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CORRELATING STUDENTS' KNOWLEDGE LEVELS OF SCIENCE PROCESS SKILLS WITH THEIR CONCEPTUAL UNDERSTANDING OF BIOLOGY AND INTRINSIC MOTIVATION LEVELS: A CASE STUDY OF MOROGORO HIGH SCHOOL STUDENTS IN TANZANIA

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ABSTRACT

The aim of this study was to correlate students' knowledge levels of science process skills with their conceptual understanding of biology and intrinsic motivation levels. Participants of the study were 263 advanced level Biology students (age range 19-20) from three selected secondary schools in Morogoro Tanzania. The three schools were Kilakala (145 students), Alfagerms (87 students) and Bigwa sisters (31 students) were involved in the study. The data were collected using i. Biology Process Skills Test-BPST", ii. Genetics test and Science Motivation Questionnaire-II adapted by researchers by examining studies related to this field. Results showed that there was a moderate positive correlation (r= 0. 45) between science process skills and genetics knowledge. This correlation was significant at 0.05. The amount of change in science process skills level of Morogoro students also significantly correlated with their amount of change in their conceptual understanding of Biology contents (genetics being the case) with r=0.352. However, no statistically significant relationship between students' achievement in science process skills and their intrinsic motivation to learn science were observed. The amount of change in science process skills level of Morogoro students also did not significantly correlate with their amount of change in their intrinsic motivation to learn science.

1.0 Background and problem statement

1.1 Introduction

Recent reforms in science education hold great promise towards teaching science process skills to all students. The implication is that science process skills are inseparable from the practice of science and play a key role in both formal and informal learning of science content. Chiappetta and Koballa (2002) define science process skills as a set of broadly transferable abilities appropriate to many science disciplines and reflective of the behavior of scientists. They are hierarchically organized, ranging from the simplest to the more complex higher order ones, called integrated science process skills (Padilla, 1990 & Dyer, et al. 2004). Integrated science process skills include skills in formulating hypotheses, identifying and controlling variables, defining operationally, experimenting, and interpreting data (Chiappetta and Koballa, 2002; Hamilton &Swortzel, 2007).They are procedural skills, experimental and investigating science habits of mind or scientific inquiry abilities (Scharmann, 1989). According to Chiapetta and Koballa (2002) science process skills are thinking skills that scientists use to construct knowledge in order to solve problems and formulate results.

Ostlund (1998) argue that science process skills are the most effective means to obtain information about the world around and to arrange this information. Science process skills facilitate learning in science, teach student research methods, help student to be active, develop students' responsibility to take part in their own learning, and increase their permanent learning.

From a learning point of view, science process skills are the necessary means by which learners engages with the world and gains intellectual control of it through the formation of concepts and development of scientific thinking (Harlen, 2000).Chiappetta and Koballa (2002) strongly argue that, the acquisition and frequent use of these skills can better equip students to solve problems, learn on their own, and appreciate science.

Science is both content (what we know) and process (how we find out). Learning science successfully requires students to acquire both declarative knowledge (knowledge about something) and procedural knowledge (knowledge of how to do something). Declarative knowledge consists of facts, principles, concepts, theories and laws that can be told to others. Basically, it is about 'what is.' Procedural knowledge on the other hand is needed 'to do and experience science.' Procedural knowledge is our knowledge of how to perform various physical and intellectual tasks. Procedural knowledge is learned by doing something with declarative knowledge, such as drawing inferences, constructing classifications, or making generalizations from facts available in the declarative knowledge system.

The association between science process skills, cognitive abilities, motivational variables and scholastic achievement has been a subject matter of various research studies (Hamilton & Swortzel, 2007; Harlen, 1999; Padilla, et al. 1983; & Scharmann, 1989). It is claimed that science process skills are needed to better understand the content of science of students (Scharmann, 1989). According to Padilla (1990), students cannot excel at skills they have not experienced or allowed to practice. Mastery of integrated science process skills can only occur after consistent practical sessions. This will allow for the development of formal thinking patterns. Padilla (1990) continues to aver that students need multiple opportunities to work with these skills in different content and context areas. In this regard science education teachers need to help the learners to develop formal thinking patterns for them to successfully master integrated science process skills. Several studies (Tobin &Capie, 1981; Padilla, et al. 1983) have shown that there is a strong correlation between process skills achievement and an individual's formal reasoning ability. According to Harlen (2000), science process skills and mastery of science concepts are inextricably intertwined, interrelated and mutually reinforcing. Athuman (2017) opines that using science process skills is an indicator of transfer of knowledge that is needed for problem solving and functional living.

However some critics have urged against the effectiveness of science process skills in enhancing academic knowledge and ability (Millar and Driver, 1987). These researchers have questioned the influence of science process skills on learner performance, and their role in the understanding of evidence in Science contents. Millar and Driver (1987) for example presented a powerful critique on the independence of science process skills from content. They argue that science process skills cannot exist on their own without being related to content. This argument is valid. However, content independence in the context of this study does not mean that the items are completely free from content, it rather means that the student does not require in-depth knowledge of the scientific content to be able to demonstrate the required science process skill.

On the other hand, educators consider intrinsic motivation to be more desirable and result in better learning outcomes than extrinsic motivation (Pintrich & Schunk, 1996; Benabou & Tirole, 2003; Vallerand & Bissonnette, 1992 & Ryan & Deci, 2000). Engagement out of intrinsic motivation requires no external incentives and enhances motivation to engage again in the future. Studies also suggest that engagement out of intrinsic motivation is associated with enhanced comprehension, creativity, cognitive flexibility, achievement, and long-term well-being (Ryan & Deci, 2000). For example, a research study was done by Lens, & Rand (1997) concluded that intrinsically motivated students learn independently and always choose to do challenging tasks and integrate their knowledge acquired in school with their experiences gained from outside school. According to Ryan & Deci (2000) intrinsic motivation arises from a desire to learn a topic due to its inherent interests, for self-fulfillment, enjoyment and to achieve a mastery of the subject.

1.2 Problem statement

There are a few studies related to studying the relationship between science process skills and academic achievement. Some studies indicated that there was a positive correlation between students' science process skills and academic achievement at university level (Walkoszve Yeany, 1984; Sittirug, 1997). In addition, some other studies showed that there was a positive correlation between science process skills and academic achievement of primary school level (Germann, 1994; Athuman, 2017). On the other hand, Sittirug (1997) emphasized that there is not complete agreement about the relationships among science process skills, cognitive development, attitude toward science, and academic achievement. Therefore, this study might be important to obtain information as regard with examining the relationship between science process skills and academic achievement of Morogoro Biology students. On the other hand, by intrinsic motivation is an internal drive or an engagement that provides means to ends that go beyond the engagement itself in contrast to extrinsic type. Intrinsically motivated students are the ones whose learning goals are mastery of content and skills not as a means to an end but as an end itself (Ryan & Deci, 2000). Therefore, this study was also interested to explore and examine the relationship between science process skills of Morogoro students and their levels of intrinsic motivation.

1.3 Aim of the study

It was the aim of this study was to assess the existing correlation between students' achievements in science process skills with their achievement in conceptual understanding of contents. The study was also interested in correlating the change of knowledge level of science process skills of students from pretest to posttest of students with their changes in their conceptual understanding of genetics. The intention was to determine whether the changes in science process skills achievement of students as a class correlates with changes in their genetics knowledge and intrinsic motivation as variables under study.

1.4 Research Questions

The research questions posed for this study were as follows:

i. Is there a statistically significant relationship between science process skills and academic achievement of advanced level Biology students in Morogoro?

ii. Is the amount of change in science process skills level of Morogoro students significantly correlate with their amount of change in their conceptual understanding of Biology contents (genetics being the case)

iii. Is there a statistically significant relationship between students' achievement in science process skills and their intrinsic motivation to learn science?

iv. Is the amount of change in science process skills level of Morogoro students significantly correlate with their amount of change in their intrinsic motivation to learn science?

2.0 Material and Methods

2.1 Research Design

This study employed a correlational design. A correlational study is a quantitative method of research in which you have two or more quantitative variables from the same group of participants, and you are trying to determine if there is a relationship (or co-variation) between the two variables. Theoretically, any two quantitative variables from the same group of participants can be correlated (for example, midterm scores & final exam scores, or midterm scores and number of body piercings) as long as you have numerical scores on these variables from the same participants. It involves the search for relationships between variables through the use of various measures of statistical associations such as Chi square, Student's t and F tests (Borg & Gall, 1989). Correlational design was chosen because this study aimed at exploring the relationship between science process skills and academic achievement of advanced level Biology students in Morogoro Tanzania.

2.2 Data Collecting Tools

2.2.1 Biology process skills test (BPST)

In assessing the knowledge level of integrated process skills of advanced Biology students in Morogoro, the Biology process skills test (BPST) developed and validated in the first stage of this study was used. The test measures five (05) individual integrated scientific skills (identifying variables, stating hypotheses, operationally defining, designing investigations and analyzing and interpreting data) to advanced secondary school learners. The reliability of the instrument was established by the researcher in the year 2014 using 610 learners to be 0.80 (Cronbach's alpha). Concurrent validity of BPST was established by comparing students score in the process skills test (TIPS II) by Burns et al. (1985) and found to be 0.51. Using experts' opinion scale, the content validity of BPST was found to be 0.88. The test has reliability coefficient well above the lower limit of the acceptable range of values for reliability, and it is within the range of reliability coefficients obtained from similar studies, such as those by Dillashaw and Okey (1980) who obtained a reliability of 0.89 and Burns, Okey and Wise (1985) who also obtained a reliability of 0.84. Biology process skills test (BPST) has a readability index of 72.2. This high readability value implies an easy to read text to students who English is not their first language like Tanzania students. The researcher adopted this test because it has been developed in the context of Tanzania using the Tanzania competence based curriculum.

2.2.2 Genetic test for measuring conceptual understanding of Genetics

In assessing the knowledge level of students in genetics as a covariate, a multiple-choice (single-select) item test containing 25 items was developed. A number of sources were reviewed for possible test items, including the example questions provided by the College Board's Advanced

Placement Biology Exam, the SAT II Biology Exam, and the Biological Science Curriculum. Suitable items were ultimately included in a pool of questions. The test measures five (05) subtopics in Genetics as listed in the Tanzania Biology syllabus for the advanced level students which include i. hereditary materials (DNA/RNA), ii. genetic coding and protein synthesis, iii. Mendelian and Non-mendelian inheritance, v. sex-linked inheritance and pedigree analysis, and v. gene and chromosomal mutation. The test was reviewed by the supervisor of this study who is a professor of zoology and didactics of Biology to assure its content validity. A panel of three science educators further determined the content validity and clarity of each item on the test. The science teachers also analyzed the relatedness of the test items to the instructional objectives. They confirmed that the content validity of the instrument was appropriate for the participants. However, psychometric validation of this conceptual test was beyond the scope of this study. For scoring purposes, each multiple-choice item was given a numeric value of 1 if the response was correct or 0 if the response was incorrect. Therefore, scores ranged from 0 to 25.

2.2.3 Science Motivation Questionnaire by Glynn et al (2011)

In assessing the level of intrinsic motivation of Morogoro Biology students, Science Motivation Questionnaire II by Glynn et al (2011) was employed. The Science Motivation Questionnaire-II is a five-point scale Likert-type questionnaire which was developed to enhance the construct validity of the Science Motivation Questionnaire (Glynn et al., 2011). It examines how motivated students are to learn science, and why those who are not motivated feel that way (Glynn et al., 2011). According to Glynn et al. (2011), Science Motivation Questionnaire-II (SMQ-II) is a 25 item scale and assesses five components of students' motivation to learn science in college or high school courses. The five components of motivation assessed include i. intrinsically motivated science learning, ii. Grade motivated science learning, iii. Self-determination for learning science, iv. Confidence (self-efficacy) in learning science, and v. career motivation for learning science (Glynn et all 2011). It was the intention of this research to study the relationship between students achievement in science process skills and their level of intrinsic motivation component.

2.3 Measuring the amount of change of students' science process skills and genetics knowledge levels

In measuring the amount of change of students in the areas of science process skills, genetics knowledge level and intrinsic motivation, the same data collection tools (science process skills test, genetics test and Science Motivation Questionnaire-II) discussed above were employed to the same group of students after 8 weeks. The intention was to have the data that would be used in answering the following questions;

i. Is the amount of change in science process skills level of Morogoro students significantly correlate with their amount of change in their conceptual understanding of Biology contents? (genetics being the case); and
ii. Is the amount of change in science process skills level of Morogoro students significantly correlate with their amount of change in their intrinsic motivation to learn science?

2.4 Participants in the study

The participants of the study were 263 advanced level Biology students (age range 19-20) from selected secondary schools in Morogoro Tanzania. Three schools namely Kilakala (145 students), Alfagerms (87 students) and Bigwa sisters (31 students) were involved in the study. As summarized in table 1 below, the number of female students involved was 200 while there were 63 male. The emphasis was on the understanding of the nature, function and correlations between the basic genetic concepts (e.g. DNA, genes, chromosomes, and meiosis) and the phenomenon of Mendelian inheritance protein synthesis and Mutation. None of the participants had been taught genetics at higher levels in the past.

Table 1: Distribution of students by type of instruction and sex in each school

			Sex		
			Female	Male	Total
Kilakala sec school	Instruction	Conventional approach	49		49
		Inquiry based method	96		96
	Total		**145**		**145**
Alfagerms	Instruction	Conventional approach	7	24	31
		Inquiry based method	17	39	56
	Total		**24**	**63**	**87**
Bigwa Sisters	Instruction	Conventional approach	14		14
		Inquiry based method	17		17
	Total		**31**		**31**
	Grand total		**200**	**63**	**263**

Source: Research survey (2016)

2.5 Interpreting the size of correlation

A Pearson Product Moment Correlation Coefficient (r) was the statistical procedure chosen to ascertain the magnitude of the relationship between the subjects' science process skills and conceptual understanding of Biology contents (genetics knowledge). This procedure is commonly used in determining the extent of a relationship existing between variables and is probably used most frequently in educational research (Downing, et al, 1997). The advantage is that correlational studies do not require large samples. If a relationship exists it is assumed that it will be evident in a sample of moderate size (Ary, et al. 1990). In interpreting the size of the correlation coefficient, this study adopted the rule of thumb for interpreting the size of a correlation coefficient as suggested by Hinkle et al. (2003), which is summarized in Table 2.

Table 2: The rule of thumb for interpreting the size of a correlation coefficient

Size of correlation	Interpretation
0.90 to 1.00 (−0.90 to −1.00)	Very high positive (negative) correlation
0.70 to 0.90 (−0.70 to −0.90)	High positive (negative) correlation

Size of correlation	Interpretation
0.50 to 0.70 (−0.50 to −0.70)	Moderate positive (negative) correlation
0.30 to 0.50 (−0.30 to −0.50)	Low positive (negative) correlation
0.00 to 0.30 (0.00 to −0.30)	negligible correlation

Hinkle, et al (2003)

2.6 Data analysis

Data analyzed by using SPSS 21.0 statistics program. Data calculated with descriptive statistics as mean, standard deviation and analyzed by using Pearson correlation. Computer SPSS Pearson's correlation was employed to find out the relationship between student's performances in the science process skills test with his/her conceptual understanding of genetics content. Pearson product-moment correlation coefficient or Pearson's correlation "ρ“ is a measure of the strength of the linear relationship between two variables. If the relationship between the variables is not linear, then the correlation coefficient does not adequately represent the strength of the relationship between the variables.

3.0 Results and Discussion

3.1 Introduction

It was the aim of this study to determine the existing correlation between student's achievements in science process skills with their achievement in conceptual understanding of Biology contents, genetics being the case study. Computer SPSS Pearson's correlation was employed to find out the relationship between students' performance in the science process skills test with their conceptual understanding of Biology contents. Pearson product-moment correlation coefficient or Pearson's correlation "ρ" is a measure of the strength of the linear relationship between two variables. The study answered the question "Is the achievement in science process skills of students significantly correlate with their conceptual understanding of Biology contents (genetics being the case)? This section presents and discusses key findings obtained.

3.2 Correlation between Science Process skills Achievement and Conceptual understanding of Biology contents (a case study of Genetics)

Educators, who are promoting the inquiry process as the essence of learning science, believe firmly that this approach will make a significant contribution to the conceptual understanding of scientific contents also. They believe also that student who is weak in the content area may not be able to apply these process skills (Harlen, 2000). Computer SPSS Pearson correlation coefficients were computed to determine whether any significant relationship existed between achievements of Morogoro students in science process skills and their achievement in the conceptual understanding of Biology contents. Students' scores in the science process skills test (BPST) and in the genetics, the test was correlated to find out their relationship. As seen in table 3 below a moderate positive correlation between students' performance in the science process skills and their performance in the genetics test were seen. This relationship was significant at 0.05. This implies that science process performance was not proven to be a strong predictor of students' achievement in the conceptual understanding of genetics in this study. This further implies that those students who perfumed well in the science process skills test did also perform well in the genetics test.

Table3: Correlation between students' achievement in science process skills and their genetics knowledge

Correlations			
		Posttest scores in BPST	Posttest scores in genetics
Posttest scores in BPST	Pearson Correlation	1	0.45**
	Sig. (2-tailed)		0.0468
	N	263	263
Posttest scores in genetics	Pearson Correlation	0.45**	1
	Sig. (2-tailed)	0.0468	
	N	263	263

Source: Field data (2015).

The result of this study showed that mastery of the science process skills does ensure acquisition of scientific knowledge. The findings that there is statistically significant relationship between students' performance in the science process skills and their achievement in science contents imply that the teaching of content must take precedent over the training of students on the acquisition of science process skills. In their study, which involved teaching students the science process skills during science experimentation, Padilla et al. (1983) concluded that these complex process skills cannot be learned via a two weeks unit in which science content is typically taught. Rather, experimenting abilities need to be practiced over a period of time. Those having the extended treatment outscored those experiencing the two-week unit. These findings are also in line with the conclusions made by Millar (1987) who argue that students' ability to use process skills depend on the extent of their knowledge of the contexts they are asked to work on. Studies by other researchers (Song and Black, 1991; Lock, 1993) also found that performance of tasks requiring these process skills is strongly content-dependent.

Overall, the results suggest that; the more science process skills students acquire the more academically successful they are. Lobo (1990) found that the teacher students who possess science process skills were able to improve pupils' achievement through their modified behaviour. It was also found that as a result of process skills teaching, teachers tend to be more heuristic, problem solving oriented and speculative in contrast with those who are not given this training. Ampili (1991) in her study assessed separately the possible relationship of process outcomes in science to science interest, scientific attitude and attitude towards academic work of total sample and relevant subsamples. She found a positive and significant relationship between process outcomes and science interest, scientific attitude and attitude towards academic work.

3.3 Correlation between Students pretest-posttest change in science process skills and their pretest-posttest change in change in Genetics knowledge

This study also correlated the change of knowledge level of science process skills of students from pretest to posttest of students with a change in their conceptual understanding of Genetics from pretest to posttest. The difference in the BPST scores from pretest to posttest and that of Genetics test were used. Table 4 shows that the pretest-posttest changes in science process skills of students significantly correlate with their pretest-posttest change in their conceptual understanding of genetics. The correlation was significant at the 0.01 level (2-tailed).

Table 4: Correlation between Students pretest-posttest change in science process skills and their pretest-posttest change in change in Genetics knowledge

Correlations			
		Pretest-posttest change in genetics	*Pretest-posttest change in BPST*
Pretest-posttest change in BPST	Pearson Correlation	1	0.352**
	Sig. (2-tailed)		0.000
	N	263	263
Pretest-posttest change in genetics	Pearson Correlation	0.352**	1
	Sig. (2-tailed)	0.000	
	N	263	263
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: Field data (2015).

A Pearson correlation coefficient value of 0.352 was found between students pretest-posttest change in science process skills of with their pretest-posttest change in genetics knowledge. Table 4indicates by the value or r = 0.352 (Hinkle et al. 2003) a moderate positive linear relationship between students pretest-posttest changes in science process skills with their pretest-posttest changes in genetics knowledge which were significant at α =0.01 (2-tailed). Some studies also showed that there was a positive correlation between science process skills and academic achievement of primary school level (Germann, 1994; Athuman, 2017). Besides, results showed that there was a moderate positive correlation (r= 0. 44) between science process skills and academic achievement of pre-service science teachers whose science process skills was higher than mean score; moreover results showed that there was a moderate positive correlation (r= 0. 39) between science process skills and academic achievement of pre-service science teachers whose academic achievement was higher than mean score.

3.4 Correlation between science process skills achievement and the intrinsic motivation of students towards science

Another purpose of this study was to test the hypothesis that there is a positive correlation between students' achievement of science process skills as an independent variable and their intrinsic motivation towards science. Researchers and educators in science education believe that intrinsic motivation is a significantly important factor for academic learning and achievement (Stipek, 1998). It has a positive impact upon learning as it stimulates, sustains and gives directions to an activity. Highly motivated students often require little guidance from the teachers and are capable of doing a higher degree of complicated work independently (Stipek, 1998).

Pearson correlation coefficients for the sum of science process skills posttest scores and for the

SMQ-II intrinsic motivation posttest scores were computed to determine whether any significant relationship existed between the two variables. Regardless of their groups in the quasi-experimental study, students' posttest scores in the science process skills test (BPST) and in the SMQ II intrinsic motivation test were correlated to find out their relationship. Table 5 hints on a moderate positive correlation between students' performance in the science process skills and their intrinsic motivation towards science after genetics intervention were seen. This relationship was not significant at 0.005. This implies that an intrinsic motivation towards science was not statistically proven to be a strong predictor of students' achievement in science process skills this study. This further implies that those students who performed well in the science process skills test did not necessarily demonstrate an intrinsic motivation towards science.

Table 5: Correlation between students' achievement in science process skills and their intrinsic motivation

Correlations			
		Posttest scores in BPST	Posttest scores in intrinsic motivation
Posttest scores in BPST	Pearson Correlation	1	0.027
	Sig. (2-tailed)		0.658
	N	263	263
Posttest scores in intrinsic motivation	Pearson Correlation	0.027	1
	Sig. (2-tailed)	0.658	
	N	263	263

Source: Field data (2015).

Although the association was not significant, the findings of a weak linear relationship between students' performance in the science process skills and their intrinsic motivation towards science resemble findings from other researchers. Many researchers (Gottfried, 1990 & Stipek, 1998) argued that motivation has a significant correlation with cognition, attitude, and acquisition of skills. These findings also resemble the conclusion made by Athuman (2017) who found that higher results in science were related to the learner's active engagement in learning tasks, to his or her positive attitude towards the subject and to a highly positive self-concept in science, which all imply the learner's intrinsic motivation to learn.

3.5 Correlation between students pretest-posttest change in science process skills and their pretest-posttest change in change in intrinsic motivation

The study also correlated the change of knowledge level of science process skills of students from pretest to posttest with their change in intrinsic motivation towards science from pretest to post-test. The aim was to find out whether a positive linear correlation exists between changes of students´ science process skills knowledge correlates with their change in intrinsic motivation to science. The resultant difference in students BPST scores from pretest to posttest and that of SMQ II intrinsic motivation test were used. Table 6 shows that the pretest-posttest change in students' science process skills did not significantly correlate with their change in intrinsic motivation to science. The correlation was not significant at the 0.01 level (2-tailed).

Table 6: Correlation between students pretest-posttest change in science process skills and

their pretest-posttest change in change in intrinsic motivation

Correlations			
		Pretest-posttest change in BPST	*Pretest-posttest change in intrinsic motivation*
Pretest-posttest change in BPST	Pearson correlation	1	0.049
	Sig. (2-tailed)		0.426
	N	263	263
Pretest-posttest change in intrinsic motivation	Pearson correlation	0.049	1
	Sig. (2-tailed)	0.426	
	N	263	263

Source: Field data (2015).

A Pearson correlation coefficient value of 0.052 was found between students' pretest-posttest change in science process skills and their pretest-posttest change in intrinsic motivation to science. According to Hinkle et al. (2003), the value or r = 0.049 indicate almost no linear relationship between the two variables. No linear relationship between students' pretest-posttest change in science process skills and their pretest-posttest change in intrinsic motivation towards science was found. This contradicts the findings by Hough & Piper (1982), who explored the relationship between attitude towards science and science achievement. A significant relationship was found between the pupils' process scores and attitude scores (r = 0.45).

REFERENCES

Ampili, V. P. (1 991). A *study of the relationship of process outcomes in science to science interest, scientific attitude and attitude towards academic work of university entrants.*Unpublished M.Phil. University of Kerala, Thiruvananthapuram. Athuman, J. (2017).

Comparing the effectiveness of an inquiry-based approach to that of conventional style of teaching in the development of students' science process skills .*International Journal of Environmental and Science Education*, 12(8), 1797-1816.

Ary, D., Jacobs, L., &Razavieh, A. (1990).*Introduction to research in education*. Fort Worth: Harcourt Brace College.

Benabou, R., & Tirole, J. (2003).Intrinsic and extrinsic motivation.*Journal of Review of Economic Studies*, 70, 489-520

Burns, J. C., Okey, J. R., & Wise K. C. (1985). Development of an integrated process skills test: TIPS II. *Journal of Research in Science Teaching*, 22 (2), 169-177.

Chiappetta, E. L., & Koballa, T. R. (2002).*Science instruction in the middle and secondary schools* (5th ed.) Upper Saddle River: Merrill Prentice Hall.

Deci, E. L., & Ryan, R. M .(2000).

Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Journal of American Psychologist*, 55(1), 68-78.

Dillashaw, F. G., &Okey, J. R. (1980). Test of integrated process skills for secondary science students. *Journal of Science Education*, 64(5), 601-608.

Downing, J., Filer, J., & Chamberlain, R. (1997).Science process skills and attitudes of preservice

elementary teachers.Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_pdf.
Dyer, J. E., Myers, B. E., & Washburn, S. G. (2004).Assessing agriculture teachers' capacity for teaching science integrated process skills. *Journal of Southern Agricultural Education Research*, 54(1), 74-84.
Gall, M. D., Borg, W. R., & Gall, J. P. (1989).*Educational research: An introduction*(2nd ed.). White Plains, NY: Longman.
Gerrnann, P.J. (1994). Testing a model of science process skill acquisition: An interaction with parents' education, preferred language, gender,science attitude, cognitive development, academic ability and biology knowledge. *Journal of Research in Science Teaching*, 31 (9), 1003-1021.
Glynn, S. M., Brickman, P., Armstrong, N., &Taasoobshirazi, G. (2011). Science Motivation Questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching*, 46(2), 127-146. Retrieved from
https://coe.uga.edu/outreach/programs/science-motivation
Gottfried, A. E. (1990). Academic intrinsic motivation in young elementary school children.*Journal of Educational Psychology*, 82(3), 525-538.
Hamilton, R., &Swortzel, K. (2007).Assessing Mississippi AEST teachers' capacity for teaching science integrated process skills.*Journal of Southern Agricultural Education Research* 57(1).Retrived from http://pubs.aged.tamu.edu/jsaer/Vol57Whole.pdf.
Harlen, W. (2000).*The teaching of science in primary schools.* (3rd Ed).London: David Fulton Publishers Ltd.
Hinkle DE, Wiersma W, Jurs SG. (2003). *Applied statistics for the behavioral sciences.*5th ed. Boston: Houghton Mifflin.
Hough, L.W., & Piper, M.P. (1982).The relationship between attitude towards science and science achievement.*Journel of Research in Science Teaching*, 19 (I), 33-38.
Lens, W., & Rand, P. (1997). Combining intrinsic goal orientation with professional instrumentality/utility in student motivation.*Polish Psychological Bulletin*, 28(1), 103–123.
Lobo, I. (1990).*Effect of developing science process skills among preservicesecondary school teachers on their classroom behaviour.*Unpublished Doctoral Dissertation, University of Mysore.
Millar, R., and Driver, R. (1987).Beyond Processes.*Journal of Studies in Science Education*, 14, 33-62.
Ostlund, K. (1998). What research says about science process skills.*Journal of Science Education*, 2 (4).
Retrieved from http://unr.edu/homepage/jcannon/ejse/ejsev2n4
Padilla, M. J. (1990), Science Process Skills- Research Matters - to the Science Teacher. (ERIC Document Reproduction Service No. ED266961).
Retrieved from: http://www.narst.org/publications/research/skill.cfm.
Padilla, M. J., Okey, J.R., &Dillashaw, F. G. (1983).The relationship between science process skill and formal thinking abilities.*Journal of Research in Science Teaching*, 20 (3), 239-246.

Pintrich, P.R., &Schunk, D.H. (1996).*Motivation in education: Theory, research and applications* (2nd ed.). Englewood Cliffs, NJ: Merrill Company.
Scharmann, L. C. (1989). Development of science process skill instruction.*Journal of Research in Science Teaching*, 26 (8), 715-726.
Stipek, D. (1998). *Motivation to learn: From theory to practice.* Boston: Allyn and Bacon

Sittirug, H. (1997). The Predictive Value of Science Process Skills, Attitude towards Science, and Cognitive Development on Achievement in a Thai Teacher Institution. Unpublished PhD Thesis, University of Missouri-Columbia.
Tobin, K. G. and W. Capie (1982). Development and validation of a group test of integrated science processes. *Research in Science Teaching*, 19(1), 133-141.
Vallerand, R.J., &Bissonnette, R. (1992). Intrinsic, extrinsic, and a motivational styles as predictors of behavior: A prospective study. *Journal of Personality*, 60(1), 599–620.
Walkoz, M and Yeany, R.H. (1984).Effects of Lab instruction emphasizing process skills on achievement of college students having different cognitive development levels.*Science Education*, 70 (3), 267.