between scores of the test of Process Outcomes with the average marks obtained in the second terminal examination in Biology using Pearson's 'r'. Thus the external criteria used for calculating the validity are the marks in Biology for the second terminal examination. The Pearson's Product Moment Coefficient of Correlation was found to be 0.570 for a sample of 32 students, indicating that the test is valid.

The psychometric properties of the test suggest that the test is an adequate instrument for measuring the variable Process Outcomes in Biology of students of standard IX.

**E. SAMPLE FOR THE STUDY**

Selection of the sample is an important aspect of any research study. Best (1996) says that a sample "is a small proportion of a population selected for observation and analysis."

For this study, the population selected is the secondary school pupils. Assessing this population as a whole within the stipulated time is difficult. Hence a representative part of the assessable portion of the population was selected and this sample consists of pupils of standard IX who were tested during the present study.

***i) Sampling Technique***

Stratified Sampling Technique was used to select the sample for ensuring that the population is properly represented. The following factors were considered for the sample selection in this study.

a) Gender of the subjects

b) Rural-Urban location of the school.

c) Management category of the school.

***a) Gender of the subject***

Gender has great influence on findings of research. In Kerala there is almost equal number of Boys and Girls who receive secondary school education. Hence the investigator included approximately equal proportion of Boys and Girls in the sample.

***b) Rural-Urban location of the school***

Student's performance is influenced by their living environment as well as the learning facilities in schools of Rural and Urban areas. While selecting the sample proper representation in this regard was given. The investigator therefore selected Rural and Urban schools for the sample in the 1:1 ratio.

***c) Management Category of the school***

There are two types of school management in Kerala. They are Private and Government schools based on the agencies, which run these schools. Since the number of aided school is more, the proportion taken for Private and Government Managed School is 6:4.

***ii) Size of the sample***

Another important aspect of a research study is the size of the sample. Kretch and Crutchfield (1968) say that a representative sample of 500 is sufficient to get the proper result. The population of the study was students of Standard IX in Kerala. It was difficult to cover the entire population and obtain conclusions, which are valid for the population. Hence the investigator decided to take the sample of population from Kozhikode district. A sample of 700 students from 12 schools was selected. The details of sample distributions are given in Table 3.2.

**TABLE 3.2**  
Break-up of the Sample

|  |  |  |  |
| --- | --- | --- | --- |
|  | Boys | Girls | Total |
| Rural | 171 | 172 | 343 |
| Urban | 178 | 179 | 357 |
| Total | 349 | 351 | 700 |

**F. DATA COLLECTION PROCEDURE**

The investigator after fixing the sample contacted the heads of the concerned schools for obtaining permission for administering the tests.   
A data collection schedule was fixed. The tests were conducted during January – February 2006. The tools were administered with the cooperation of the respective class teacher. One or two divisions were selected from each school and two consecutive days were taken in each school.

Precise instructions as how to respond to the items in the tests and inventories were given to the pupils. The instructions given in the test manual, in the Test of Process outcomes in Biology, was strictly followed. First the test of Process outcomes in Biology and the response sheets were distributed among the pupils and the method of answering is explained. The next period, the Learning Style Inventory and the response sheet were distributed. After this was completed, Multiple Intelligences Inventory and the response sheets were distributed and completed materials were collected back from each student.

**G. SCORING AND CONSOLIDATION OF DATA**

***a) Scoring***

Scoring was done separately for all the response sheets collected from the 12 sample schools. Separate scoring keys were used to score the Learning Style Inventory, Multiple Intelligences Inventory and Test of Process Outcomes in Biology.

The scoring of Learning Style Inventory was scored separately for the four style areas namely, Environmental, Emotional, Sociological and Physical. Similarly Multiple Intelligences Inventory was scored according to the directions given by Dr. Sudheesh Kumar. The scoring of Test of Process Outcomes in Biology was done by using the punched scoring keys. Response sheets with incomplete data had to be rejected. Only those answer sheets, which were complete in all respects, were selected for the final analysis. So the investigator was then left with 700 subjects. The final sample details are given in Table 3.3.

TABLE 3.3

**Details of Final Sample**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Name of School | Type of School | Locale | Management | No. Of Boys | No. Of Girls | Total Pupils |
| 1. | Sevamandhiram Post Basic School, Ramanattukara | Co.ed | Rural | Private | 30 | 26 | 56 |
| 2. | Crescent High School; Vanimel | Co.ed | Rural | Private | 22 27 | 25 16 | 47 43 |
| 3. | T.I.M. Girls School, Nadapuram | Girls | Rural | Private | -- -- | 33 30 | 33 30 |
| 4. | Umbichi Haji High School, Chaliyam | Co.ed | Rural | Private | 23  18 | 23 20 | 46 38 |
| 5. | B.E.M. High School, Vadakara | Co. ed | Urban | Private | 30 | 22 | 52 |
| 6. | Sri. Ramakrishna Mission | Co.ed | Urban | Private | 27 | 16 | 43 |
| 7. | M.M.V.H.S. Parappil | Boys | Urban | Private | 32 | -- | 32 |
| 8. | Govt. Ganapat. H.S., Feroke | Co.ed | Rural | Govt. | 32 | 18 | 50 |
| 9. | G.G.H.S.S., Chalappuram | Girls | Urban | Govt. | -- -- | 42 39 | 42 39 |
| 10. | G.B.H.S.S., Chalappuram | Boys | Urban | Govt. | 41  33 | --  -- | 41  33 |
| 11. | Government Model H.S.S., Calicut | Co.ed | Urban | Govt. | 19 | 24 | 43 |
| 12. | Govt. V.H.S.S., Meenchanda | Co.ed | Rural | Govt. | 15 | 17 | 32 |
|  |  |  |  | Total | 349 | 351 | 700 |

***b. Consolidation of Data***

The different tools were scored. Then the scores of these tools for each student were tabulated. During consolidation the important subgroups, were kept in mind viz; Gender of subject, Locale of the School and Management category of school.

**H. STATISTICAL TECHNIQUES USED**

**1. Preliminary Analysis**

**2. Pearson's Product Moment Coefficient of Correlation**

The most often used and most precise Coefficient of Correlation is known as the Pearson's Product Moment Coefficient (r). The degree of relationship is measured and represented by the coefficient of correlation.



Where,

ΣX = Sum of X scores

ΣY = Sum of the Y scores

ΣX2 = Sum of the squared X score

ΣY2 = Sum of the squared Y Score

ΣXY = Sum of the Products of paired X and Y scores.

N = Number of paired scores.

In this study Correlation Coefficient 'r' is used to find out the extent of relationship between 'Process Outcomes in Biology' and the independent variables 'Learning Style' and 'Multiple Intelligences'.

**3. Stepwise Regression Analysis (by ANOVA approach) [Cohen and Mantion32, (1989)]**

This is a statistical technique to select the set of variables that best predicts the criterion variable and that eliminates superfluous predictor variables.

In regression analysis, the predictor variables are entered one by one on the basis of the size of the partial correlation to see the extent of contribution of each variable in predicting the criterion variable. Hence, as the first step, predictor variable having the highest correlation with the criterion variable is entered. Then, the variable having the next highest partial correlation is entered second and so on. Proceeding like this, a stage may come that further entering of variables won't make significant change either in the percentage variance or in R. It is an indication that the variable entered last and the remaining variables are not significant predictors of the criterion variable.

A model Table of Stepwise Regression Analysis is given as Table 3.4.

TABLE 3.4  
 **Model Table of Stepwise Regression Analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables entered - | | |  |  |
| Multiple R = | β = | SER= | B = | SEB |
|  |  |  |  |  |
| Source | DF` | SS | MSS | F |
| Total |  |  |  |  |
| Regression |  |  |  |  |
| Residual |  |  |  |  |

**3.1. The Coefficient of Determination R2**

The coefficient of determination, R2 in terms of β and r which gives the efficiency of each predictor variable in predicting the criterion variable is calculated using the formula.­

R1­­­­2 (2,3…n) = β12.34 -- nr12 + β13.24 -- nr13 + β14.23 - - nr14 + βln .23-- (n-1) r1n

Where 1 stands for the criterion variable and 2, 3 . . . for the significant predictor variable as found by regression analysis. The product of β and r is used as the index of the predictive efficiency.

ANALYSIS

A statistical analysis of the study as to test the hypotheses stated and a discussion of the results are presented in this chapter. Before entering into the details of analysis and discussion of results, the objectives and hypotheses set up for the study are restated below, to have a clear picture of the study.

**OBJECTIVES**

1. To estimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. To estimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

3. To find out the relationship between different multiple Intelligence groups and their Process Outcomes.

4. To identify the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

**HYPOTHESES**

1. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the total sample.

2. There exists significant relation between Process Outcomes in Biology and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

The analysis of data and interpretations of results are presented under the following heads.

A. Preliminary Analysis.

B. Estimation of extent of relation between 'Process Outcomes in Biology' and each of the select independent variables.

C. Identification of the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

**A. PRELIMINARY ANALYSIS**

Standardized tools were used to collect data for the present investigation. The required data was obtained from the scores of these tools. These data on the variables of the final sample (N=700) were then statistically analyzed.

The important statistical constants of distributions of the independent and dependent variable for the total sample are presented in tables.

The important statistical constants of distributions of the independent variable Multiple Intelligences for the total sample (N=700) are given in Table 4.1.

TABLE 4.1

**Statistical Constants of Distribution of   
Multiple Intelligences for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Mean | Median | Mode | S.D |
| 1. | Multiple Intelligences – Linguistic | 6.249 | 6.000 | 7.000 | 1.705 |
| 2. | Multiple Intelligences – Logical | 5.556 | 6.000 | 6.000 | 1.796 |
| 3. | Multiple Intelligences – Spatial | 6.094 | 6.000 | 7.000 | 1.815 |
| 4. | Multiple Intelligences – Musical | 5.439 | 5.000 | 5.000 | 1.925 |
| 5. | Multiple Intelligences – Bodily | 5.757 | 6.000 | 5.000 | 2.185 |
| 6. | Multiple Intelligences – Naturalistic | 7.346 | 8.000 | 8.000 | 1.749 |
| 7. | Multiple Intelligences – Intrapersonal | 6.991 | 7.000 | 7.000 | 1.707 |
| 8. | Multiple Intelligences – Interpersonal | 6.767 | 7.000 | 7.000 | 1.963 |
| 9. | Multiple Intelligences – Total | 50.156 | 50.000 | 49.000 | 9.303 |

This table reveals that for the independent variable Multiple Intelligences, the Linguistic Intelligence has its three measures of central tendency viz; mean, median and mode are almost equal. The measure of standard deviation is 1.705. Thus the curve for Linguistic Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Logical Intelligence of variable Multiple Intelligences are almost equal. The measure of standard deviation is 1.796. Thus the curve for Logical Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median, mode for Spatial Intelligence of variable Multiple Intelligences are almost equal. The measure of standard deviation is 1.815. Thus curve for Spatial Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz., mean, median and mode for Musical Intelligence are almost equal. The measure of Standard deviation is 1.925. Thus the curve for Musical Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Bodily Intelligence are almost equal. The measure of standard deviation is 2.185.Thus the curve for Bodily intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Naturalistic Intelligence are almost equal. The measure of standard deviation is 1.749. Thus the curve for Naturalistic Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Intrapersonal Intelligence are almost equal. The measure of standard deviation is 1.707. Thus the curve for Intrapersonal Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Interpersonal Intelligence are almost equal. The measure of standard deviation is 1.963.Thus the curve for Interpersonal Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Multiple Intelligences Total are almost equal. The measure of standard deviation is 9.303. Thus the curve for the Multiple Intelligences Total of independent variable Multiple Intelligences approximates normality.

The important statistical constants of distribution of the independent variable Learning Style for the total sample (N=700) are given in Table 4.2.

TABLE 4.2

**Statistical Constants of Distribution of  
Learning Style for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Mean | Median | Mode | S.D |
| 1. | Learning Style - Environmental | 13.097 | 13.000 | 12.000 | 7.922 |
| 2. | Learning Style - Emotional | 16.030 | 16.000 | 16.000 | 3.132 |
| 3. | Learning Style - Sociological | 11.389 | 11.000 | 12.000 | 8.020 |
| 4. | Learning Style – Physical | 18.440 | 19.000 | 18.000 | 3.543 |
| 5. | Learning Style – Total | 58.411 | 59.000 | 59.000 | 8.021 |

This table reveals that for the independent variable Learning Style, the Environmental Style area has its three measures of Central tendency viz; mean, median and mode are almost equal. The measure of S.D is 7.922. Thus the curve for Environmental Style area of independent variable Learning Style approximates normality.

The three measures of central tendency viz; mean, median and mode for Emotional Style area of independent variable Learning Style are almost equal. The measure of S.D is 3.132. Thus the curve for Emotional Style area of independent variable Learning Style approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Sociological Style area of independent variable Learning Style are almost equal. The measure of S.D is 8.020. Thus the curve for Sociological Style area of independent variable Learning Style approximates normality.

The three measures of central tendency viz; mean, median and mode for Physical Style area of independent variable Learning Style are almost equal. The measure of S.D is 3.543. Thus the curve for Physical Style area of independent variable Learning Style approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Learning Style Total of the independent variable Learning Style are almost equal. The measure of S.D is 8.021.Thus the curve for Learning Style Total of independent variable Learning Style approximates normality.

The important statistical constants of distribution of the dependent variable Process Outcomes in Biology for the total sample (N=700) are given in Table 4.3.

## TABLE 4.3

**Statistical Constants of Distribution of   
Process Outcomes in Biology for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Dependent Variable | Mean | Median | Mode | S.D |
| 1. | Process Outcomes in Biology | 14.814 | 14.000 | 13.000 | 5.715 |

The three measures of central tendency in this table viz; mean, median and mode for Process Outcomes in Biology are almost equal. The measure of S.D is 5.715. Thus the curve for Process Outcomes in Biology of dependent variable Process Outcomes in Biology approximates normality.

**B. ESTIMATION OF THE EXTENT OF RELATION BETWEEN PROCESS OUTCOMES IN BIOLOGY AND EACH OF THE SELECT INDEPENDENT VARIABLES**

The data collected have been analyzed to examine the nature and extent of relationship between the dependent variable, 'Process Outcomes in Biology' and each of the independent variables. These were estimated using Pearson's Products Moment Coefficient of Correlation.

a) The results of Correlation of Multiple Intelligences with Process Outcomes in Biology for the total and subsamples are given in table 4.4.

b) The correlation results of Learning Style with Process Outcomes in Biology for the total and subsamples are given in table 4.5.

TABLE 4.4

**Correlation of Multiple Intelligences with Process Outcomes in Biology for the Total and Sub Samples**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable |  | Total | Boys | Girls | Rural | Urban | Private | Government |
| 1. | Multiple Intelligences - Linguistic | r | 1.357 | 0.1696 | 0.0983 | 0.1024 | 0.1733 | .0980 | 0.2276 |
| 2. | Multiple Intelligences - Logical | r | 0.2922 | 0.2759 | 0.3147 | 0.1737 | 0.3863 | 0.2607 | 0.3625 |
| 3. | Multiple Intelligences - Spatial | r | 0.1716 | 0.2278 | 0.1088 | 0.1331 | 0.2126 | 0.1565 | 0.2086 |
| 4. | Multiple Intelligences- Musical | r | 0.0389 | 0.0599 | 0.0229 | 0.1031 | -0.0216 | 0.0597 | 0.0243 |
| 5. | Multiple Intelligences - Bodily | r | 0.0400 | 0.0455 | 0.0336 | 0.0282 | 0.0769 | -0.0326 | 0.1533 |
| 6. | Multiple Intelligences - Naturalistic | r | 0.1992 | 0.1898 | 0.2080 | 0.1949 | 0.2090 | 0.1289 | 0.3007 |
| 7. | Multiple Intelligences - Interpersonal | r | 0.1580 | 0.2085 | 0.0965 | 0.0941 | 0.2298 | 0.1095 | 0.2415 |
| 8. | Multiple Intelligences - Intrapersonal | r | 0.1534 | 0.1097 | 0.1991 | 0.2027 | 0.1229 | 0.1254 | 0.2226 |
| 9. | Multiple Intelligences - Total | r | 0.2294 | 0.2486 | 0.2081 | 0.2011 | 0.2702 | 0.1731 | 0.3361 |

The coefficient of correlation between the Linguistic Intelligence of Independent Variable, Multiple Intelligences and Process Outcomes in Biology for the total sample is 0.1357 and for the subsamples it ranges from 0.09-0.22, which shows there is negligible, positive relationship between these variables. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level out of which, Girls and Private are significant at 0.05 level because it is higher than the table value for significance at that level.

The correlation coefficient between the Logical Intelligence and Process Outcomes in Biology for the total sample is 0.2922 and for the subsamples it ranges from 0.17-0.38, which shows there is low, positive relationship between these variables, out of which, the subsample Rural shows negligible relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The coefficient of correlation between the Spatial Intelligence and Process Outcomes in Biology for the total sample is 0.1716 and for the subsamples it ranges from 0.10-0.22 which shows there is negligible, positive relationship between these variables, out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The correlation coefficient between Musical Intelligence and Process Outcomes in Biology for the total sample is 0.0389 and for the subsamples it ranges from -0.021 - 0.1 which shows there is negligible, positive correlation between these variables, out of which the subsample Urban shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level because it is lower than the table value for significance at that level.

The coefficient of correlation between Bodily Intelligence and Process Outcomes in Biology for the total sample is 0.0400 and for the subsamples it ranges from 0.02-0.15, which shows there is negligible, positive relationship between these variables, out of which the subsample Private shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level except the subsample Government which is significant at 0.05 level.

The Correlation Coefficient between Naturalistic Intelligence and Process Outcomes in Biology for the total sample is 0.1992 and for the subsamples it ranges from 0.18 - 0.30 which shows there is negligible, positive relationship between these variables, out of which the subsamples Girls, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Private which is significant at 0.05 level.

The coefficient of correlation between Intrapersonal Intelligence and Process Outcomes in biology for the total sample is 0.1580 and for the subsamples it ranges from 0.094 -0.2415 which shows there is negligible, positive correlation between these variables out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsamples Girls and Rural which are not significant at 0.01 level.

The correlation coefficient between Interpersonal intelligence and Process Outcomes in Biology for the total sample is 0.1534 and for the sub samples it ranges from 0.10 -0 .22 which shows there is negligible, positive correlation between these variables, out of which the subsamples Rural and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The coefficient of correlation between Multiple Intelligences Total and Process Outcomes in Biology for the total sample is 0.2294 and for the subsamples it ranges from 0.17 -0.33 which shows there is low, positive correlation between these variables. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

TABLE 4.5  
**Correlation of Learning Style with Process Outcomes in Biology for the Total and Subsamples**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Total | Boys | Girls | Rural | Urban | Private | Government |
| 1. | Learning Style - Environmental Style area | 0.0133 | -0.0045 | 0.1113 | 0.0533 | 0.0027 | 0.0592 | -0.0007 |
| 2. | Learning Style - Emotional style area | 0.2138 | 0.2174 | 0.2081 | .0806 | 0.3175 | 0.1475 | 0.3021 |
| 3. | Learning Style - Sociological Style area | 0.0888 | 0.2426 | 0.0767 | .0664 | 0.3213 | 0.0801 | 0.1130 |
| 4. | Learning Style - Physical style area | 0.1868 | 0.2304 | 0.1338 | .0705 | 0.2906 | 0.1552 | 0.2295 |
| 5. | Learning Style - Total | 0.2607 | 0.2962 | 0.2152 | .0705 | 0.4021 | 0.1665 | 0.3808 |

The coefficient of correlation between Environmental Learning Style area and Process Outcomes in Biology for the total sample is 0.0133 and for the subsamples it ranges from -0.0007-0.113 which shows there is negligible, positive correlation between these variables, out of which the subsamples Boys and Government shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level.

The correlation coefficient between Emotional Learning Style area and Process Outcomes in Biology for the total sample is 0.2138 and for the subsamples it ranges from 0.08-0.31 which shows there is low, positive correlation between these variables, out of which the subsamples Rural and Private shows negligible correlation. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Rural which is not significant at 0.01 level.

The coefficient of correlation between Sociological Learning Style area and Process Outcomes in Biology for the total sample is 0.0888 and for the subsamples it ranges from 0.06 -0.32 which shows there is negligible, positive correlation between these variables. The obtained 'r' values for the total and subsamples are statistically not significant out of which the subsamples Boys and Urban are significant at 0.01 level and Total is significant at 0.05 level.

The correlation coefficient between Physical Learning Style area and Process Outcomes in Biology for the total sample is .1868 and for the subsamples it ranges from 0.07-0.29 which shows there is negligible, positive relationship between these variables, out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Girls which is significant at 0.05 level.

The coefficient of correlation between Learning Style Total and Process Outcomes in Biology for the total sample is 0.2607 and for the subsamples it ranges from 0.07-0.38 which shows there is low, positive relationship between these variables, out of which the subsample Private shows negligible relationship and Urban shows moderate relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Rural which is not significant at 0.01 level.

**C. IDENTIFICATION OF THE SIGNIFICANT PREDICTORS OF PROCESS OUTCOMES IN BIOLOGY BY REGRESSION ANALYSIS OF PSYCHOLOGICAL VARIABLES AND ESTIMATION OF THEIR PREDICTIVE EFFICIENCY (IN TERMS OF β AND PARTIAL r's)**

The fourth objective of the study is the Identification of the Significant Psychological Predictors of Process Outcomes in Biology. As almost all the Psychological Variables were found to have significant effect on Process Outcomes in Biology and are significantly related to Process outcomes in Biology (r ranges from 0.038 to 0.29). It becomes apt to conduct Regression Analysis to know the psychological variables, which are significant predictors of Process Outcomes in Biology. The techniques followed for this Stepwise Regression Analysis (ANOVA approach) for which computation was made by means of the SPSS programme of computer.

The basic statistics mean and standard deviation of the criterion and predictor variables are given in Table 4.6 as a preliminary to the Regression Analysis.

TABLE 4.6

**Mean and Standard Deviations   
of the Selected Psychological Variables as   
Input Data for Stepwise Regression Analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| Sl. No. | Psychological Variables | Mean | S.D |
|  | Criterion Variable |  |  |
| 1. | Y- Process Outcomes in Biology | 14.814 | 5.715 |
|  | Predictor Variables |  |  |
| 2. | X1-Linguistic Intelligence | 6.249 | 1.705 |
| 3. | X2 - Logical Intelligence | 5.556 | 1.796 |
| 4. | X3 - Spatial Intelligence | 6.094 | 1.815 |
| 5. | X4 - Musical Intelligence | 5.439 | 1.925 |
| 6. | X5 - Bodily Intelligence | 5.757 | 2.185 |
| 7. | X6 - Naturalistic Intelligence | 7.346 | 1.749 |
| 8. | X7 - Intrapersonal Intelligence | 6.991 | 1.707 |
| 9. | X8 - Interpersonal Intelligence | 6.767 | 1.963 |
| 10. | X9 - Multiple Intelligences- Total | 50.156 | 9.303 |
| 11. | X10 - Environmental Learning Style area | 13.097 | 7.922 |
| 12. | X11 - Emotional Learning Style area | 16.030 | 3.132 |
| 13. | X12 - Sociological learning style area | 11.389 | 8.020 |
| 14. | X13 - Physical Learning Style area | 18.440 | 3.543 |
| 15. | X14 - Learning Style area – Total | 58.411 | 8.021 |

The Correlation Matrix of the criterion variable Process Outcomes in Biology with the Predictor Psychological Variables, which is also an input data of the Regression Analysis, is given in Table 4.7.

**TABLE 4.7**Correlation Matrix of the Criterion Variable with the Predictor Variables

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl No. | Psychological Variables | Y | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 |
|  | **Criterion Variable** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. | Process Outcome in Biology (Y) | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Predictor Variables** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. | X1 - Linguistic Intelligence | .14\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. | X2 - Logical Intelligence | .29\*\* | .14\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. | X3 - Spatial Intelligence | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| 5. | X4 - Musical Intelligence | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |
| 6. | X5 - Bodily Intelligence | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |
| 7. | X6 - Naturalistic Intelligence | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |
| 8. | X7 - Intrapersonal Intelligence | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |
| 9. | X8- Interpersonal Intelligence | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |
| 10. | X9 - Multiple Intelligences- Total | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |
| 11. | X10‑Environmental Learning style area | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |
| 12. | X11 - Emotional Learning style area | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |
| 13. | X12 - Sociological Learning style area | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |
| 14. | X13 - Physical Learning style area | .19\*\* | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |
| 15. | X14‑Learning Style area- Total | .26\*\* | .19\*\* | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |

Note: N = 700 \* Indicates significance of r at 0.05 level; \*\* Indicates Significance of r at 0.01 level.

The indices of correlation reported in Table 4.7 indicates that the predictor variable Logical Intelligence (X2) has the highest correlation (r=.29) with the criterion variable and hence it was selected to enter first in the analysis.

**STEP I**

The result of Step-I analysis is given as Table 4.8.

**RESULT OF STEP-I REGRESSION ANALYSIS**

Variable entered = X2 (Logical Intelligence)

Correlation (r) = 0.2922 . . .

Percentage Variance (r2 x 100) = 8.536 SEr = 5.46

Beta2 (β2) = 0.29 B2 = 0.93 SEB2 = .12

Constant = 9.64

TABLE 4.8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 65.14 (P<0.01) |
| Regression | 1 | 1948.81 | 1948.81 |  |
| Residual | 698 | 20881.04 | 29.915 |  |

The result shown in Table 4.8 suggests that the F-value 65.14 highly exceeds the F-value for significance at 0.01 level for (1,698) df and hence the regressor X2 (Logical Intelligence) is highly significant in predicting the criterion variable Process Outcomes in Biology.

The percentage variance accounted for by the variable Logical Intelligence (X2) in predicting Process Outcomes in Biology is 8.54.

**STEP II**

The second predictor input variable is the one, which has the highest partial correlation with the criterion variable. In this case the variable is Emotional Style area (X11) of the independent variable Learning Style.

The result of this analysis is shown as Table 4.9.

**RESULT OF STEP-II REGRESSION ANALYSIS**

Variables entered: X2 and X11

Multiple Correlation (R) = .328

Percentage Variance (R2 x 100) = 10.81 SER = 5.40

Beta2 (β2) = .26 B2 = .82 SEB2 = .12

Beta11 (β11) = .15 B11 = .28 SEB11 = .07

Constant = 5.75

TABLE 4.9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 42.24  (P<0.01) |
| Regression | 2 | 2467.81 | 1233.90 |  |
| Residual | 697 | 20362.05 | 29.21 |  |

The result shown in Table 4.9 suggests that the obtained F-value 42.24 highly exceeds the F-value for significance at 0.01 level for (2,697) df. The regressor X11 therefore also is highly significant in predicting the criterion variable Process Outcomes in Biology.

Hence the index of predictability 'R' is 0.328 and the Percentage Variance accounted for by the variable Logical Intelligence and Emotional Learning Style area in Predicting Process Outcomes in Biology is 10.81.

This further suggests that by adding (X2 to X11) R the index of prediction has changed from 0.292 to 0.32 and that the percentage variance rose from 8.53 to 10.81. The increase in R is 0.036 and that in percentage variance is 2.27.

**STEP III**

The third variable entered having highest partial correlation with the Criterion Variable is Naturalistic Intelligence (X6).

The result of this Analysis is shown in Table 4.10.

**RESULT OF STEP-III REGRESSION ANALYSIS**

Variables entered: X2, X11 and X6

Multiple Correlation (R) = .347

Percentage Variance (R2 x 100) = 12.06

Beta2 (β2) = 0.22 B2 = 0.70 SER = 5.37

Beta11 (β11) = 0.15 B11 = 0.28 SEB2 = 0.12

Beta6 (β6) = 0.12 B6 = 0.38 SEB11 = 0.07

Constant = 3.619 SEB6 = 0.12

## TABLE 4.10

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 31.80  (P<0.01) |
| Regression | 3 | 2752.12 | 917.3740 |  |
| Residual | 696 | 20077.7 | 28.847 |  |

The result shown in Table 4.10 suggests that the obtained F-value 31.80 exceeds the F-value for significance at 0.01 level for (3,696) df and hence the regressor X6 (Naturalistic Intelligence) also is significant in predicting the criterion variable Process Outcomes in Biology.

Table 4.10 reveals that when the third variable viz., Naturalistic Intelligence was entered; R became 0.347 with percentage variance 12.05. That is, the multiple correlations of the three variables with Process Outcomes in Biology is 0.347 and that the percentage variance accounted for by the three variables Logical Intelligence, Emotional Learning Style area and Naturalistic Intelligence, in predicting Process Outcomes in Biology is 12.05.

This further suggests that by adding X2, X11 and X6, the multiple correlation R has increased from 0.292 to 0.347 and percentage variance has increased from 8.54 to 12.05. The increase in R and percentage variance is 0.055 and 3.51 respectively.

### STEP IV

The fourth variable entered is Physical Learning Style area (X13). The result of this analysis is shown as table 4.11.

### RESULT OF STEP-IV REGRESSION ANALYSIS

Variables entered: X2, X11, X6 and X13

Multiple Correlation (R) = 0.357

Percentage Variance (R2 x 100) = 12.76

Beta2 (β2) = 0.21 B2 = 0.66 SER = 5.35

Beta11 (β11) = 0.12 B11 = 0.23 SEB2 = 0.12

Beta6 (β6) = 0.11 B6 = 0.37 SEB11 = 0.07

Beta13 (β13) = 0.09 B13 = 0.15SEB6 = 0.12

Constant = 2.069 SEB13 = 0.06

## TABLE 4.11

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 25.42  (P<0.01) |
| Regression | 4 | 2913.54 | 728.38 |  |
| Residual | 695 | 19916.31 | 28.65 |  |

The result shown in Table 4.11 suggests that the F-value 25.42 exceeds the F-value for significance at 0.01 level for (4,695) df and that the regression X13 (Physical Learning style area) is also significant in predicting the criterion variable Process Outcomes in Biology.

When the fourth variable Physical Learning Style area was entered, R became 0.357 with percentage variance 12.76. That is the multiple correlation of the fourth variable Physical Learning style area is 0.357 and percentage variance accounted for four variables Logical Intelligence, Emotional Learning Style area, Naturalistic Intelligence and Physical Learning Style area is 12.76.

This further suggests that by adding X13 to X6, X11 and X2 the multiple correlation R has changed from 0.347 to 0.357 and percentage variance from 12.06 to 12.76. The increase in R and percentage variance is 0.01 and 0.7 respectively.

After step IV analysis, it was found that the further addition of predictor variables has not much to contribute to R or for the percentage variance. When fourth variable X13 was entered, R increased only by 0.01 and the percentage variance increased only by 0.7.

Thus it was found out that almost all the Fourteen Psychological Variables have significant effect and relation with Process Outcomes in Biology, only four are significant predictors. These four predictors in the order as found in the Stepwise Regression Analysis, the successive R's percentage variance and increase in R and the percentage variance, reported in Table 4.12.

TABLE 4.12

**Significant Predictors of Regression Analysis**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| STEP | Variables Entered | R | Increase in R | % Of variance (R2 x 100) | Increase in % of variance |
| I | X2 (Logical Intelligence) | 0.292 | -- | 8.54 | -- |
| II | X11 (Emotional Learning Style) area | 0.328 | 0.036 | 10.81 | 2.27 |
| III | X6 (Naturalistic Intelligence) | 0.347 | 0.019 | 12.06 | 1.25 |
| IV | X13 (Physical Learning style area) | 0.357 | 0.01 | 12.76 | 0.7 |

The successive Regression Equation for predicting Process Outcomes in Biology by means of the above four predictor variables is:

i) Ŷ = 0.93 + 9.64

ii) Ŷ = 0.82 +0.28 + 5.75

iii) Ŷ = 0.70 + 0.28 + 0.38 + 3.61

iv) Ŷ = 0.66 + 0.23 + 0.37 + 0.15 + 2.06

When Ŷ denotes the predicted values of Ŷ the criterion Variable Process Outcomes in Biology and X2, X11, X6 and X13 are the significant predictors viz; Logical Intelligence, Emotional Learning Style area, Naturalistic Intelligence and Physical Learning Style area.

**PREDICTIVE EFFICIENCY OF THE SIGNIFICANT PREDICTORS**

The multiple correlation R between the criterion variable Y and of the four significant predictors Logical Intelligence (X2), Emotional Learning Style area (X11), Naturalistic Intelligence (X6), and Physical Learning Style Area (X13) is 0.357 and this index of Prediction is highly significant as SER = 0.12.

This suggests that Process Outcomes in Biology can be significantly predicted by means of the four predictors X2, X11, X6 and X13.

In order to find the predictive efficiency of each of these four significant predictor variables, the coefficient of determination R2 as Σβr is computed and presented in Table 4.13.

TABLE 4.13  
**Relative Weights of the Four Significant Predictor Variables**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable number | Variables | Regression Coefficient (β) | Coefficient of Correlation (r) | β x r |
| X2 | Logical Intelligence | 0.21 | 0.29 | 0.061 |
| X11 | Emotional Learning Style area | 0.12 | 0.21 | 0.025 |
| X6 | Naturalistic Intelligence | 0.11 | 0.20 | 0.022 |
| X13 | Physical Learning Style area | 0.09 | 0.19 | 0.017 |
|  |  |  |  | Σβr= R2=0.125 |

The results of Table 4.13 thus suggests that,

i) 6.19 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Logical Intelligence.

ii) 2.52 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Emotional Learning Style area.

iii) 2.20 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Naturalistic Intelligence.

iv) 1.70 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Physical Learning Style area.

v) R2 = Σβr = 0.125 indicates that 12.5percentage of whatever makes students differ in Process Outcomes in Biology is attributable to differerence in the four predictor variables viz; Logical Intelligence X2, Emotional Learning Style area X11, Naturalistic Intelligence X6 and Physical Learning Style area X13. That is, around 12.5 percentage variance in Process Outcomes in Biology is attributable to the variation in four variables obtained as best predictors by Stepwise Regression Analysis. This also means that the remaining 87.5 percentage of the variance in Process Outcomes in Biology is attributable to the variation in the variables other than those studied.

**FINDINGS**

Four variables were found to be significant predictors of Process Outcomes in Biology. These variables are listed below on the basis of the extent of predictability of Process Outcomes in Biology.

i) Logical Intelligence.

ii) Emotional Learning Style Area

iii) Naturalistic Intelligence

iv) Physical Learning Style Area.

ANALYSIS

A statistical analysis of the study as to test the hypotheses stated and a discussion of the results are presented in this chapter. Before entering into the details of analysis and discussion of results, the objectives and hypotheses set up for the study are restated below, to have a clear picture of the study.

**OBJECTIVES**

1. To estimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. To estimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

3. To find out the relationship between different multiple Intelligence groups and their Process Outcomes.

4. To identify the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

**HYPOTHESES**

1. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the total sample.

2. There exists significant relation between Process Outcomes in Biology and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

The analysis of data and interpretations of results are presented under the following heads.

A. Preliminary Analysis.

B. Estimation of extent of relation between 'Process Outcomes in Biology' and each of the select independent variables.

C. Identification of the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

**A. PRELIMINARY ANALYSIS**

Standardized tools were used to collect data for the present investigation. The required data was obtained from the scores of these tools. These data on the variables of the final sample (N=700) were then statistically analyzed.

The important statistical constants of distributions of the independent and dependent variable for the total sample are presented in tables.

The important statistical constants of distributions of the independent variable Multiple Intelligences for the total sample (N=700) are given in Table 4.1.

TABLE 4.1

**Statistical Constants of Distribution of   
Multiple Intelligences for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Mean | Median | Mode | S.D |
| 1. | Multiple Intelligences – Linguistic | 6.249 | 6.000 | 7.000 | 1.705 |
| 2. | Multiple Intelligences – Logical | 5.556 | 6.000 | 6.000 | 1.796 |
| 3. | Multiple Intelligences – Spatial | 6.094 | 6.000 | 7.000 | 1.815 |
| 4. | Multiple Intelligences – Musical | 5.439 | 5.000 | 5.000 | 1.925 |
| 5. | Multiple Intelligences – Bodily | 5.757 | 6.000 | 5.000 | 2.185 |
| 6. | Multiple Intelligences – Naturalistic | 7.346 | 8.000 | 8.000 | 1.749 |
| 7. | Multiple Intelligences – Intrapersonal | 6.991 | 7.000 | 7.000 | 1.707 |
| 8. | Multiple Intelligences – Interpersonal | 6.767 | 7.000 | 7.000 | 1.963 |
| 9. | Multiple Intelligences – Total | 50.156 | 50.000 | 49.000 | 9.303 |

This table reveals that for the independent variable Multiple Intelligences, the Linguistic Intelligence has its three measures of central tendency viz; mean, median and mode are almost equal. The measure of standard deviation is 1.705. Thus the curve for Linguistic Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Logical Intelligence of variable Multiple Intelligences are almost equal. The measure of standard deviation is 1.796. Thus the curve for Logical Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median, mode for Spatial Intelligence of variable Multiple Intelligences are almost equal. The measure of standard deviation is 1.815. Thus curve for Spatial Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz., mean, median and mode for Musical Intelligence are almost equal. The measure of Standard deviation is 1.925. Thus the curve for Musical Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Bodily Intelligence are almost equal. The measure of standard deviation is 2.185.Thus the curve for Bodily intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Naturalistic Intelligence are almost equal. The measure of standard deviation is 1.749. Thus the curve for Naturalistic Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Intrapersonal Intelligence are almost equal. The measure of standard deviation is 1.707. Thus the curve for Intrapersonal Intelligence of independent variable Multiple Intelligences approximates normality.

The three measures of central tendency viz; mean, median and mode for Interpersonal Intelligence are almost equal. The measure of standard deviation is 1.963.Thus the curve for Interpersonal Intelligence of independent variable Multiple Intelligences approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Multiple Intelligences Total are almost equal. The measure of standard deviation is 9.303. Thus the curve for the Multiple Intelligences Total of independent variable Multiple Intelligences approximates normality.

The important statistical constants of distribution of the independent variable Learning Style for the total sample (N=700) are given in Table 4.2.

TABLE 4.2

**Statistical Constants of Distribution of  
Learning Style for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Mean | Median | Mode | S.D |
| 1. | Learning Style - Environmental | 13.097 | 13.000 | 12.000 | 7.922 |
| 2. | Learning Style - Emotional | 16.030 | 16.000 | 16.000 | 3.132 |
| 3. | Learning Style - Sociological | 11.389 | 11.000 | 12.000 | 8.020 |
| 4. | Learning Style – Physical | 18.440 | 19.000 | 18.000 | 3.543 |
| 5. | Learning Style – Total | 58.411 | 59.000 | 59.000 | 8.021 |

This table reveals that for the independent variable Learning Style, the Environmental Style area has its three measures of Central tendency viz; mean, median and mode are almost equal. The measure of S.D is 7.922. Thus the curve for Environmental Style area of independent variable Learning Style approximates normality.

The three measures of central tendency viz; mean, median and mode for Emotional Style area of independent variable Learning Style are almost equal. The measure of S.D is 3.132. Thus the curve for Emotional Style area of independent variable Learning Style approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Sociological Style area of independent variable Learning Style are almost equal. The measure of S.D is 8.020. Thus the curve for Sociological Style area of independent variable Learning Style approximates normality.

The three measures of central tendency viz; mean, median and mode for Physical Style area of independent variable Learning Style are almost equal. The measure of S.D is 3.543. Thus the curve for Physical Style area of independent variable Learning Style approximates normality.

The table reveals that the three measures of central tendency viz; mean, median and mode for Learning Style Total of the independent variable Learning Style are almost equal. The measure of S.D is 8.021.Thus the curve for Learning Style Total of independent variable Learning Style approximates normality.

The important statistical constants of distribution of the dependent variable Process Outcomes in Biology for the total sample (N=700) are given in Table 4.3.

## TABLE 4.3

**Statistical Constants of Distribution of   
Process Outcomes in Biology for the Total Sample (N=700)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Dependent Variable | Mean | Median | Mode | S.D |
| 1. | Process Outcomes in Biology | 14.814 | 14.000 | 13.000 | 5.715 |

The three measures of central tendency in this table viz; mean, median and mode for Process Outcomes in Biology are almost equal. The measure of S.D is 5.715. Thus the curve for Process Outcomes in Biology of dependent variable Process Outcomes in Biology approximates normality.

**B. ESTIMATION OF THE EXTENT OF RELATION BETWEEN PROCESS OUTCOMES IN BIOLOGY AND EACH OF THE SELECT INDEPENDENT VARIABLES**

The data collected have been analyzed to examine the nature and extent of relationship between the dependent variable, 'Process Outcomes in Biology' and each of the independent variables. These were estimated using Pearson's Products Moment Coefficient of Correlation.

a) The results of Correlation of Multiple Intelligences with Process Outcomes in Biology for the total and subsamples are given in table 4.4.

b) The correlation results of Learning Style with Process Outcomes in Biology for the total and subsamples are given in table 4.5.

TABLE 4.4

**Correlation of Multiple Intelligences with Process Outcomes in Biology for the Total and Sub Samples**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable |  | Total | Boys | Girls | Rural | Urban | Private | Government |
| 1. | Multiple Intelligences - Linguistic | r | 1.357 | 0.1696 | 0.0983 | 0.1024 | 0.1733 | .0980 | 0.2276 |
| 2. | Multiple Intelligences - Logical | r | 0.2922 | 0.2759 | 0.3147 | 0.1737 | 0.3863 | 0.2607 | 0.3625 |
| 3. | Multiple Intelligences - Spatial | r | 0.1716 | 0.2278 | 0.1088 | 0.1331 | 0.2126 | 0.1565 | 0.2086 |
| 4. | Multiple Intelligences- Musical | r | 0.0389 | 0.0599 | 0.0229 | 0.1031 | -0.0216 | 0.0597 | 0.0243 |
| 5. | Multiple Intelligences - Bodily | r | 0.0400 | 0.0455 | 0.0336 | 0.0282 | 0.0769 | -0.0326 | 0.1533 |
| 6. | Multiple Intelligences - Naturalistic | r | 0.1992 | 0.1898 | 0.2080 | 0.1949 | 0.2090 | 0.1289 | 0.3007 |
| 7. | Multiple Intelligences - Interpersonal | r | 0.1580 | 0.2085 | 0.0965 | 0.0941 | 0.2298 | 0.1095 | 0.2415 |
| 8. | Multiple Intelligences - Intrapersonal | r | 0.1534 | 0.1097 | 0.1991 | 0.2027 | 0.1229 | 0.1254 | 0.2226 |
| 9. | Multiple Intelligences - Total | r | 0.2294 | 0.2486 | 0.2081 | 0.2011 | 0.2702 | 0.1731 | 0.3361 |

The coefficient of correlation between the Linguistic Intelligence of Independent Variable, Multiple Intelligences and Process Outcomes in Biology for the total sample is 0.1357 and for the subsamples it ranges from 0.09-0.22, which shows there is negligible, positive relationship between these variables. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level out of which, Girls and Private are significant at 0.05 level because it is higher than the table value for significance at that level.

The correlation coefficient between the Logical Intelligence and Process Outcomes in Biology for the total sample is 0.2922 and for the subsamples it ranges from 0.17-0.38, which shows there is low, positive relationship between these variables, out of which, the subsample Rural shows negligible relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The coefficient of correlation between the Spatial Intelligence and Process Outcomes in Biology for the total sample is 0.1716 and for the subsamples it ranges from 0.10-0.22 which shows there is negligible, positive relationship between these variables, out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The correlation coefficient between Musical Intelligence and Process Outcomes in Biology for the total sample is 0.0389 and for the subsamples it ranges from -0.021 - 0.1 which shows there is negligible, positive correlation between these variables, out of which the subsample Urban shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level because it is lower than the table value for significance at that level.

The coefficient of correlation between Bodily Intelligence and Process Outcomes in Biology for the total sample is 0.0400 and for the subsamples it ranges from 0.02-0.15, which shows there is negligible, positive relationship between these variables, out of which the subsample Private shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level except the subsample Government which is significant at 0.05 level.

The Correlation Coefficient between Naturalistic Intelligence and Process Outcomes in Biology for the total sample is 0.1992 and for the subsamples it ranges from 0.18 - 0.30 which shows there is negligible, positive relationship between these variables, out of which the subsamples Girls, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Private which is significant at 0.05 level.

The coefficient of correlation between Intrapersonal Intelligence and Process Outcomes in biology for the total sample is 0.1580 and for the subsamples it ranges from 0.094 -0.2415 which shows there is negligible, positive correlation between these variables out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsamples Girls and Rural which are not significant at 0.01 level.

The correlation coefficient between Interpersonal intelligence and Process Outcomes in Biology for the total sample is 0.1534 and for the sub samples it ranges from 0.10 -0 .22 which shows there is negligible, positive correlation between these variables, out of which the subsamples Rural and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

The coefficient of correlation between Multiple Intelligences Total and Process Outcomes in Biology for the total sample is 0.2294 and for the subsamples it ranges from 0.17 -0.33 which shows there is low, positive correlation between these variables. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level.

TABLE 4.5  
**Correlation of Learning Style with Process Outcomes in Biology for the Total and Subsamples**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Independent Variable | Total | Boys | Girls | Rural | Urban | Private | Government |
| 1. | Learning Style - Environmental Style area | 0.0133 | -0.0045 | 0.1113 | 0.0533 | 0.0027 | 0.0592 | -0.0007 |
| 2. | Learning Style - Emotional style area | 0.2138 | 0.2174 | 0.2081 | .0806 | 0.3175 | 0.1475 | 0.3021 |
| 3. | Learning Style - Sociological Style area | 0.0888 | 0.2426 | 0.0767 | .0664 | 0.3213 | 0.0801 | 0.1130 |
| 4. | Learning Style - Physical style area | 0.1868 | 0.2304 | 0.1338 | .0705 | 0.2906 | 0.1552 | 0.2295 |
| 5. | Learning Style - Total | 0.2607 | 0.2962 | 0.2152 | .0705 | 0.4021 | 0.1665 | 0.3808 |

The coefficient of correlation between Environmental Learning Style area and Process Outcomes in Biology for the total sample is 0.0133 and for the subsamples it ranges from -0.0007-0.113 which shows there is negligible, positive correlation between these variables, out of which the subsamples Boys and Government shows negative correlation. The obtained 'r' values for the total and subsamples are statistically not significant at 0.01 level.

The correlation coefficient between Emotional Learning Style area and Process Outcomes in Biology for the total sample is 0.2138 and for the subsamples it ranges from 0.08-0.31 which shows there is low, positive correlation between these variables, out of which the subsamples Rural and Private shows negligible correlation. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Rural which is not significant at 0.01 level.

The coefficient of correlation between Sociological Learning Style area and Process Outcomes in Biology for the total sample is 0.0888 and for the subsamples it ranges from 0.06 -0.32 which shows there is negligible, positive correlation between these variables. The obtained 'r' values for the total and subsamples are statistically not significant out of which the subsamples Boys and Urban are significant at 0.01 level and Total is significant at 0.05 level.

The correlation coefficient between Physical Learning Style area and Process Outcomes in Biology for the total sample is .1868 and for the subsamples it ranges from 0.07-0.29 which shows there is negligible, positive relationship between these variables, out of which the subsamples Boys, Urban and Government shows low relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Girls which is significant at 0.05 level.

The coefficient of correlation between Learning Style Total and Process Outcomes in Biology for the total sample is 0.2607 and for the subsamples it ranges from 0.07-0.38 which shows there is low, positive relationship between these variables, out of which the subsample Private shows negligible relationship and Urban shows moderate relationship. The obtained 'r' values for the total and subsamples are statistically significant at 0.01 level except the subsample Rural which is not significant at 0.01 level.

**C. IDENTIFICATION OF THE SIGNIFICANT PREDICTORS OF PROCESS OUTCOMES IN BIOLOGY BY REGRESSION ANALYSIS OF PSYCHOLOGICAL VARIABLES AND ESTIMATION OF THEIR PREDICTIVE EFFICIENCY (IN TERMS OF β AND PARTIAL r's)**

The fourth objective of the study is the Identification of the Significant Psychological Predictors of Process Outcomes in Biology. As almost all the Psychological Variables were found to have significant effect on Process Outcomes in Biology and are significantly related to Process outcomes in Biology (r ranges from 0.038 to 0.29). It becomes apt to conduct Regression Analysis to know the psychological variables, which are significant predictors of Process Outcomes in Biology. The techniques followed for this Stepwise Regression Analysis (ANOVA approach) for which computation was made by means of the SPSS programme of computer.

The basic statistics mean and standard deviation of the criterion and predictor variables are given in Table 4.6 as a preliminary to the Regression Analysis.

TABLE 4.6

**Mean and Standard Deviations   
of the Selected Psychological Variables as   
Input Data for Stepwise Regression Analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| Sl. No. | Psychological Variables | Mean | S.D |
|  | Criterion Variable |  |  |
| 1. | Y- Process Outcomes in Biology | 14.814 | 5.715 |
|  | Predictor Variables |  |  |
| 2. | X1-Linguistic Intelligence | 6.249 | 1.705 |
| 3. | X2 - Logical Intelligence | 5.556 | 1.796 |
| 4. | X3 - Spatial Intelligence | 6.094 | 1.815 |
| 5. | X4 - Musical Intelligence | 5.439 | 1.925 |
| 6. | X5 - Bodily Intelligence | 5.757 | 2.185 |
| 7. | X6 - Naturalistic Intelligence | 7.346 | 1.749 |
| 8. | X7 - Intrapersonal Intelligence | 6.991 | 1.707 |
| 9. | X8 - Interpersonal Intelligence | 6.767 | 1.963 |
| 10. | X9 - Multiple Intelligences- Total | 50.156 | 9.303 |
| 11. | X10 - Environmental Learning Style area | 13.097 | 7.922 |
| 12. | X11 - Emotional Learning Style area | 16.030 | 3.132 |
| 13. | X12 - Sociological learning style area | 11.389 | 8.020 |
| 14. | X13 - Physical Learning Style area | 18.440 | 3.543 |
| 15. | X14 - Learning Style area – Total | 58.411 | 8.021 |

The Correlation Matrix of the criterion variable Process Outcomes in Biology with the Predictor Psychological Variables, which is also an input data of the Regression Analysis, is given in Table 4.7.

**TABLE 4.7**Correlation Matrix of the Criterion Variable with the Predictor Variables

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sl No. | Psychological Variables | Y | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 |
|  | **Criterion Variable** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. | Process Outcome in Biology (Y) | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Predictor Variables** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. | X1 - Linguistic Intelligence | .14\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. | X2 - Logical Intelligence | .29\*\* | .14\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. | X3 - Spatial Intelligence | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| 5. | X4 - Musical Intelligence | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |
| 6. | X5 - Bodily Intelligence | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |  |
| 7. | X6 - Naturalistic Intelligence | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |  |
| 8. | X7 - Intrapersonal Intelligence | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |  |
| 9. | X8- Interpersonal Intelligence | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |  |
| 10. | X9 - Multiple Intelligences- Total | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |  |
| 11. | X10‑Environmental Learning style area | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |  |
| 12. | X11 - Emotional Learning style area | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |  |
| 13. | X12 - Sociological Learning style area | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |  |
| 14. | X13 - Physical Learning style area | .19\*\* | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |  |
| 15. | X14‑Learning Style area- Total | .26\*\* | .19\*\* | .09\* | .21\*\* | .01 | .23\*\* | .15\*\* | .16\*\* | .20\*\* | .04 | .03 | .17\*\* | .29\*\* | .13\*\* | 1.00 |

Note: N = 700 \* Indicates significance of r at 0.05 level; \*\* Indicates Significance of r at 0.01 level.

The indices of correlation reported in Table 4.7 indicates that the predictor variable Logical Intelligence (X2) has the highest correlation (r=.29) with the criterion variable and hence it was selected to enter first in the analysis.

**STEP I**

The result of Step-I analysis is given as Table 4.8.

**RESULT OF STEP-I REGRESSION ANALYSIS**

Variable entered = X2 (Logical Intelligence)

Correlation (r) = 0.2922 . . .

Percentage Variance (r2 x 100) = 8.536 SEr = 5.46

Beta2 (β2) = 0.29 B2 = 0.93 SEB2 = .12

Constant = 9.64

TABLE 4.8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 65.14 (P<0.01) |
| Regression | 1 | 1948.81 | 1948.81 |  |
| Residual | 698 | 20881.04 | 29.915 |  |

The result shown in Table 4.8 suggests that the F-value 65.14 highly exceeds the F-value for significance at 0.01 level for (1,698) df and hence the regressor X2 (Logical Intelligence) is highly significant in predicting the criterion variable Process Outcomes in Biology.

The percentage variance accounted for by the variable Logical Intelligence (X2) in predicting Process Outcomes in Biology is 8.54.

**STEP II**

The second predictor input variable is the one, which has the highest partial correlation with the criterion variable. In this case the variable is Emotional Style area (X11) of the independent variable Learning Style.

The result of this analysis is shown as Table 4.9.

**RESULT OF STEP-II REGRESSION ANALYSIS**

Variables entered: X2 and X11

Multiple Correlation (R) = .328

Percentage Variance (R2 x 100) = 10.81 SER = 5.40

Beta2 (β2) = .26 B2 = .82 SEB2 = .12

Beta11 (β11) = .15 B11 = .28 SEB11 = .07

Constant = 5.75

TABLE 4.9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 42.24  (P<0.01) |
| Regression | 2 | 2467.81 | 1233.90 |  |
| Residual | 697 | 20362.05 | 29.21 |  |

The result shown in Table 4.9 suggests that the obtained F-value 42.24 highly exceeds the F-value for significance at 0.01 level for (2,697) df. The regressor X11 therefore also is highly significant in predicting the criterion variable Process Outcomes in Biology.

Hence the index of predictability 'R' is 0.328 and the Percentage Variance accounted for by the variable Logical Intelligence and Emotional Learning Style area in Predicting Process Outcomes in Biology is 10.81.

This further suggests that by adding (X2 to X11) R the index of prediction has changed from 0.292 to 0.32 and that the percentage variance rose from 8.53 to 10.81. The increase in R is 0.036 and that in percentage variance is 2.27.

**STEP III**

The third variable entered having highest partial correlation with the Criterion Variable is Naturalistic Intelligence (X6).

The result of this Analysis is shown in Table 4.10.

**RESULT OF STEP-III REGRESSION ANALYSIS**

Variables entered: X2, X11 and X6

Multiple Correlation (R) = .347

Percentage Variance (R2 x 100) = 12.06

Beta2 (β2) = 0.22 B2 = 0.70 SER = 5.37

Beta11 (β11) = 0.15 B11 = 0.28 SEB2 = 0.12

Beta6 (β6) = 0.12 B6 = 0.38 SEB11 = 0.07

Constant = 3.619 SEB6 = 0.12

## TABLE 4.10

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 31.80  (P<0.01) |
| Regression | 3 | 2752.12 | 917.3740 |  |
| Residual | 696 | 20077.7 | 28.847 |  |

The result shown in Table 4.10 suggests that the obtained F-value 31.80 exceeds the F-value for significance at 0.01 level for (3,696) df and hence the regressor X6 (Naturalistic Intelligence) also is significant in predicting the criterion variable Process Outcomes in Biology.

Table 4.10 reveals that when the third variable viz., Naturalistic Intelligence was entered; R became 0.347 with percentage variance 12.05. That is, the multiple correlations of the three variables with Process Outcomes in Biology is 0.347 and that the percentage variance accounted for by the three variables Logical Intelligence, Emotional Learning Style area and Naturalistic Intelligence, in predicting Process Outcomes in Biology is 12.05.

This further suggests that by adding X2, X11 and X6, the multiple correlation R has increased from 0.292 to 0.347 and percentage variance has increased from 8.54 to 12.05. The increase in R and percentage variance is 0.055 and 3.51 respectively.

### STEP IV

The fourth variable entered is Physical Learning Style area (X13). The result of this analysis is shown as table 4.11.

### RESULT OF STEP-IV REGRESSION ANALYSIS

Variables entered: X2, X11, X6 and X13

Multiple Correlation (R) = 0.357

Percentage Variance (R2 x 100) = 12.76

Beta2 (β2) = 0.21 B2 = 0.66 SER = 5.35

Beta11 (β11) = 0.12 B11 = 0.23 SEB2 = 0.12

Beta6 (β6) = 0.11 B6 = 0.37 SEB11 = 0.07

Beta13 (β13) = 0.09 B13 = 0.15SEB6 = 0.12

Constant = 2.069 SEB13 = 0.06

## TABLE 4.11

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | DF | SS | MSS | F |
| Total | 699 |  |  | 25.42  (P<0.01) |
| Regression | 4 | 2913.54 | 728.38 |  |
| Residual | 695 | 19916.31 | 28.65 |  |

The result shown in Table 4.11 suggests that the F-value 25.42 exceeds the F-value for significance at 0.01 level for (4,695) df and that the regression X13 (Physical Learning style area) is also significant in predicting the criterion variable Process Outcomes in Biology.

When the fourth variable Physical Learning Style area was entered, R became 0.357 with percentage variance 12.76. That is the multiple correlation of the fourth variable Physical Learning style area is 0.357 and percentage variance accounted for four variables Logical Intelligence, Emotional Learning Style area, Naturalistic Intelligence and Physical Learning Style area is 12.76.

This further suggests that by adding X13 to X6, X11 and X2 the multiple correlation R has changed from 0.347 to 0.357 and percentage variance from 12.06 to 12.76. The increase in R and percentage variance is 0.01 and 0.7 respectively.

After step IV analysis, it was found that the further addition of predictor variables has not much to contribute to R or for the percentage variance. When fourth variable X13 was entered, R increased only by 0.01 and the percentage variance increased only by 0.7.

Thus it was found out that almost all the Fourteen Psychological Variables have significant effect and relation with Process Outcomes in Biology, only four are significant predictors. These four predictors in the order as found in the Stepwise Regression Analysis, the successive R's percentage variance and increase in R and the percentage variance, reported in Table 4.12.

TABLE 4.12

**Significant Predictors of Regression Analysis**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| STEP | Variables Entered | R | Increase in R | % Of variance (R2 x 100) | Increase in % of variance |
| I | X2 (Logical Intelligence) | 0.292 | -- | 8.54 | -- |
| II | X11 (Emotional Learning Style) area | 0.328 | 0.036 | 10.81 | 2.27 |
| III | X6 (Naturalistic Intelligence) | 0.347 | 0.019 | 12.06 | 1.25 |
| IV | X13 (Physical Learning style area) | 0.357 | 0.01 | 12.76 | 0.7 |

The successive Regression Equation for predicting Process Outcomes in Biology by means of the above four predictor variables is:

i) Ŷ = 0.93 + 9.64

ii) Ŷ = 0.82 +0.28 + 5.75

iii) Ŷ = 0.70 + 0.28 + 0.38 + 3.61

iv) Ŷ = 0.66 + 0.23 + 0.37 + 0.15 + 2.06

When Ŷ denotes the predicted values of Ŷ the criterion Variable Process Outcomes in Biology and X2, X11, X6 and X13 are the significant predictors viz; Logical Intelligence, Emotional Learning Style area, Naturalistic Intelligence and Physical Learning Style area.

**PREDICTIVE EFFICIENCY OF THE SIGNIFICANT PREDICTORS**

The multiple correlation R between the criterion variable Y and of the four significant predictors Logical Intelligence (X2), Emotional Learning Style area (X11), Naturalistic Intelligence (X6), and Physical Learning Style Area (X13) is 0.357 and this index of Prediction is highly significant as SER = 0.12.

This suggests that Process Outcomes in Biology can be significantly predicted by means of the four predictors X2, X11, X6 and X13.

In order to find the predictive efficiency of each of these four significant predictor variables, the coefficient of determination R2 as Σβr is computed and presented in Table 4.13.

TABLE 4.13  
**Relative Weights of the Four Significant Predictor Variables**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable number | Variables | Regression Coefficient (β) | Coefficient of Correlation (r) | β x r |
| X2 | Logical Intelligence | 0.21 | 0.29 | 0.061 |
| X11 | Emotional Learning Style area | 0.12 | 0.21 | 0.025 |
| X6 | Naturalistic Intelligence | 0.11 | 0.20 | 0.022 |
| X13 | Physical Learning Style area | 0.09 | 0.19 | 0.017 |
|  |  |  |  | Σβr= R2=0.125 |

The results of Table 4.13 thus suggests that,

i) 6.19 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Logical Intelligence.

ii) 2.52 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Emotional Learning Style area.

iii) 2.20 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Naturalistic Intelligence.

iv) 1.70 percent of the variance of Process Outcomes in Biology is accountable by the Predictor Variable Physical Learning Style area.

v) R2 = Σβr = 0.125 indicates that 12.5percentage of whatever makes students differ in Process Outcomes in Biology is attributable to differerence in the four predictor variables viz; Logical Intelligence X2, Emotional Learning Style area X11, Naturalistic Intelligence X6 and Physical Learning Style area X13. That is, around 12.5 percentage variance in Process Outcomes in Biology is attributable to the variation in four variables obtained as best predictors by Stepwise Regression Analysis. This also means that the remaining 87.5 percentage of the variance in Process Outcomes in Biology is attributable to the variation in the variables other than those studied.

**FINDINGS**

Four variables were found to be significant predictors of Process Outcomes in Biology. These variables are listed below on the basis of the extent of predictability of Process Outcomes in Biology.

i) Logical Intelligence.

ii) Emotional Learning Style Area

iii) Naturalistic Intelligence

iv) Physical Learning Style Area.

SUMMARY, CONCLUSIONS  
 AND SUGGESTIONS

This section of the report provides a summary of the procedure, important findings of the study, tenability of hypotheses, educational implications and suggestions for further research.

## A. STUDY IN RETROSPECT

The study was entitled “RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS”.

## VARIABLES OF THE STUDY

The study was designed with Process Outcomes in Biology as the dependent variable and two variables Learning Style and Multiple Intelligences as the independent variables.

**OBJECTIVES**

1 Toestimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2**.** Toestimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

a. Gender

b. Locale

c. Management

3. To find out the relationship between different Multiple Intelligence groups and their Process Outcomes.

4. To identifythe Significant Predictors of 'Process Outcomes in Biology' by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r' s).

**HYPOTHESES**

1. There exists significant relation between 'Process Outcome in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

a. Gender

b. Locale

c. Management

**METHODOLOGY**

The methodology of the present investigation is given below.

**a. Sample**

The study was conducted on a stratified sample of 700 students of standard IX. The sample was drawn giving due representation to factors like Gender, Locale and Type of Management of school.

**b. Tools**

Standardized tools of satisfactory reliability and validity were used for measuring the variables. The tools used were,

1. Learning Style Inventory developed by Kumar, P.K.S *et al*, (1996).

2. Multiple Intelligences Inventory (developed and standardized by Kumar et al).

3. Test of Process Outcomes in Biology (developed and standardized by Rashada Banu and A. Faziluddin, 2006).

**STATISTICAL TECHNIQUES USED**

The following statistical techniques were used for the study

1. Preliminary Analysis.

2. Pearson's Product Moment Coefficient Of Correlation.

3. Multiple Regression- Stepwise Analysis were used by SPSS (Statistical Package for Social Sciences) method.

**B. MAJOR FINDINGS OF THE STUDY**

Important findings of the study are presented below

**1. Estimation of the extent of relation between 'Process Outcomes in Biology' and each of the select independent variables.**

The relation between 'Process Outcomes in Biology' and each of the select independent variables for the total sample and subsamples were studied. The results of 'r' are presented in table 5.1.

TABLE 5.1

### Summary of Correlation between Process Outcomes in Biology and Select Independent Variables

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Total | Boys | Girls | Rural | Urban | Private | Govern-ment |
| **A.** 1. | **Multiple Intelligences** Linguistic Intelligence | r | 0.1357 | 0.1696 | 0.0983 | 0.1024 | 0.1733 | 0.0980 | 0.2276 |
| 2. | Logical Intelligence | r | 0.2922 | 0.2759 | 0.3147 | 0.1737 | 0.3863 | 0.2607 | 0.3625 |
| 3. | Spatial Intelligence | r | 0.1716 | 0.2278 | 0.1088 | 0.1331 | 0.2126 | 0.1565 | 0.2086 |
| 4. | Musical Intelligence | r | 0.0389 | 0.0599 | 0.0229 | 0.1031 | -0.0216 | 0.0597 | 0.0243 |
| 5. | Bodily Intelligence | r | 0.0400 | 0.0455 | 0.0336 | 0.0282 | 0.0769 | -0.0326 | 0.1533 |
| 6. | Naturalistic Intelligence | r | 0.1992 | 0.1898 | 0.2080 | 0.1949 | 0.2090 | 0.1289 | 0.3007 |
| 7. | Intrapersonal Intelligence | r | 0.1580 | 0.2085 | 0.0965 | 0.0941 | 0.2298 | 0.1095 | 0.2415 |
| 8. | Interpersonal Intelligence | r | 0.1534 | 0.1097 | 0.1991 | 0.2027 | 0.1229 | 0.1254 | 0.2226 |
| 9 | Multiple Intelligences- Total | r | 0.2294 | 0.2486 | 0.2981 | 0.2011 | 0.2702 | 0.1731 | 0.3361 |
| **B.** 1. | Learning Style Environmental Style area | r | 0.0133 | -0.0045 | 0.1113 | 0.0533 | 0.0027 | 0.0592 | -0.0007 |
| 2. | Emotional Style area | r | 0.2138 | 0.2174 | -0.2081 | 0.0806 | 0.3175 | 0.1475 | 0.3023 |
| 3. | Sociological Style area | r | 0.0888 | 0.2426 | 0.0767 | 0.0664 | 0.3213 | 0.0801 | 0.1130 |
| 4. | Physical Style area | r | 0.1868 | 0.2304 | 0.1338 | 0.0705 | 0.2906 | 0.1552 | 0.2295 |
| 5. | Learning Style area- Total | r | 0.2607 | 0.2962 | 0.2152 | 0.0705 | 0.4021 | 0.1665 | 0.3808 |

**a) For the total sample**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Linguistic Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology in Biology' and the 'Logical Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Spatial Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Musical Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Bodily Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Naturalistic Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Intrapersonal Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Interpersonal Intelligence' of the independent variable Multiple Intelligences.

The results showed that low relation exists between 'Process Outcomes in Biology' and the 'Multiple Intelligences-Total' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Environmental Style Area' of the independent variable Learning Style.

The results showed low relation exists between 'Process Outcomes in Biology' and the 'Emotional Style Area' of the independent variable Learning Style.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Sociological Style Area' of the independent variable Learning Style.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the Physical Style Area of the independent variable Learning Style.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology, and the Learning Style-Total of the independent variable Learning Style.

**b) For the subsamples**

**i) Boys**

The results showed that there exists, a negligible relationship between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Logical, Spatial, Intrapersonal and Multiple Intelligences-Total which shows low relationship.

It was noted that there exits, a negligible relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which the components Emotional and Learning style-Total shows low relationship.

**ii) Girls**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Logical, Naturalistic and Multiple Intelligences-Total, which show low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which the components Emotional and Learning Style-Total shows low relationship.

**iii) Rural**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Interpersonal and Multiple Intelligences-Total, which shows low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and all the components of Learning Style.

**iv) Urban**

The results showed that low relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Linguistic, Musical, Bodily and Interpersonal shows negligible relationship.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which Environmental shows negligible relationship and Learning Style Area-Total shows moderate relationship.

**v) Private**

The results showed that negligible relation exists between 'Process Outcome in Biology' and all the components of Multiple Intelligences except the component Logical that shows low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and all the components of Learning Style Area.

**vi) Government**

The results showed that low relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Musical and Bodily, which shows negligible relationship.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which Environmental and Sociological Style shows negligible relationship.

**2 Identification Of The Significant Predictors Of Process Outcomes In Biology By Regression Analysis Of Psychological Variables And Estimation Of Their Predictive Efficiency (in terms of β and partial r 's).**

Identification of Significant Predictors of Process Outcomes in Biology by Regression Analysis resulted that among the fourteen psychological variables; only four variables are significant predictors. These four variables are Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning Style Area. The Predictor variables entered in each step of Stepwise Regression Analysis, the value of Multiple Correlation R and the Multiple Regression equation developed in the successive steps are given as table 5.2.

TABLE 5.2

Multiple Correlation R and Multiple Regression Equation Developed in the Successive stepwise Regression Analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Variables Entered** | **Multiple Correlation R** | **Regression Equation** |
| **I** | **X2 (Logical Intelligence).** | **0.292** | **Y^­ = 0.93X2 + 9.64** |
| **II.** | **X11 (Emotional Learning Style area).** | **0.328** | **Y^ = 0.82X­­­11+ 0.28 + 5.75** |
| **III** | **X6 (Naturalistic Intelligence).** | **0.347** | **Y^ = 0.70X6 + 0.28+0.38+3.61** |
| **IV** | **X13 (Physical learning Style area).** | **0.357** | **Y^=0.66X13+0.23+0.37+0.15+2.06** |

Note (i) All the values of Multiple Correlation R cited are significant at 0.01 level

(ii) Y^ is the predicted value of Y, the Process Outcomes in Biology.

.

2.1 The Coefficient of Multiple Determination, R2 as ∑βr = 0.125 suggests 12.5 percent of variance in Process Outcomes in Biology is attributable to the four psychological variables identified as significant predictors. So that contribution of each significant predictor is as follows.

1) Logical Intelligence = 6.21 percentage.

2) Emotional Learning Style Area = 2.52 percentage.

3) Naturalistic Intelligence = 2.20 percentage.

4) Physical Learning Style Area = 1.70 percentage.

**C. TENABILITY OF HYPOTHESES**

The tenability of hypotheses is examined in the light of the above findings.

Hypotheses 1, states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, (Learning Style and Multiple Intelligences) for the total sample.

The results of Pearson's Product Moment Correlation calculated between 'Process Outcomes in Biology' and each of the two main variables namely, 'Multiple Intelligences' and 'Learning Style' and their component dimensions reveal the following. Multiple Intelligences-Total and its components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal, Interpersonal and Learning Style-Total and its four components areas Emotional, Sociological and Physical are significantly and positively related to 'Process Outcomes in Biology' in all or majority of total samples.

Hence Hypotheses 1 is partially substantiated

Hypotheses 2 (a), states that there exists significant relation between ‘Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples based on Gender. For the independent variable Multiple Intelligences-Total and its six components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The Value of 'r' is not significant for Girls in Intrapersonal Intelligence. For the variable Learning Style-Total and its three component areas Emotional, Sociological and Physical are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Girls in Sociological Style Area.

Hence Hypotheses 2 (a) is partially substantiated.

Hypotheses 2 (b), states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, 'Multiple Intelligences' and 'Learning Style' for the relevant subsample based on Locale. For the independent variable, Multiple Intelligences-Total and its seven components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal, and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Rural in Interpersonal Intelligence. For the variable Learning Style-Total and its three components Emotional, Sociological and Physical Learning Style are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Rural in Emotional, Sociological and Total Learning Style Area.

Hence Hypotheses 2 (b) is partially substantiated.

Hypotheses 2 (c) states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ‘Multiple Intelligences' and 'Learning Style' for the relevant subsample based on Management. For the Independent variable, Multiple Intelligences-Total and its seven components Logical, Linguistic, Spatial, Bodily, Naturalistic, Intrapersonal and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Private in Bodily Intelligence. For the variable Learning Style-Total and its two component areas Emotional and Physical Area are significantly and positively related to 'Process Outcomes in Biology'.

Hence Hypotheses 2 (c) is partially substantiated.

**D. CONCLUSIONS**

The investigator made the following conclusions after conducting the study.

In the independent variable Multiple Intelligences and the component dimensions Linguistic, Spatial, Naturalistic, Intrapersonal, Interpersonal Intelligence and Multiple Intelligences-Total have found to be significantly and positively related to 'Process Outcomes in Biology'.

It is concluded from the findings that Musical and Bodily Intelligence have no significant relationship with 'Process Outcomes in Biology'.

In the independent variable Learning Style the component style areas Emotional, Sociological, Physical and Learning Style-Total have found to be significantly and positively related to 'Process Outcomes in Biology'.

It is concluded from the findings that Environmental Learning Style Area has no significant relationship with 'Process Outcomes in Biology'.

From the findings it is obvious that

1. The Musical and Bodily Intelligence of the Multiple Intelligences have no impact on 'Process Outcomes in Biology'.

2. The Environmental Style Area has no impact on 'Process Outcomes in Biology'.

It was found out that almost all the fourteen psychological variables have significant effect and relation with 'Process Outcomes in Biology', indicating that all the variables are able to predict Process Outcomes in Biology. But Stepwise Regression Analysis pointed out, only four of the fourteen psychological predictor variables as significant predictor of Process Outcomes in Biology. These four predictors contributing 12.5 percent of variance in the variance of Process Outcomes in Biology are Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning Style Area.

All these findings led the investigator to conclude that out of the Fourteen Psychological Variables, put as predictor (independent) variables; only four of them viz; Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning style Area are turned to be the significant predictors of Process Outcomes in Biology with 6.21 percentage, 2.52 percentage, 2.20 percentage and 1.70 percentage respectively as the percentage of variances contributable to the variation in the variance of Process Outcomes in Biology.

**E. EDUCATIONAL IMPLICATIONS**

In the light of results of the present investigation, certain suggestions were put forth for improving the existing educational practices.

1 In the present study the results of correlation analysis of Multiple Intelligences reveals that its components Logical Intelligence and Naturalistic Intelligence is highly related with 'Process Outcomes in Biology' and other dimensions are related only to a negligible extent. So teachers should be trained to present their lessons in a wide variety giving importance to provide activities which enhance the power of Logical and Naturalistic Intelligence for improving student's processing skill.

It is clear from the findings that the Emotional Learning Style Area and Physical Learning Style Areas are more related to 'Process Outcomes in Biology' and other areas are related only to a negligible extent. It helps the teachers to provide a stimulating, challenging and happy classroom with achieving pupils. By knowing preferred Style areas of students having high process outcomes, will help the teachers to provide learning style best suited for maximum efficiency in processing skills. They can stimulate the students to develop process skills for aspiring and maximizing performance in Biology.

The study also helped to identify certain Psychological Variables, which correlates significantly with 'Process Outcomes in Biology'. The present study has also helped to find out the best predictors of 'Process Outcomes in Biology' from among the set of certain Psychological Variables. It also helps to expand our horizon of available teaching or learning tools beyond the conventional Linguistic and Logical methods used in most school.

## F. SUGGESTIONS FOR FURTHER RESEARCH

The findings of the study and the limitations encountered in the present study helped the investigator to suggest the following for further research.

1. Causal relationship of Learning Style, Multiple Intelligences and Process Outcomes in Biology can be studied separately for Boys, Girls, Rural and Urban subjects.

2. Replication of the present study using samples from Higher Secondary and College levels.

3. The investigation in the present study can be extended to other sciences like Physical sciences.

4. Interaction effect of Leaning Style (total and component style areas) and Multiple Intelligences (total and component dimensions) on 'Process Outcomes' in other school subjects can be studied.

5. An experimental study to enquire into how far the components of Multiple Intelligences and Learning Style influences in the attainment of Process Skills in Biology.

6. Effectiveness of teaching methods in the development of Process Outcomes in Biology of Standard IX pupils.

7. Comparative study of the Relation of Learning Style with Process Outcomes in Biology for Primary and Secondary School children.

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**SUMMARY**

Science is an endless voyage of discovery, a continued venture into the unknown, a quest to know and understand the world in which we live. The current innovations in schools emphasize the processes of science, the way in which scientists advance their knowledge and solve problems. Traditionally science education has been dominated by the transmission of knowledge as the principal component of teaching and was mostly content oriented. Science education should aim at developing scientific values such as accepting truth, respect for evidence, seeking clarification, open mindedness and being objective in interpretation. To achieve these expected learning outcomes, the teacher has to allow students to construct their own concept, to work at their own pace and to provide all students with opportunities to engage in learning tasks. This demands changes in the various aspects of instructional methods.

Since science education is viewed seriously, the student's ability of process outcomes in science is likely to be of very high profile. Science has both process and product approaches. Process denotes the learning experiences given to the learner, which results in product that denotes the learning outcomes. As science education is process oriented, emphasis on process outcomes has found its way into every level of education from the elementary school to the university. In order to understand science, the students must not only have some understanding of the concepts, theories, principles and laws of the particular discipline, but must also be able to appreciate how this knowledge is obtained and how it is organized into a logical framework. This has developed a process approach to science learning. The process skills required for learning science and understanding its process, which are present in the students can be made explicit through the evaluation of their Process Outcomes.

In schools, students are all instructed the same way in the classroom, yet the way they process and learn new information is as unique as their potentialities. Specifically biological science students may show unique learning style preferences. Optimising learning for all students in classrooms can be achieved through creating multiple learning opportunities and style shifts for all students as their differences are valued and celebrated (Sulaiman, 1996). It is hypothesized that learner characteristics and individual differences have considerable bearing upon the learning process and learning outcomes. An awareness of Learning Styles of pupils having high Process Outcomes will facilitate in the development of an appropriate framework, within which teaching should be carried out to optimize effectiveness in process skills.

As the early concept of intelligence has changed, it is now reflecting in teaching learning process. Howard Gardner argued that we do not have one underlying general intelligence, but instead have Multiple Intelligences each being controlled by an independent system in the brain. The theory of Multiple Intelligences is presently being applied in classrooms. It provides educators with an expanded framework to use when assessing the student's strengths, potentialities and strongest intelligences, which promote Process Outcomes. The present study aims to explore the relation of Learning Style and Multiple Intelligences with Process Outcomes in Biology.

# NEED AND SIGNIFICANCE OF THE STUDY

Science is a creative process, which has so much of importance in life, that it cannot be denied an important place in the school curriculum. Science Learning should emphasize on understanding of scientific processes like recognizing and defining the problem, formulating hypotheses, collecting data, interpreting data etc. Hence both the objectives and the curriculum are being redefined to make them more oriented towards process outcomes. It helps the teachers to improve their teaching skills to develop Process Outcomes in students and to identify the specific components to maximize the Process Outcomes. To improve creativity and divergent thinking training in process skills is necessary. The process skills exhibited by the students can be measured through their Process Outcomes.

Effective and less effective learners can be differentiated in terms of their learning strategies and less effective student can be assisted in developing skill at strategy use through instruction. Knowledge about the Learning Styles and brain behaviour is a fundamental tool at the service of teachers and schools. It will facilitate in the development of an appropriate framework within which a sound theory and practice of learning and instruction may be built. Once Learning Style have been identified, instructors can estimate the approach(s), method(s) and sequence(s) that are likely to make learning relatively comfortable for each person. The personal preference by which one perceives and processes new method determines his or her unique Learning Style. Learning styles responsive instruction will increase the achievement or improve the attitude towards learning. The potential utility lies in providing learning styles suitable for developing process skills for successful learning outcomes.

For improving the present classroom practices it is important that we recognize and nurture all the varied type of human intelligences and all of the combination of intelligences. As the early concept about intelligence has changed, it is reflecting in teaching learning process. Since Howard Gardner first published 'Frames of mind', the theory of Multiple Intelligences in 1983, educators began to apply this in classroom. Intelligences used for science processes have to be identified and teacher should provide learning activities to enhance the student's ability. As Multiple Intelligences theory widely discussed among the educational practitioners, studies related to this helps to know the students type of intelligence, which is used for scientific processing, and improve their problem solving skill.

Educational researchers in India have not adequately dealt with Process Outcomes in science, especially the relation of Process Outcomes with other factors like Learning Style and Multiple Intelligences. Such studies are needed so as to help the teacher in guiding the pupils along proper lines in their attempts to acquire process skills. This will help in developing a better understanding in the way in which process skills can be acquired or even taught to pupils. An initial review of related literature revealed that the number of studies conducted in this area found to be few. So the investigator selected this area for her research. The present study has its objective to find out whether there is any relation and if so, the extent of this relation of Learning Style and Multiple Intelligences on 'Process Outcomes in Biology'.

**STATEMENT OF THE PROBLEM**

The present study is entitled as "**RELATION OF LEARNING STYLE WITH PROCESS OUTCOMES IN BIOLOGY AMONG DIFFERENT MULTIPLE INTELLIGENCE GROUPS OF SECONDARY SCHOOL STUDENTS."**

**DEFINITION OF KEY TERMS**

**1. Relation**

Relation refers to the existence or effect of a connection, of Process Outcomes in Biology with Learning Style and Multiple Intelligences.

**2. Learning Style**

Eysenck (1994) defined Learning Style as the general tendency to adopt similar set of strategies consistently across different tasks and settings.

**3. Process Outcomes in Biology**

Process Outcomes in Biology refers to behavioural evidences which shows mastery over the accepted scientific processes like recognizing and defining the problem, formulating hypotheses, collecting data, interpreting data, evaluating hypotheses and formulating generalizations in Biology.

**4. Multiple Intelligences**

Human beings possess a number of distinct intelligences that manifest themselves in different skills and abilities. All human beings apply these intelligences to solve problems, invent process and create things. According to Gardner each person has a unique profile of these intelligences, with strengths in some areas and weakness in others.

**5. Secondary School Students**

The term refers to the students studying in class VIII, IX andX. In this study only standard IX students are taken as the accessible population of the study.

### OBJECTIVES

1. To estimate the extent of relationship between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the total sample.

2. To estimate the extent of relation between 'Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

3. To find out the relationship between different Multiple Intelligence groups and their Process Outcomes.

4. To identify the Significant Predictors of Process Outcomes in Biology by Regression Analysis of Psychological Variables and Estimation of their Predictive Efficiency (in terms of β and partial r's).

### HYPOTHESES

1. There exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the total sample.

2. There exists significant relation between Process Outcomes in Biology and each of the independent variables, ('Learning Style' and 'Multiple Intelligences') for the relevant subsamples viz;

Boys

a) Gender

Girls

Rural

b) Locale

Urban

Private

c) Management

Government

**METHODOLOGY**

**a. Sample**

The study was conducted on a representative sample of 700 students of standard IX drawn from 12 schools of kozhikode district of kerala. The sample was selected using stratified sampling technique giving due representation to factors like Gender of the subject, Locale of schools and Management categories of the schools.

**b. Variables**

The study is designed with 'Process Outcomes in Biology' as the dependent variable and 'Learning Style' and 'Multiple Intelligences' as the two independent variables.

**c. Tools**

The investigator used the following standardized tools of satisfactory reliability and validity for measurement of the variables.

1. Learning Style Inventory developed by Kumar, P.K.S *et al*., (1996)

2. Multiple Intelligences Inventory (developed and standardized by  
 Kumar *et al*.)

3. Test of Process Outcomes in Biology (developed and standardized by Rashida Banu and A. Faziluddin,2006) the investigator for the study.

**d. Statistical Techniques Used**

The data was analyzed and results were discussed using the following statistical techniques.

1 Preliminary Analysis.

2. Pearson's Product Moment Coefficient Of Correlation.

3. Multiple Regression -Stepwise Analysis were used by SPSS (Statistical Package for Social Sciences) Method.

#### SCOPE AND LIMITATIONS

The aim of present study is to know whether any relation exists between Learning Style and Multiple Intelligences on 'Process Outcomes in Biology' and if so, whether the relation is significant or not.

The investigator selected a representative sample of 700 students from 12 secondary schools of Kozhikode district. While selecting the sample due representation was given to factors like Gender of subjects, School Locale and Type of management of the schools. The study was restricted to one representative group of secondary school students attending standard IX. Standardized tools of accepted reliability and validity were used for data collection. This study helps to find out whether students with high process outcomes have specifically selected or preferred learning style area and type of multiple intelligences. It also helps the teachers to modify their instruction according to the student's preference. The present study serves the purpose of finding the extent of relationship between them. Therefore, it is hoped that the findings of the study will be valid to a great extent.

Even though considerable efforts were made to make the study precise and scientific, the investigator could identify the following limitations also. Some of these are;

1. The sample of the present study was limited to one educational level, i.e; standard IX only due to practical reasons. This was done with the notion that standard IX will reasonably represent standard VIII, IX and X of the secondary schools.

2. The study was conducted on a sample selected from students of standard IX of Kozhikode district, due to constraints of time, effort economy and traveling difficulty. However, more generalisable results could have been obtained from the study, if stratified sample from the whole state was used.

3. The study was limited to Biology only.

In spite of these limitations, the investigator hopes that the study will provide dependable findings.

**MAJOR FINDINGS OF THE STUDY**

Important findings of the study are presented below

**1. Estimation of the extent of relation between 'Process Outcomes in Biology' and each of the select independent variables.**

The relation between 'Process Outcomes in Biology' and each of the select independent variables for the total sample and subsamples were studied. The results of 'r' are presented in table 1.

TABLE 1

### Summary of Correlation between Process Outcomes in Biology and Select Independent Variables

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Total | Boys | Girls | Rural | Urban | Private | Government |
| **A.** 1. | **Multiple Intelligences** Linguistic Intelligence | r | 0.1357 | 0.1696 | 0.0983 | 0.1024 | 0.1733 | 0.0980 | 0.2276 |
| 2. | Logical Intelligence | r | 0.2922 | 0.2759 | 0.3147 | 0.1737 | 0.3863 | 0.2607 | 0.3625 |
| 3. | Spatial Intelligence | r | 0.1716 | 0.2278 | 0.1088 | 0.1331 | 0.2126 | 0.1565 | 0.2086 |
| 4. | Musical Intelligence | r | 0.0389 | 0.0599 | 0.0229 | 0.1031 | -0.0216 | 0.0597 | 0.0243 |
| 5. | Bodily Intelligence | r | 0.0400 | 0.0455 | 0.0336 | 0.0282 | 0.0769 | -0.0326 | 0.1533 |
| 6. | Naturalistic Intelligence | r | 0.1992 | 0.1898 | 0.2080 | 0.1949 | 0.2090 | 0.1289 | 0.3007 |
| 7. | Intrapersonal Intelligence | r | 0.1580 | 0.2085 | 0.0965 | 0.0941 | 0.2298 | 0.1095 | 0.2415 |
| 8. | Interpersonal Intelligence | r | 0.1534 | 0.1097 | 0.1991 | 0.2027 | 0.1229 | 0.1254 | 0.2226 |
| 9 | Multiple Intelligences- Total | r | 0.2294 | 0.2486 | 0.2981 | 0.2011 | 0.2702 | 0.1731 | 0.3361 |
| **B.** 1. | Learning Style Environmental Style area | r | 0.0133 | -0.0045 | 0.1113 | 0.0533 | 0.0027 | 0.0592 | -0.0007 |
| 2. | Emotional Style area | r | 0.2138 | 0.2174 | -0.2081 | 0.0806 | 0.3175 | 0.1475 | 0.3023 |
| 3. | Sociological Style area | r | 0.0888 | 0.2426 | 0.0767 | 0.0664 | 0.3213 | 0.0801 | 0.1130 |
| 4. | Physical Style area | r | 0.1868 | 0.2304 | 0.1338 | 0.0705 | 0.2906 | 0.1552 | 0.2295 |
| 5. | Learning Style area- Total | r | 0.2607 | 0.2962 | 0.2152 | 0.0705 | 0.4021 | 0.1665 | 0.3808 |

**a) For the total sample**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Linguistic Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology in Biology' and the 'Logical Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Spatial Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Musical Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Bodily Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Naturalistic Intelligence' of the independent variable Multiple Intelligences.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the 'Intrapersonal Intelligence' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Interpersonal Intelligence' of the independent variable Multiple Intelligences.

The results showed that low relation exists between 'Process Outcomes in Biology' and the 'Multiple Intelligences-Total' of the independent variable Multiple Intelligences.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Environmental Style Area' of the independent variable Learning Style.

The results showed low relation exists between 'Process Outcomes in Biology' and the 'Emotional Style Area' of the independent variable Learning Style.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the 'Sociological Style Area' of the independent variable Learning Style.

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the Physical Style Area of the independent variable Learning Style.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology, and the Learning Style-Total of the independent variable Learning Style.

**b) For the subsamples**

**i) Boys**

The results showed that there exists, a negligible relationship between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Logical, Spatial, Intrapersonal and Multiple Intelligences-Total which shows low relationship.

It was noted that there exits, a negligible relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which the components Emotional and Learning style-Total shows low relationship.

**ii) Girls**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Logical, Naturalistic and Multiple Intelligences-Total, which show low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which the components Emotional and Learning Style-Total shows low relationship.

**iii) Rural**

The results showed that negligible relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Interpersonal and Multiple Intelligences-Total, which shows low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and all the components of Learning Style.

**iv) Urban**

The results showed that low relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Linguistic, Musical, Bodily and Interpersonal shows negligible relationship.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which Environmental shows negligible relationship and Learning Style Area-Total shows moderate relationship.

**v) Private**

The results showed that negligible relation exists between 'Process Outcome in Biology' and all the components of Multiple Intelligences except the component Logical that shows low relationship.

It was noted that there exists, a negligible relationship between 'Process Outcomes in Biology' and all the components of Learning Style Area.

**vi) Government**

The results showed that low relation exists between 'Process Outcomes in Biology' and the components of Multiple Intelligences except the components Musical and Bodily, which shows negligible relationship.

It was noted that there exists, a low relationship between 'Process Outcomes in Biology' and the components of Learning Style out of which Environmental and Sociological Style shows negligible relationship.

**2 Identification Of The Significant Predictors Of Process Outcomes In Biology By Regression Analysis Of Psychological Variables And Estimation Of Their Predictive Efficiency (in terms of β and partial r 's).**

Identification of Significant Predictors of Process Outcomes in Biology by Regression Analysis resulted that among the fourteen psychological variables; only four variables are significant predictors. These four variables are Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning Style Area. The Predictor variables entered in each step of Stepwise Regression Analysis, the value of Multiple Correlation R and the Multiple Regression equation developed in the successive steps are given as table 2.

TABLE.2

Multiple Correlation R and Multiple Regression   
Equation Developed in the Successive stepwise Regression Analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Variables Entered** | **Multiple Correlation R** | **Regression Equation** |
| **I** | **X2 (Logical Intelligence).** | **0.292** | **Y^­ = 0.93X2 + 9.64** |
| **II.** | **X11 (Emotional Learning Style area).** | **0.328** | **Y^ = 0.82X­­­11+ 0.28 + 5.75** |
| **III** | **X6 (Naturalistic Intelligence).** | **0.347** | **Y^ = 0.70X6 + 0.28+0.38+3.61** |
| **IV** | **X13 (Physical learning Style area).** | **0.357** | **Y^=0.66X13+0.23+0.37+0.15+2.06** |

Note (i) All the values of Multiple Correlation R cited are significant at 0.01 level

(ii) Y^ is the predicted value of Y, the Process Outcomes in Biology.

2.1 The Coefficient of Multiple Determination, R2 as ∑βr = 0.125 suggests 12.5 percent of variance in Process Outcomes in Biology is attributable to the four psychological variables identified as significant predictors. So that contribution of each significant predictor is as follows.

1) Logical Intelligence = 6.21 percentage.

2) Emotional Learning Style Area = 2.52 percentage.

3) Naturalistic Intelligence = 2.20 percentage.

4) Physical Learning Style Area = 1.70 percentage.

**TENABILITY OF HYPOTHESES**

The tenability of hypotheses is examined in the light of the above findings.

Hypotheses 1, states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, (Learning Style and Multiple Intelligences) for the total sample.

The results of Pearson's Product Moment Correlation calculated between 'Process Outcomes in Biology' and each of the two main variables namely, 'Multiple Intelligences' and 'Learning Style' and their component dimensions reveal the following. Multiple Intelligences-Total and its components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal, Interpersonal and Learning Style-Total and its four components areas Emotional, Sociological and Physical are significantly and positively related to 'Process Outcomes in Biology' in all or majority of total samples.

Hence Hypotheses 1 is partially substantiated

Hypotheses 2 (a), states that there exists significant relation between ‘Process Outcomes in Biology' and each of the independent variables, 'Learning Style' and 'Multiple Intelligences' for the relevant subsample based on Gender. For the independent variable Multiple Intelligences-Total and its six components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The Value of 'r' is not significant for Girls in Intrapersonal Intelligence. For the variable Learning Style-Total and its three component areas Emotional, Sociological and Physical are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Girls in Sociological Style Area.

Hence Hypotheses 2 (a) is partially substantiated.

Hypotheses 2 (b), states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, 'Multiple Intelligences' and 'Learning Style' for the relevant subsample based on Locale. For the independent variable, Multiple Intelligences-Total and its seven components Linguistic, Logical, Spatial, Naturalistic, Intrapersonal, and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Rural in Interpersonal Intelligence. For the variable Learning Style-Total and its three components Emotional, Sociological and Physical Learning Style are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Rural in Emotional, Sociological and Total Learning Style Area.

Hence Hypotheses 2 (b) is partially substantiated.

Hypotheses 2 (c) states that there exists significant relation between 'Process Outcomes in Biology' and each of the independent variables, ‘Multiple Intelligences' and 'Learning Style' for the relevant subsample based on Management. For the Independent variable, Multiple Intelligences-Total and its seven components Logical, Linguistic, Spatial, Bodily, Naturalistic, Intrapersonal and Interpersonal are significantly and positively related to 'Process Outcomes in Biology'. The value of 'r' is not significant for Private in Bodily Intelligence. For the variable Learning Style-Total and its two component areas Emotional and Physical Area are significantly and positively related to 'Process Outcomes in Biology'.

Hence Hypotheses 2 (c) is partially substantiated.

**CONCLUSIONS**

The investigator made the following conclusions after conducting the study.

In the independent variable Multiple Intelligences and the component dimensions Linguistic, Spatial, Naturalistic, Intrapersonal, Interpersonal Intelligence and Multiple Intelligences-Total have found to be significantly and positively related to 'Process Outcomes in Biology'.

It is concluded from the findings that Musical and Bodily Intelligence have no significant relationship with 'Process Outcomes in Biology'.

In the independent variable Learning Style the component style areas Emotional, Sociological, Physical and Learning Style-Total have found to be significantly and positively related to 'Process Outcomes in Biology'.

It is concluded from the findings that Environmental Learning Style Area has no significant relationship with 'Process Outcomes in Biology'.

From the findings it is obvious that

1. The Musical and Bodily Intelligence of the Multiple Intelligences have no impact on 'Process Outcomes in Biology'.

2. The Environmental Style Area has no impact on 'Process Outcomes in Biology'.

It was found out that almost all the fourteen psychological variables have significant effect and relation with 'Process Outcomes in Biology', indicating that all the variables are able to predict Process Outcomes in Biology. But Stepwise Regression Analysis pointed out, only four of the fourteen psychological predictor variables as significant predictor of Process Outcomes in Biology. These four predictors contributing 12.5 percent of variance in the variance of Process Outcomes in Biology are Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning Style Area.

All these findings led the investigator to conclude that out of the Fourteen Psychological Variables, put as predictor (independent) variables; only four of them viz; Logical Intelligence, Emotional Learning Style Area, Naturalistic Intelligence and Physical Learning style Area are turned to be the significant predictors of Process Outcomes in Biology with 6.21 percentage, 2.52 percentage, 2.20 percentage and 1.70 percentage respectively as the percentage of variances contributable to the variation in the variance of Process Outcomes in Biology.

**EDUCATIONAL IMPLICATIONS**

In the light of results of the present investigation, certain suggestions were put forth for improving the existing educational practices.

1 In the present study the results of correlation analysis of Multiple Intelligences reveals that its components Logical Intelligence and Naturalistic Intelligence is highly related with 'Process Outcomes in Biology' and other dimensions are related only to a negligible extent. So teachers should be trained to present their lessons in a wide variety giving importance to provide activities which enhance the power of Logical and Naturalistic Intelligence for improving student's processing skill.

It is clear from the findings that the Emotional Learning Style Area and Physical Learning Style Areas are more related to 'Process Outcomes in Biology' and other areas are related only to a negligible extent. It helps the teachers to provide a stimulating, challenging and happy classroom with achieving pupils. By knowing preferred Style areas of students having high process outcomes, will help the teachers to provide learning style best suited for maximum efficiency in processing skills. They can stimulate the students to develop process skills for aspiring and maximizing performance in Biology.

The study also helped to identify certain Psychological Variables, which correlates significantly with 'Process Outcomes in Biology'. The present study has also helped to find out the best predictors of 'Process Outcomes in Biology' from among the set of certain Psychological Variables. It also helps to expand our horizon of available teaching or learning tools beyond the conventional Linguistic and Logical methods used in most school.

## SUGGESTIONS FOR FURTHER RESEARCH

The findings of the study and the limitations encountered in the present study helped the investigator to suggest the following for further research.

1. Causal relationship of Learning Style, Multiple Intelligences and Process Outcomes in Biology can be studied separately for Boys, Girls, Rural and Urban subjects.

2. Replication of the present study using samples from Higher Secondary and College levels.

3. The investigation in the present study can be extended to other sciences like Physical sciences.

4. Interaction effect of Leaning Style (total and component style areas) and Multiple Intelligences (total and component dimensions) on 'Process Outcomes' in other school subjects can be studied.

5. An experimental study to enquire into how far the components of Multiple Intelligences and Learning Style influences in the attainment of Process Skills in Biology.

6. Effectiveness of teaching methods in the development of Process Outcomes in Biology of Standard IX pupils.

7. Comparative study of the Relation of Learning Style with Process Outcomes in Biology for Primary and Secondary School children.

**APPENDIX VI**

**UNIVERSITY OF CALICUT**

**FAROOK TRAINING COLLEGE**

**TEST OF PROCESS OUTCOMES IN BIOLOGY (2006) FINAL**

# A.FAZILUDDIN RASHIDA BANU. M.

**Lecturer (Selection Grade) M.Ed Student**

**Farook Training College Farook Training College**

This test of science consists of 30 items. Each item has four answers indicted by A,B,C,D: Out of which only one is correct. Answers should be marked only in the answer sheet given to you. Find the correct answer and mark your answer against the letter in the serial order of the answer by ‘X’ mark. Return the question booklet and answer sheet to the investigator.

Time: 40 minutes.

1. It is said that food items containing Vitamin. C should not be cooked. Here the problem is

1. Whether it causes cancer
2. Whether it causes loss of eyesight.
3. Whether it causes loss of Vitamin C.
4. Whether Vitamin C combines with fat

2. Earth worm does not come out of their holes during daytime. Here the problem is.

1. Is it to reduce loss of skin moisture
2. Is it to escape from enemies.
3. Is it to balance the body temperature
4. Is it to prevent the blockage of blood circulation.

3. Doctors suggest that consumption of given leafy vegetables are good for yes. Here the problem is.

1. Whether leafy vegetables are available in plenty
2. How leafy vegetables influence eye diseases.
3. Whether leafy vegetables are nutritious.
4. Which are the diseases affected to eyes.

4. Doctors usually suggest Leukemia Patients to replace their bone marrow. Here the problem is.

1. Whether Leukemia causes dislocation
2. Whether Leukemia causes deadly diseases to the bone marrow.
3. Whether bone marrow helps to produce blood cells.
4. Whether joints have ceased functioning.

5. It is seen that mirror becomes misty when air is blown by standing near it. Here the problem is

1. Whether the amount of oxygen in the exhaled air is less.
2. Whether the amount of moisture in the exhaled air is more.
3. Whether the amount of Co2in the exhaled air is less.

D) Whether the amount of temperature in the exhaled air is less

6. Vitamin K is essential for blood clotting. The probable assumption here is

1. It helps to produce Prothrombin.
2. It helps to produce Insulin.
3. It helps to produce Heparin.
4. It helps to produce Ptyalin.

7. Breast milk is the best food for infants. The possible assumption here is.

1. Amount of Iron is less
2. It gets rid of hunger for a long time.
3. Amount of Lactose is les.
4. Digest easily.
   1. Pain occurs in muscles when involved in unusual labour. The possible assumption here is.
5. Due to the availability of excess oxygen in muscles.
6. Lactic acid obstructs the functioning of muscles.
7. Due to the production of more Co2 in muscles.
8. Due to the dysfunction of involuntary muscles

9. It is cooler where plants are seen in plenty. The possible assumption here is.

1. Loss of water through transpiration.
2. Plants release O2 during photosynthesis.
3. Plant receives Co2 during photosynthesis.
4. Anabolic rate increases in the plants.

10. A plant kept for few days in a dark room. Covered the half of the leaf with a black cloth and kept in sunlight. When the leaf is test for the presence of starch, there is no sign of starch synthesis in the portion of the leaf covered with black cloth. Here the possible assumption here

1. Absence of sunlight
2. Unavailability of water
3. Absence of chlorophyll
4. Destruction of cells.

11. The digestion of good particles beings from mouth. An experiment to prove this is

1. Take starch in two test tubes, and add saliva. Observe whether it is converted to maltose.
2. Take starch in two test tubes; add saliva in the first one and Hcl in second one. Observe the conversion.
3. Take starch in two test tubes, add saliva to the first and keep the second without adding saliva. Observer whether it is converted to maltose.
4. Take starch in two test tubes, add saliva and trypsin to both and observer whether the starch is converted to maltose.

12. Fishes respire O2 dissolved in water. An experiment to prove this is.

1. Experiment by putting a fish in lukewarm water and the other in water
2. Experiment a putting both fishes in lukewarm water.
3. Experiment by putting both fishes in water.
4. Check the amount of O2 in the lukewarm water.

13. Which of the following methods will you choose to understand the process of imbibitions

1. Experiment by putting green gram in oil.
2. Experiment by putting groundnut in water
3. Experiment by mixing water and oil.
4. Experiment by dipping iron in water.

14. The experiment to understand the functioning of earthworm’s skin.

1. Experiment by taking two earthworms and keeping the first one in dry soil and the other one in moist soil.
2. Experiment by keeping with the earthworms in moist soil.
3. Experiment with two earthworms, in which one is kept in dry soil and the other in sunlight.
4. Experiment by keeping both the earthworms in dry soil.

15. The experiment which can be done by you to prove the idea of osmosis.

1. Observer dilute salt solution.
2. Observer mixed solution of concentrated and diluted salt solutions.
3. Observer a mango in concentrated salts solution.
4. Experiment by pouring a drop of ink in fresh water.

16. Blood is colourless in insects. The most suitable explanation for this is.

1. Due to lack of W.B.C. in blood
2. Due to higher quantity of oxygen in blood.
3. Due to lack of oxygen carrying haemoglobin in blood
4. Due to lesser quantity of carbondioxide in blood.

17. While vomiting the glottis remains closed. The explanation for this is.

1. The open glottis plays a role in preventing vomiting.
2. Helps the process of digestion
3. Prevents the entry of food into the respiratory tract.
4. Due to the cessation of blood flow into the glottis.

18. Alcoholism adversely affects the working of the liver. Explain.

1. The blood flow to the liver ceases.
2. The liver gets infected.
3. The liver gets affected by Cirrhosis
4. Silicosis affects the liver.

19. Diabetic patients are infused with insulin. Explanation for this is.

1. It helps to convert glucose into glycogen.
2. It helps to convert glycogen into glucose.
3. It helps to produce glucagons.
4. It increases the level of glucose.

20. In athletes even random smoking results in respiratory problems during rigorous exercise. Explain.

1. Nicotine contracts the bronchus near alveoli and makes cilia functionless.
2. Nicotine reduces the rate of heartbeat.
3. Nicotine makes the glottis in the respiratory tract to function less.
4. Nicotine causes bleeding of the blood vessels.

21. The leaf of plant grown in dark room does not indicate blue colour after starch test. Which of the following the best conclusion for this.

* 1. Chlorophyll is essential for starch synthesis.
  2. Water is essential for starch synthesis
  3. Sunlight is essential for starch synthesis
  4. Carbondioxide is essential for starch synthesis.

22. Cosmonauts used chlorella, a green algae in special chambers, which of the following is the best conclusion for this.

1. Chlorella releases carbondioxide rapidly.
2. Chlorella is used as food
3. Chlorella releases enormous amount of oxygen during the synthesis of food.
4. Chlorella absorbs oxygen during the synthesis of food.

23. Blue and red are the only component colours of sunlight that play a major role in photosynthesis.

1. They have the wavelength required for the synthesis of food.
2. They are able to absorb Co2 required for the synthesis of food.
3. They are able to absorb H2O required for the synthesis of food.
4. They are able to absorb O2 required for the synthesis of food.

24. Anu brought a skull that she got on the way to school and handed over to her teacher. The teacher identified it as a carnivore even though she did not identify the animal. What will you infer from this?

1. By considering the size of the skull.
2. By observing the nature and characteristics of teeth.
3. By considering the flexible movement of the jaw bones.
4. By observing the flat and elongated skull.

25. Two leaves were collected, one before sunrise and the second one at noon. On starch test the first leaf showed low amount of starch. What inference can be drawn from this.

1. Roots had absorbed water from the soil
2. There is no relation between synthesis of starch and sunrise.
3. The plant subjected to the starch test was infected.
4. No synthesis of starch occurs before sunrise.

26. During injury bones of infants are not usually fractured. What is the best generalization for this.

1. The bones become rigid due to the deposition of calcium phosphate between bone cells.
2. The bones become rigid due to the deposition of calcium hydroxide between bone cells.
3. The bones become rigid due to the deposition of calcium oxide between bone cells.
4. The bones become rigid due to the deposition of Calcium Carbonate between bone cells.

27. Children and Youth require nutritious diet. From this we can generalize that.

1. The growth of both children and youth are determined by the diet of that particular period.
2. There are greater chance for disease in both children and youth.
3. Both children and youth perform greater physical exercises.
4. The content of nutrients will be comparatively lesser in the bodies of children and youth.

28. Blue colour appears when iodine added to rice. The general reason for this.

1. Rice contains protein.
2. Rice contains fat.
3. Rice contains vitamins
4. Rice contains starch.

29. Aquatic plants found to be grown in aquarium. From this we can generalize that.

1. Plants serve as food for fishes.
2. Water is not contaminated because plants intake O2 and release Co2.
3. Plants gets nutrition.
4. To increase attractiveness.

30. O2 directly enters the cells of insects. What is the best generalization for this.

1. Insects have no blood cells.
2. Blood cells has no pigment
3. Cells are in direct contact with the atmosphere.
4. Insects respiratory organs have no blood capillaries

APPENDIX III

**SCORING KEY OF THE**

**DRAFT TEST OF PROCESS OUTCOMES IN BIOLOGY**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Question No.** | **Key** | **Question No.** | Key | **Question No.** | **Key** |
| 1 | B | 21 | B | 41 | B |
| 2 | A | 22 | A | 42 | C |
| 3 | C | 23 | A | 43 | C |
| 4 | C | 24 | B | 44 | A |
| 5 | A | 25 | A | 45 | B |
| 6 | B | 26 | B | 46 | B |
| 7 | D | 27 | A | 47 | D |
| 8 | C | 28 | C | 48 | B |
| 9 | B | 29 | C | 49 | B |
| 10 | B | 30 | B | 50 | C |
| 11 | A | 31 | B | 51 | A |
| 12 | D | 32 | C | 52 | B |
| 13 | C | 33 | C | 53 | D |
| 14 | C | 34 | C | 54 | A |
| 15 | B | 35 | C | 55 | D |
| 16 | A | 36 | B | 56 | C |
| 17 | A | 37 | A | 57 | B |
| 18 | A | 38 | A | 58 | A |
| 19 | A | 39 | A | 59 | B |
| 20 | D | 40 | A | 60 | C |

APPENDIX V

**SCORING KEY OF THE**

**FINAL TEST OF PROCESS OUTCOMES IN BIOLOGY**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Question No.** | **Key** | **Question No.** | Key | **Question No.** | **Key** |
| 1 | C | 11 | B | 21 | C |
| 2 | A | 12 | A | 22 | C |
| 3 | B | 13 | B | 23 | A |
| 4 | C | 14 | A | 24 | B |
| 5 | B | 15 | C | 25 | D |
| 6 | A | 16 | C | 26 | A |
| 7 | D | 17 | C | 27 | A |
| 8 | B | 18 | C | 28 | D |
| 9 | A | 19 | A | 29 | B |
| 10 | A | 20 | A | 30 | C |