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**EFFECTS OF INFORMATION PROCESSING TEACHING MODELS ON SENIOR  
SECONDARY SCHOOL BIOLOGY STUDENTS' ACADEMIC PERFORMANCE IN  
ADAMAWA STATE, NIGERIA**

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**ABSTRACT**

This study was conducted to determine the effects of information processing teaching models on senior secondary school biology students' academic Performance in Adamawa state, Nigeria. A quasi-experimental research design involving non-randomized, pretest-posttest, experimental, control groups was employed. The population of the study included all year 2 (SS II) biology students of the 365 Senior Secondary Schools in Adamawa state. A multistage sampling method was employed. The instruments for data collection was Biology Performance Test (BPT). For descriptive statistics, research questions were answered using descriptive statistics of mean and standard deviation while for inferential statistics, hypotheses were tested at 0.05 level of significance using two-way Analysis of Covariance (ANCOVA), Results of the study showed significant difference in the mean Performance scores of students taught biology using BSIM, CAM and lecture method,  $F = 12.94$  (df 2, 329),  $P = 0.00$ ; no significant difference in the mean Performance scores of male and female students when taught biology using BSIM, CAM lecture method,  $F = 1.85$  (df 1, 329),  $P = 0.67$ ; significant interaction effect of BSIM, CAM, lecture method and gender on biology students' academic Performance,  $F = 3.122$  (df 2, 329),  $P = 0.045$ ; Based on the findings some of the recommendations made were; the models should be employed for teaching biology in senior secondary schools in Adamawa state, teachers should employ the use of the models in teaching biology by engaging students in collaborative learning irrespective of gender.

**Keywords:** biology, performance, inquiry, attainment, concept

## INTRODUCTION

Science is an integral part of human activity. The acquisition and utilization of scientific knowledge are shouldered upon science educators to produce scientifically educated citizens that are capable of solving problems in order to be self-reliant. Biology is one of the science subjects. Concerned with the study of life and living organisms including their structure, function, and growth (Bozie, 2014). Arokoyu and Aderonmu (2018) asserted that science education is considered as a double scholarly discipline because of its application of scientific theories, facts, principles and laws utilizing educational theories and practice in conveying the fluid body of knowledge to learners. Science education prepares students for shifting from the teacher-centered methods of teaching science to child-centered activity based methods which encourage and develop spirit of inquiry, curiosity, investigation, critical thinking and reasoning ability; it provides understanding of scientific thinking, scientific innovation and scientific approach (Akinbobola & Afolabi, 2010).

The study of biology in senior secondary schools can equip students with useful concepts, principles and theories that will enable them face the challenges during the learning process and after graduation. Apart from career opportunities from biological studies, the subject has also contributed to the survival of man like in raising desired stocks through cross breeding of varieties of plant and animal species. Other applications of knowledge of biology and techniques for the interest of man include; the development of vaccines and drugs for prevention and curing of disease, invitro fertilization which helps infertile couples to have babies (Joda & Mohammed, 2017).

Teaching models are instructional designs that describe the process of specifying and producing particular environmental situations which cause the students to interact in such a way that those specific changes occur in behaviour (Thanavathi, 2022). Information processing models (IPM) are teaching strategies based on information processing theory that is designed to help students learn content at the same time as they practice thinking skills under the guidance and direction of an active teacher.

Academic performance signifies accomplishment or gain, or a performance carried out successfully by an individual on the completion of a task. It refers to all those behavioral changes that take place in an individual as a result of learning experiences of various kinds (Kauts & Kauts, 2020). Bossaert, Doumen, Buyse and Verschueren (2011) defined academic performance as students' success in meeting short- or long-term goals in education in the big picture. Academic performance is a measure of knowledge gained in formal education usually indicated by test scores, grades, grade point average and degrees; that result into the award of scores and grades by examiners on examinations conducted to students (Lawrence & Vimala, 2012).

Some factors that have effect on students' academic Achievement/Performance include: teacher's method of teaching, environment in which learning is taking place, student factors such as interest in a particular

subject, peer group factors, parents' factors and teaching materials, students' effort, parents' educational background, family income, self-motivation of students, age of students, learning preferences, and entry qualification, provision of adequate educational materials and regular checking of children's work by parents, personal factors teaching techniques and institution related factors (Obeta, 2014, Alani & Hawas 2021). For any given factor that influence or has negative effect on performance, there are ways to remedy such effects. Parents and the society at large need to work towards improving the academic performance and achievement of students. For instance, if the factor is teaching method, new methods of teaching or strategies have to be introduced or tried. If the factor is an environment that is not conducive, it should be made conducive for learning to take place for the improvement of academic performance. Student's interest in some subjects should be developed while bad peer group that affects academic performance be taken care of.

Airekar (2017) conducted a study on effectiveness of biological science inquiry model for science students in Manchar city. The objective of the study was to check the effectiveness of biological science inquiry model. The Design for the study was quasi experimental design which involved posttest-only. Two equivalent groups were used for the research. Biological science inquiry model was used to teach the experimental group while lecture method was employed to teach the control group. Result of the study showed there was significant difference on the performance of students of seventh standard using biological science inquiry model than lecture method.

Manishimwe, Shivoga and Nsengimana (2022) conducted a study on effect of inquiry-based learning on students' attitude towards learning biology at upper secondary schools in Rwanda. The design for the study was a quasi-experimental involving pre-test and post-test non-equivalent research design. Two independent variables with experimental and control groups were used. Pre-and post-test scores were dependent variables, while gender-based influence was considered as an independent variable. Findings of the study showed that the students taught with inquiry-based learning had a remarkable increase in positive attitude change compared to their counterparts that were taught through lecture method. Regarding gender aspect, inquiry –based learning did not show significant differences in attitude change between male and female students.

Parkash and Hooda (2016) conducted a study on effectiveness of biological science inquiry model and lecture method on biology in. DAV centenary public school, Sirsa (Haryana), India. A pre-test, post-test experimental treatment design was employed. Purposive sampling was used for the research work. Four sections of IXth class were taken. The groups are experimental group I and control group II. The experimental group I and control group were equated on mental ability or intelligence and socio- economic status. After equating the groups, there were 40 students in each group The Experimental Group-I was taught biology through science inquiry model and the control group was taught biology through lecture method. Results of the study showed that the groups of students taught biology through science inquiry model have scored significantly higher on the criterion performance test than the group of students taught biology through lecture method.

Bozie (2014) investigated the effect of biological science inquiry model on the performance in biology among VIII class students in Zurich, Switzerland. The design of the study was experimental control group design. The sample of the study was restricted to 240 students of 8th grade students. For research questions, descriptive statistics were employed. Results of the study showed that for null hypothesis one ( $H_{01}$ ), the value of t-calculated was greater than t-tabulated so the hypothesis was upheld. For Null hypothesis two ( $H_{02}$ ), t- calculated was greater than tabulated so the hypothesis was upheld. On gender base, result showed that male students had higher performance than their female counterparts when taught with biological science inquiry model than the lecture method.

Mwenda and Ndayambaje (2021) had a study on effects of inquiry-based teaching on students' academic achievement in biology in lower secondary schools in Ilala Dar es Salaam Tanzania. The design of the study was quasi experimental involving pre-test and post-test. A total of 94 form three students from two different secondary schools in the Ilala district in Dar es Salaam – Tanzania were used. Two groups: experimental and control were taken from intact classes from two different secondary schools for the study. Findings of the study showed that students taught through inquiry-based teaching performed better than those taught through lecture method.

### **Statement of The Problem**

It is observed that the performance of students in biology as a subject offered in the West African Senior School Certificate Examination (WASSCE) was poor. The researcher therefore embarked on a study “effects of information processing teaching models on senior secondary school students' academic performance and retention in Adamawa state, Nigeria to see if teaching method as one of the factors affecting performance and retention is a contributory factor.

### **Research Questions**

1. What are the mean performance scores of students when taught biology using biological science inquiry model, concept attainment model and lecture method?
2. What are the mean performance scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method?

### **Hypotheses**

**H<sub>01</sub>.** There is no significant difference in the mean performance scores of students when taught biology using biological science inquiry model, concept attainment model and lecture method.

**H<sub>02</sub>.** There is no significant difference in the mean performance scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method.

**H<sub>03</sub>.** There is no significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' academic Performance.

## METHODOLOGY

This study was carried out in Adamawa state on SS 2 students. It was a quasi-experimental research design involving non-randomized, pretest-posttest, experimental, control groups. This design was employed because it was not possible to randomize the subjects (students) and so intact classes were used to avoid disruption of normal class lessons (Njoroge, Changeiywo, & Ndirangu, 2014).

## RESULTS

**Research Question 1.** What are the mean performance scores of students when taught biology using biological science inquiry model, concept attainment model and lecture method?

**Table 1: Mean and Standard Deviation of Performance scores of students taught with Biological Science Inquiry Model (BSIM), Concept Attainment Model (CAM) and lecture method.**

Model	N	Pretest		Posttest	
		Mean	SD	Mean	SD
BSIM	114	16.41	6.13	24.46	9.72
CAM	111	13.84	6.12	22.24	9.95
Lecture	105	17.76	5.53	18.05	7.91

The descriptive statistics in Table 1 showed that Biological Science Inquiry Model with 114 students has a pretest mean score of 16.41 and standard deviation of 6.13. On Posttest, Biological Science Inquiry Model has mean score of 24.46 and standard deviation of 9.72. Concept Attainment Model with 111 students has a pretest mean score of 13.84 and standard deviation of 6.12. On Posttest, Concept Attainment Model has mean score of 22.24 and standard deviation of 9.95. Lecture teaching method with 105 students has a pretest mean score of 17.76 and standard deviation of 5.53. On Posttest, Lecture Method has mean score of 18.05 and standard deviation of 7.91. In summary, the mean difference between pretest and posttest is high which means Biological Science Inquiry Model, Concept Attainment Model and Lecture teaching methods have improved students' achievement at different levels

## Research Question 2.

What are the mean performance scores of male and female students when taught biology using biological science inquiry teaching model, concept attainment teaching model and lecture method?

**Table 2: Mean and standard deviation of performance scores of students taught with biological science inquiry model (BSIM), concept attainment model (CAM) and lecture method based on gender**

	n	Pretest		Posttest	
		Mean	SD	Mean	SD
<b>BSIM</b>					
Male	53	18.19	5.77	24.87	9.30
Female	61	14.87	6.06	24.10	10.14
<b>CAM</b>					
Male	62	15.08	7.07	20.32	9.83
Female	49	12.27	4.21	24.67	9.67
<b>Lecture</b>					
Male	47	18.10	5.75	18.79	8.42
Female	58	17.48	5.37	18.05	7.90

The descriptive statistics in Table 2 showed that biological science inquiry model (BSIM) has 53 male students and 61 female students. The mean score of male students is 18.19 and standard deviation of 5.77. The mean score of females is 14.87 and standard deviation of 6.06. On posttest the mean score of male students is 24.87 with standard deviation of 9.30. The mean score of females on posttest is 24.10 with standard deviation 10.14. Concept Attainment Model has 62 male students and 49 female students. The mean score of male students is 15.08 and standard deviation of 7.07. The female students have mean score of 12.27 and standard deviation of 4.21. On posttest the mean score of male students is 20.32 with standard deviation of 9.83. The mean score of females on posttest is 24.67 with standard deviation 9.67. Lecture Method has 47 male students and 58 female students. The mean score of male students is 18.10 and standard deviation of 5.75. The mean score of female students is 17.48 and standard deviation of 5.37. On posttest the mean score of male students is 18.79 with standard deviation of 8.42. The mean score of female students on posttest is 18.05 with standard deviation 7.90. In summary, with biological science inquiry model the mean score of males is higher than that of male on pretest while on posttest the differences in mean score among male and female is negligible. With concept attainment model, the mean score of males is higher than that of female on pretest while on posttest the differences is in favour of female. With lecture method, the mean score of males is higher than that of male on pretest while on posttest the difference is negligible

**Testing Hypotheses**

**Ho<sub>1</sub>.** There is no significant difference in the mean Performance scores of students taught biology using biological science inquiry teaching model, concept attainment teaching model and lecture method

**Table 3: Summary of ANCOVA of Biological Science Inquiry Model, Concept Attainment Model and Lecture Method on SS II Biology Students' Academic Performance in Adamawa state.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2307.496 <sup>a</sup>	3	769.165	8.933	.000	.076
Intercept	19213.616	1	19213.616	223.134	.000	.406
PRETEST	8.316	1	8.316	.097	.756	.000
MODELS	2229.057	2	1114.528	12.943	.000	.074
Error	28071.159	326	86.108			
Total	185382.000	330				
Corrected Total	30378.655	329				

a. R Squared = .076 (Adjusted R Squared = .067) = significant  $P < 0.05$

The results of the analysis in Table 3 shows that there is significant difference in the mean Performance scores of students taught biology using biological science inquiry model, concept attainment model and lecture method.  $F = 12.94(df 2, 329)$ ,  $P = 0.00$ . Since the computed p-value (0.00) is less than 0.05 level of significant, therefore, the null hypothesis of no significant difference is rejected, and it is concluded that there is significant difference in the mean performance scores of students taught biology using biological science inquiry model, concept attainment model and lecture method in SS II in Adamawa state.

**Ho2.** There is no significant difference in the mean Performance scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method.

**Table 4: Summary of ANCOVA of SS II Male and Female Biology Students' Academic Performance in Adamawa State**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	95.575 <sup>a</sup>	2	47.787	.516	.597	.003
Intercept	21573.759	1	21573.759	232.956	.000	.416
PRETEST	65.284	1	65.284	.705	.402	.002.
GENDER	17.136	1	17.136	.185.	.667	.001
Error	30283.080	327	92.609			
Total	185382.000	330				
Corrected Total	30378.655	329				

a. R Squared = .003 (Adjusted R Squared = -.003)



The results of the analysis in Table 4 shows that, there is no significant difference in the mean performance scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method,  $F = 1.85$  (df 1, 329),  $P = 0.67$  Since the computed p-value (0.67) is greater than 0.05 level of significant, therefore, the null hypothesis of no significant difference is upheld.

**H<sub>03</sub>.** There is no interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' academic Performance.

**Table 5: Summary of ANCOVA of Interaction Effects of BSIM, CAM, Gender and Lecture Method on SS II Biology Students' Academic Performance in Adamawa State.**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2881.058 <sup>a</sup>	6	480.176	5.640	.000	.095
Intercept	18055.204	1	18055.204	212.085	.000	.396
PRETEST	.429	1	.429	.005	.943	.000
MODELS	2228.700	2	1114.350	13.090	.000	.075
GENDER	42.289	1	42.289	.497	.481	.002
MODELS * GENDER	531.575	2	265.787	3.122	.045	.019
Error	27497.597	323	85.132			
Total	185382.000	330				
Corrected Total	30378.655	329				

a. R Squared = .095 (Adjusted R Squared = .078) = Significant  $P < 0.05$

The results of the analysis in Table 5 shows that, there is significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' academic performance in Adamawa. State  $F = 3.122$  (df 2, 329),  $P = 0.045$ . Since the computed p-value (0.045) is less than 0.05 level of significant, therefore, the null hypothesis of no interaction effect is rejected.

### Findings of the Study

1. There is significant difference in the mean performance scores of students taught biology using biological science inquiry model, concept attainment model and lecture method in Adamawa State,  $F=12.94$ (df 2,329),  $P= 0.00$



2. There is no significant difference in the mean performance scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method in Adamawa State.  $F = 1.85$  (df 1, 329),  $P = 0.67$
3. There is significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' academic performance in Adamawa state,  $F = 3.122$  (df 2, 329),  $P = 0.045$

## DISCUSSION

This finding corroborates with that of Waziri (2018) who found out that BSIM, enhanced students' cognitive Performance in Adamawa state. Parkash and Hooda (2016), Airekar (2017), Kumar and Geetha (2013), Norwood (2019) have all reported the effectiveness of biological science inquiry model. This finding disagrees with the finding of Bozie (2014) who reported the that  $t$ - calculated was greater than 0.05 level of significance indicating the insignificant mean difference scores of students exposed to biological science inquiry model. Athuman (2017), Maasawet, Retnaningsih and Boleng (2017), Nisa et al (2018), Abdi (2014), Njoroge, Changeiywo and Ndirangu (2014), Ogheneakoke (2014) all reported significant mean difference of students' performance on the use of inquiry method of teaching.

The finding of this study also agrees with the finding of Latchanna and Swarnalatha (2016) which showed that teaching biology through concepts attainment model had significant mean difference, Noreen and Chaudhary (2021), Maridi and Masykuri (2018), Anjum (2014), Arokoyu and Aderonmu (2018), Citra and Sigit (2023), Ostad and Soleymannpour (2014) have all reported significant mean differences in students' performance through concept attainment model. This finding of significant mean difference of CAM however disagrees with the finding of Alam (2017) who reported insignificant difference in the mean performance scores of science students when exposed to concepts attainment model.

The findings of this study also showed that there is no significant difference in the mean Performance scores of male and female students when taught biology through BSIM, CAM, and lecture method in Adamawa State.  $F = 1.85$  (df 1, 329),  $P = 0.67$  Since the computed  $p$ -value (0.67) is greater than 0.05 level of significance, therefore, the null hypothesis of no significant difference is upheld. The  $P$ -value of 0.67 is greater than 0.05 which means that the teaching methods were equally effective for both genders. This finding corroborates that of Manishimwe, Shivoga and Nsengimana (2022) who reported no significant mean difference between male and female students when exposed to inquiry-based learning. Alam (2017) and Dania (2014) also reported no significant difference in the mean performance scores of secondary school male and female when exposed to inquiry learning.

## Recommendations

Based on the above findings, the study recommends that; workshops for training biology teachers on how to use the models in teaching biology in senior secondary schools of Adamawa state should be organized to enhance students' performance. With no significant

gender difference in the mean performance scores of students, teaching biology using these models should be encouraged since it has no gender bias

## CONCLUSION

Based on the findings of the study, it is concluded that BSIM was the best followed by CAM and lecture method was the least on enhancing students' Performance. Gender on the other hand did not have a significant effect on students' Performance.

## REFERENCES

- Abdi, A. (2014). Effect of inquiry-based learning method on students' academic performance in science course *Universal Journal of Educational Research*, 2(1); 37-41. DOI: 10.13189/ujer.2014.020104.
- Airekar, A. J. (2017). Effectiveness of biological science inquiry model for subject of science. *Scholarly Research Journal for Humanity Science & English Language*, 6(29),5.068, [www.srjis.com](http://www.srjis.com)
- Akinbobola, A. O. & Afolabi, F. (2010). Analysis of science process skills in West African senior secondary school certificate physics practical examinations in Nigeria. *Bulgarian Journal of Science and Education Policy*, 4 (1), 32-47.
- Alam, M. M. (2017). Effectiveness of concept attainment model of teaching on Performance in sciences among secondary school students. *International Journal of advance research*
- Alani, S. F. & Hawas, T. A. (2021). Factors affecting students' academic performance: a case study of Sohah University. *Psychology and Education*, 58(5), 4624-4635.  
<https://www.researchgate.net/publication>
- Anjum, S. K. (2014). A study of effect of concept attainment model on Performance of geometric concepts of viii standard students of English medium students of Aurangabad city. *Scholarly Research Journal for Interdisciplinary Studies*, 2(15), 2451-2456.
- Arokoyu, A. A. & Aderonmu, T. S. B. (2018). Conceptual formation, attainment and retention of Chemistry and Physics students in real-life phenomena. *International Journal of Scientific Research and Innovative Technology*, 5 (5), 2313-3759.
- Athuman, J. 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 & Science Education*, 12(8),1797-1816.
- Bossaert, G., Doumen S. B. & Verschueren K. (2011). Predicting children's academic performance after the transition to first grade: A two-year longitudinal study. *Journal of Applied Developmental*

*Psychology, (32), 47-57.*

- Bozie, M. (2014). Impact of technology on teaching methods. A forward Look. *Scholedge International Journal of Management & Development, 1(1),34-43.* [www.Scholedge.Org](http://www.Scholedge.Org).
- Citra, A. N. & Sigit, S. (2023). Implementation of concept attainment learning model to increase independence and reduce misconception of MA students on circulatory system learning material. *Journal of Biology education, 12(2); 217-299*
- Dania, P. O. (2014), Effect of gender on students' academic performance in secondary school social studies. *Journal of Education and Practice, 5(21); (Online).*[www.iiste.org.daniapore@yahoo.com](http://www.iiste.org.daniapore@yahoo.com).
- Joda, F. M. & Mohammed, A. A. (2017), Effect of guided inquiry teaching method on senior secondary biology students' academic Performance and retention in Yola education zone, Adamawa state, Nigeria. *Multidisciplinary Journal of Science, Technology and Vocational Education, 5(1), 89-96.*
- Kauts, D. S. & Kauts, A. (2020) Effect of Taba's inductive thinking model on Performance in science and creative thinking in relation to intelligence of students at secondary school stage. *MIER Journal of Educational Studies, Trends & Practices, 10(2) 151 - 166.*
- Lawrence, A. S. A. & Vimala, A. (2012) School environment and academic performance of standard IX students. *Journal of Educational and Instructional Studies in the World, 2 (3), 2146-7463*
- Maasawet, E. T., Retnaningsih, W. S. & Boleng, D. T. (2017). Inquiry model-based device to increase learning skill writing a scientific balance of biology projects. *Advances in intelligent systems research (AISR), (144). International conference on education and technology ICEduTech.*
- Manishimwe, H. Shivoga, W. A. & Nsengimana, V. (2022). Effect of inquiry-based learning on students' attitude towards learning biology at upper secondary schools in Rwanda. *Journal of Baltic Science Education, 21(5). 21(5), 862- 874.* <https://doi.org/10.33225/jbse/22.21.862>
- Mwenda, S. K. & Ndayambaje, I, (2021). Effects of inquiry-based teaching on students academic Performance in biology in lower secondary schools in Ilala Dar es Salaam Tanzania. *LWATI: A Journal of Contemporary Research, 18 (4), 2-14.* [www.universalacademicservices.org](http://www.universalacademicservices.org)
- Nisa, E. K., Koestiari, T., Habibulloh, M. & Jatmiko, B. (2018). Effectiveness of guided inquiry learning model to improve students' critical thinking skills at senior high school. *IOPConf. Series: Journal of Physics: Conf. Series, 997, 012049 Doi :10.1088/1742-6596/997/1/012049.* E-mail: [budijatmiko@unesa.ac.id](mailto:budijatmiko@unesa.ac.id)

- Njoroge, G.N., Changeiywo, J. M. & Ndirangu, M. (2014). Effects of inquiry-based teaching approach on secondary school students' Performance and motivation in physics in Nyeri County, Kenya. *International Journal of Academic Research in Education and Review*, 2(1), 1-16. DOI;10.14662/IJARER2013010.
- Norwood, M. (2019). Impact of the biological sciences curriculum study (BSCS) 5E model on middle-level students' content knowledge, University of South Carolina. (Doctoral dissertation). Retrieved from <https://scholarcommons.sc.edu/etd/5190>
- Obeta, A.O. (2014). Home environmental factors affecting students' academic performance in Abia State, Nigeria. *In Rural Environment*, 1(4), .20-29
- Ostad, G. & Soleymanpour, J. (2014). The impact of concept attainment teaching model and mastery teaching method on female high school students' academic Performance and metacognitive skills. *International Journal of Innovative Research in Science, Engineering and Technology*, 3(2), 9774 - 9781.
- Parkash, J. & Hooda, S. (2016). A Comparative study of the effectiveness of science inquiry model and advance organizer model in Performance in biology. *International Journal of Advanced Research in Education & Technology*, 3(3), 21-30. .
- Thanavathi, C. (2022). Model of teaching: meaning, definitions, and function-models: philosophical teaching models: insight model (Plato) impression model (John Locke) and rul. <https://www.researchgate.net/publication/358641922>