

**MAKING THE STRANGE FAMILIAR MODEL AND STUDENTS' CREATIVE THINKING SKILLS IN BASIC SCIENCE IN OYO SOUTH SENATORIAL DISTRICT, NIGERIA****Mary Otitooluwa IYANDA-TAIWO Ph.D & Edidiong E. UKOH Ph.D**

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**Abstract**

Students ought to be the architects of their own learning but majority of schools aim to educate their students to achieve high exam scores by cramming and memorising the material which deprives students of thinking, creativity and exploration. Educational approaches should change to suit new demands in order to provide the workforce required for a technologically advanced and quickly changing society. This study therefore, investigated Making the Strange Familiar Model (MSFM) on students' creative thinking skills in Basic Science (BS) in Oyo South Senatorial District. It also examined the moderating effect of scientific reasoning ability (SRA) and self-efficacy on students' creative thinking skills in BS. The pretest-posttest control group quasi-experimental design was adopted. The instruments were Basic Science Creative Thinking Skills ( $r = 0.79, 0.76, 0.80, 0.76$  and  $0.78$ ), Scientific Reasoning ( $r = 0.80$ ) tests, Basic Science Self-efficacy ( $r = 0.84$ ) scale and instructional guides. The data were analysed using ANCOVA and EMM at 0.05 level of significance. The participants' age was  $12.05 \pm 1.10$  years, 79.2% were concrete thinkers and 89.6% had low self-efficacy. There was a significant main effect of treatment on students' creative thinking skills in BS ( $F(1,172) = 78.72, p = 0.48$ ). The participants in MSFM had the highest post- creative thinking skills mean score (13.97), followed by the control (9.98) groups. There was no significant interaction effect of SRA and self-efficacy on students' creative thinking skills in BS. Basic Science teachers should adopt this model for improved students' creative thinking skills regardless of SRA and self-efficacy.

**Keywords:** Making the strange familiar model, Synectics Instructional Model, Creative thinking skills in basic science, Basic Science students in Oyo South Senatorial District

## 1.0 Introduction

The rapid pace at which the world is experiencing globalisation has influenced the use of science and technology to overcome humanity's challenges and achieve the Sustainable Development Goals (SDGs). This is seen through the knowledge of science and technology that profoundly changes all spheres of life, starting from the energy sector and electricity, to education sector, environmental problems among others. For this purpose, science education has become an essential tool for the nations of the world to live in peace and to overcome some of the challenges posed by man's intentional and unintentional changes in the environment. Generating people with scientific knowledge, abilities, and attitudes that support global, social, economic, and industrial growth which is increasingly fuelled by scientific and technological advancements is one of the primary objectives of science (Olofin et al., 2023).

Basic science, also known as the foundation of all science subjects in secondary schools, is a part of the science education offered at junior secondary level in Nigeria as a subject (Babajide, 2015). It was introduced at the primary school level as a basis for other sciences. The overarching goals of the basic science curriculum according to Maranzu & Nwosu (2023) cited by NERDC (2014) are to: foster interest in science and technology; grasp basic science and technology concepts; apply knowledge to meet societal needs; tap into career paths that science and technology provide; prepare for advanced studies in these fields; steer clear of drug addiction and related addictions; and to be safety awareness. Additionally, the ministry clarified that the goal of the basic science subject aims to foster creativity and critical thinking in students. Thus, help students to better appreciate the contemporary world and change the world and help them develop an entrepreneurial spirit among others. Mbanefo (2016) affirmed that the 21st century's challenges, with their intricate environmental, social and economic demands, necessitate youth being creative, innovative, enterprising and adaptable and showing the confidence and skills to apply critical and creative thinking suitably. Achieving the goals of basic science would contribute to the establishment of a solid basis for future doctors, architects, engineers, computer scientists, and others aiming to bring the nation to excellence like developed nations. This would also shape a nation where citizens can engage in global issues, without drug addiction, with the resulting effect of a crime-free society (STAN, 2010).

Students' ability to express their creative talents is meant to be greatly influenced by their school environment. Schools provide a platform for developing students' capacity in fostering students' creative thinking skills as well as their achievements in a variety of areas of life. Currently, majority of schools aim to educate their students to achieve high exam scores by cramming and memorising the material. Schools may foster logical and creative thinking skills of students in what they see, hear and read. Students ought to be the architects of their own learning (Gordon, 1961). Unfortunately, conventional method deprives students of thinking, creativity and exploration. In other words, students merely retain certain scientific facts and notions in their minds rather than learning, thinking, and being creative. Thus, to boost students' creative thinking skills, suitable teaching methods should be emphasised that allow students to think critically and divergently, fostering both understanding and creative thinking abilities.

The learning process in the 21st century has adapted to equip students with skills for global economy (Fatmawati, 2016). Creative thinking skill is among the essential 21st-century skills for students. Creative thinking can drive, stimulate and enable research, development and inquiry to address challenges of industrial revolution 4.0. To meet this challenge, learning quality must be

enhanced. Education can be enhanced by shifting learning paradigm, especially in basic science. Conventional method emphasising discipline-specific learning and rote memorisation don't adequately prepare students for complex issues in their lives (Fatmawati, 2016). Creative thinking skills are required in learning basic science. The goal of teaching students basic science is to provide them with the critical, creative, and logical thinking skills necessary to respond to societal problems brought on by the advancement of science and technology (Rashid & Asghar, 2016). Therefore, every student should be able to think creatively and innovatively in order to produce original work.

Science educators generally agreed that the teaching strategy or method used in the classroom has a significant effect on students' achievement, interest, creative thinking skills and so on (Athuman, 2017; Kalantarnia et al., 2020; Somappa, 2020; Darlington, 2018; Ali et al., 2024). Taking into account the intrinsic flaws in the conventional method of teaching basic science where inadequate attention was given to creative thinking skills of basic science students. It is necessary to adopt newer innovative students-friendly instructional model to improve students' creative thinking skills in basic science in order to successfully implement appropriate skills and knowledge that is relevant and meaningful to them. There are different creativity techniques, these include: polya's method, classical brainstorming, synectics instructional model, morphological analysis, free association, kipling method, scamper, phoenix checklist, lateral thinking technique, mind mapping, six thinking hats, wishful thinking, TRIZ method, role playing, free writing and dream journaling. Synectics Instructional Model is one of the strategies which seem to have real potential for boosting students' creativity as it allows them to engage in a variety of metaphorical activities that are needed for developing creative thinking skills. This makes teaching more innovative for a higher standard of living by giving the students the opportunity to think differently and fulfill their responsibilities (Ramadhani, et al., 2020). Therefore, successful teaching strategies designed to foster divergent thinking skills should be carefully added to the current approaches that place an excessive amount of focus on convergent thinking.

Synectics Instructional Model is one of the innovative strategies used to stimulate creativity and problem solving in education, business, industry and politics. According to Tumangger and Ernidawati (2012), Synectics Instructional Model, which Gordon (1961) modified for use in education, is a problem solving and creative thinking skills model that requires the free generation of ideas on a topic and the evaluation of ideas that arise from it (Rajput, 2014). Metaphor is the backbone of the Synectics Instructional Model and it deals with series of analogies in the classroom (Estes et al., 2010). According to SNTD Women's University (2020) the term 'Synectics' is derived from the Greek word 'Synecticos' and refers to the joining of unrelated elements or the combining of different things. The Synectics Instructional Model favours a logical solution, embraces creative possibilities and follows two teaching strategies. They are: Making the Familiar Strange Model and Making the Strange Familiar Model.

Making the Strange Familiar is the second model of the Synectics Instructional Model and it is designed to transform new and unfamiliar ideas into more understandable and meaningful ideas (Djudin, 2017). The second version is more like an analytical step because it first requires individuals to grasp the problem until they are comfortable with it. The second version, Making the Strange Familiar, links new and existing information and makes new knowledge more relevant, which focuses on problem-stating and problem-solving process (Estes et al., 2010). In other words, Making the Strange Familiar is a bridge between the known and the unknown. Valdez &

Sobremisana, (2020) carried out a research on effect of Making the Strange Familiar Model on students' problem solving and creative thinking skills in physics. Their results demonstrated that the Making the Strange Familiar Model had an impact on physics students' problem solving and creative thinking skills. More so, Fernandez *et al* (2021) conducted a study on Making the Strange Familiar Model in teaching grade 9 science. Compared to the group taught using lecture methods, the average value of the group that received an intervention using the Making the Strange Familiar Model in teaching improved strongly, and the post-test scores of both groups showed a boost in good achievement levels. The findings also showed that the control and experimental groups of pre-test and post-test scores differed significantly.

Added to be an indicator of creative thinking skills are Scientific Reasoning Ability (SRA) and self-efficacy. According to Lawson (2000), Scientific Reasoning Ability is a collection of core competencies that are frequently necessary for students to carry out successful research. These skills include problem-solving, observation, hypothesis development and testing, data control and manipulation, result and evaluation. Bao, Xiao, Koeing & Han (2009) affirmed that SRA is important for the generation of scientific knowledge; it affects students' achievement long-term and also makes learning science concepts more interesting for students. Studies on SRA were conducted in various scientific fields except basic science. Oloyede & Adeoye (2012) found a significant connection between students' reasoning ability, science process skills and their chemistry achievement. As far as the researcher's knowledge goes, no study has examined how scientific reasoning ability affects basic science students' creative thinking skills. In this study, it was determined and grouped into three: concrete, transitional and formal.

Students' self-efficacy is their belief in being able to accomplish a task or attain a goal (Bandura, 1997). It has been discovered that students' self-efficacy affects difficulty level they tackle, the effort they invest, and the length of time they endure through difficult assignments. Since students would need to exert control over their academic learning environments based on new model that include thinking skills and an interest in learning new skills in science class, it is crucial that they have high self-efficacy (Bryant, 2017). As far as the researcher's knowledge goes, the majority of studies conducted on self-efficacy in science focused on mathematics and physics, while the research on the self-efficacy of basic science students has been scarce. Based on the above observations, it is critical to assess junior secondary school basic science students' self-efficacy in order to ascertain how it affects their creative thinking skills.

Therefore, it is in this context that this study aimed to compare Making the Strange Familiar Model and Conventional Method on students' creative thinking skills in basic science in Oyo South Senatorial District, Nigeria. The study also determined the moderating effects of scientific reasoning ability and self-efficacy on students' creative thinking skills in basic science.

### **1.1 Statement of the Problem**

Students ought to be the architects of their own learning, however, creative thinking skills which is one of the objectives of basic science is rarely considered as important in learning basic science. It seems that teachers do not give creative thinking skills adequate consideration. As a result of the way the subject is taught, students lack sufficient creative thinking skills. This trend has been attributed to a number of variables, primarily the usage of the lecture approach despite the promotion of numerous creative alternatives.

Although, Making the Strange Familiar Model have been successfully used by researchers outside the shores of Nigeria, but no one has ventured to use them in any discipline in Nigeria to the best of the knowledge of the researcher. It is therefore expected that if Making the Strange Familiar Model is implemented properly, this model could facilitate a higher level of students' creative thinking skills in basic science as in the case of United States of America and other foreign countries where it was used.

This study therefore determined Making the Strange Familiar Model and students' creative thinking skills in basic science in Oyo South Senatorial District, Nigeria. It also determined the moderating effect of scientific reasoning ability and self-efficacy on students' creative thinking skills in basic science.

## **1.2 Null Hypotheses**

This study tested the following null hypotheses at  $p < 0.05$  level of significance:

**Ho1:** There is no significant main effect of treatment on students' creative thinking skills in basic science.

**Ho2:** There is no significant interaction effect of treatment and scientific reasoning ability on students' creative thinking skills in basic science.

**Ho3:** There is no significant interaction effect of treatment and self-efficacy on students' creative thinking skills in basic science.

## **2.0 Literature Review**

### **2.1 Theoretical framework**

According to Piaget (1954), students interact with objects and events that are available in physical and social environment and thereby comprehend the feature held by such objects or events by using the process of assimilation and accommodation. The students therefore construct their own conceptualisation and use their own conceptualisation to generate solutions to problem. His theory suggested that human create and construct knowledge and they try to bring meaning to their experience. Also, Vygotsky (1978) stressed the individual's active role in development; his research showed that student can always do more in collaboration than he can do independently. The effectiveness of Making the Strange Familiar Model provide support to the constructivist learning theory's assumption that learning is optimised when students are given autonomy to create their own interpretations of reality by connecting previous learnt material with new information. The students' prior knowledge of their daily lives was used in this research, and each one was given the chance to build new information based on his prior experiences. This allowed the students to learn independently and come up with new ideas within themselves. Also, students work together in groups and actively participated in the learning process, which fosters collaborative learning settings by allowing students to share different viewpoints on the same topic at the same time.

According to Kolb (1984), "Learning is the process whereby knowledge is created through the transformation of experience". Kolb believed that the information needed to bring about learning could be obtained from either concrete experience (CE) or abstract conceptualisation (AC) but not both simultaneously. The findings of efficiency of Making the Strange Familiar Model also support the assumption of experiential learning theory that students learn better when they create

knowledge through experience. Students are able to generate analogies from their everyday life experiences under the guidance and supervision of the teacher. During this study, students are guided consciously to construct analogies based on their previous experience from everyday life or local life to develop understanding of abstract concepts in basic science which helped the experimental groups obtain higher results. Also, from the students' responses, the researcher found out that students were eager and interested in answering questions because all of the analogies and examples came from their own everyday local experiences. Also, students participate actively in the process of gaining comprehension of novel ideas.

## 2.1 Empirical review

### **Making the Strange Familiar Model and Students' Creative Thinking Skills in Science**

A study on the effects of Making the Strange Familiar Model on the students' problem solving and creative thinking skills in physics was examined out by (Valdez & Sobremisana, 2020). To ascertain whether applying the Making the Strange Familiar Model improves the physics students' problem-solving and creative thinking abilities in Grade 12, the researchers employed the quantitative research method, especially the descriptive quasi-experimental design. Intact groups were chosen and matched according to age, final Physics grade 1, and pre-tests of problem-solving and creative thinking abilities. The experimental and control groups' respective post-test mean scores were 17.52 and 14.90. The experimental group's creative thinking skills score was 3.978, while the control group's score was 3.61, suggesting that the students' creative thinking skills had improved. The experimental group's problem-solving skills test showed better improvement when the Making the Strange Familiar Model was used in the eight (8) modules, according to the difference in the two groups' pre- and post-test results. The two groups' post-test mean scores differ significantly, as indicated by the p-value of 0.00243. In terms of problem-solving abilities, the experimental group outperformed the control group. Lastly, the experimental group's relationship between problem-solving and creative thinking skills revealed that the interaction between creative thinking techniques and problem-solving techniques has a low significant relationship as implied by p-value of -0.045 which demonstrates that students with high problem-solving techniques vary inversely with creative thinking techniques.

Sedaghat, Darivash, & Fooladi (2015) assessed the impact of a Making the Strange Familiar Model on enhancing creativity in students' composition. The findings demonstrated that the Making the Strange Familiar Model is a more efficient way to advance students' thinking flexibility in composition study than the traditional teaching method. Kalantarnia *et al* (2020) conducted a research on the effect of Bybee and Making the Strange Familiar Model on creativity, creative problem-solving, and achievement of ninth-grade students in geometry. A pre-test, post-test and control group were all part of the quasi-experimental research methodology. Three whole classes, each with thirty students, were chosen using the cluster sampling approach from among all of the ninth-grade female students enrolled in Tehran's public high schools. Next, two classes were split into two experimental groups and a control group at random. Furthermore, a researcher-made

geometry test, Basadur's problem-solving creative test, and Abedi's creativity test were among the research tools. The subjects were first given achievement, creativity, and problem-solving pre-tests in order to gather data. Post-tests of achievement, creativity, and problem-solving were administered to the subjects following the execution of the patterns in the groups. Lastly, the data was analysed using SPSS software using descriptive statistics (mean and standard deviation) and ANCOVA. Bybee and the Making the Strange Familiar Model had a considerably greater impact on students' creativity, problem-solving, and geometry achievement than typical teaching techniques, according to the data.

Paltasingh (2008) studied the effect of Making the Strange Familiar Model on the development of students' creativity in a life sciences course. He contrasted learning a science using the Making the Strange Familiar Model with learning a science using the traditional method. The study's findings provided strong evidence in favor of Making the Strange Familiar Model's application in the classroom. First, it was discovered that there was a significant difference between the effects of Making the Strange Familiar Model and the conventional method of teaching life sciences in the development of creative thinking skills. Creativity training through Making the Strange Familiar Model resulted in significantly higher achievement in science. Additionally, the experimental group taught by the Making the Strange Familiar Model obtained significantly higher post-test scores than the control group in terms of academic achievement.

### **Scientific Reasoning Ability and Students' Creative Thinking Skills in Science**

Shouldika *et al* (2019) attempted to analyse the relationship between students' scientific reasoning ability in relation to a sound concept and their scientific creative and critical thinking skills. For this research, 42 science students in the eleventh grade from one of Bandung's private schools participated. In order to solve sound problems and in terms of open-ended questions and tools of scientific reasoning skills in terms of multiple-choice questions related to a whole concept, they employ a set of creative and critical scientific thinking in this research. The outcomes of this research indicated that students' average scores in scientific critical thinking and creative thinking are 17.36 and 23.67, respectively, with a maximum score of 64 and 48. Both fall into the low achievement category. The average score for scientific reasoning skills is 36.70, which falls into the low achievement category, compared to the maximum score of 100. In the meantime, the relationship between scientific reasoning ability and creative-critical thinking is 0.57 respectively.

### **Self-efficacy and Students' Creative Thinking Skills in Science**

Self-efficacy strongly influences students' creative thinking abilities. The study's finding of Kisti *et al* (2012) showed that creativity and self-efficacy have a significant relationship. The self-confidence in question is self-efficacy. Self-efficacy is a person's confidence in the emergence of new actions used to overcome a problem to reach the goal. The research findings of Wahyu *et al* (2017) were based on the researchers' experience as PPL teaching assistants in schools; students are often reluctant to express their opinions. According to Bandura's theory, this problem is related to students' low self-efficacy. According to Bandura (1997), if an individual has low self-efficacy,

he or she tends to give up easily and is powerless. Therefore, it can be concluded that students of this class have low self-efficacy (Solihin, 2025).

## **2.2 Appraisal of Literature Reviewed**

According to the reviewed research, basic science is a required subject in Nigerian junior secondary schools and may have an effect on students' creative thinking skills. One of the innovative and user-friendly teaching model that can help students and teachers in teaching and learning of basic science is the Synectics Instructional Model (Making the Strange Familiar Model). It is an interesting approach adapted for education by William Gordon in 1961 to promote problem solving and creative thinking that requires the free generation of ideas on a subject. The key principle of model is metaphors which involve the use of analogies. The model gives students a framework to build imagination and knowledge in everyday activities. It does not limit the students' learning experience and does not intimidate students with the value of their creative thinking skills but respect the creative ideas that arise from student's opinion. Although, Making the Strange Familiar Model has been successfully used by researchers outside the shores of Nigeria, no work has been done in this area in Nigeria and to the teaching of basic science to the best of the researchers' knowledge.

Based on the researchers' knowledge, no work has been done on the effects of scientific reasoning ability on students' creative thinking skills in basic science. In this research, it was determined and classified into three categories: concrete, transitory and formal. Based on the researcher's knowledge, majority of studies carried on students' self-efficacy in science focused on mathematics and physics, while its research on basic science students' self-efficacy has been scarce. Based on the above submissions, it is important to examine junior secondary school basic science students' self-efficacy in order to determine its effect on students' creative thinking skills in basic science.

It is therefore expected that if Making the Strange Familiar Model is properly applied, this model would improve students' creative thinking skills in basic science as in the case of United States of America and other foreign countries where it was used.

## **3.0 Methodology**

### **3.1. Research Design**

The study made use of pretest-posttest control group quasi-experimental design. The design employed was 2 x 3 x 3 factorial matrix with the instructional strategies as treatment at two levels, scientific reasoning ability at three levels (concrete, transitional and formal) and self-efficacy at three levels (low, medium and high).

### **3.2. Sample and sampling techniques**

A total of 183 students who took part in the study were drawn from public Junior Secondary School II (JSII) in Oyo South senatorial district, Oyo State. Two Local Government Areas out of nine Local Government Areas in Oyo South senatorial district were randomly selected. Six schools were purposively selected based on availability of qualified basic science teachers and willingness to participate in the study. Six intact classes of JS II Basic science students participated. Three schools from each chosen local government areas were randomly assigned to MSFM (3) and control (3) groups. This was done to reduce allocation bias at the school level.

Intact classes of JS II students were chosen because they are not pressured by external examination preparation and to ensure minimal disruption to the schools' regular academic activities. Living Things and Chemicals were the contents addressed. They were chosen based on a preliminary survey among Oyo State basic science students, indicating that, these were among the concepts seen as challenging in the NERDC basic science curriculum and were scheduled for first term. To minimise potential confounding variables, the selected schools were comparable in curriculum structure, school type, and educational resources. Pretesting and the use of analysis of covariance (ANCOVA) further helped control for initial differences between groups.

### **3.3. Ethical consideration**

A letter introducing the researcher to the schools was obtained from the Department of Science and Technology Education, University of Ibadan, to request permission for the study. Only schools that voluntarily agreed to participate were selected, and the principals of these schools granted official approval. Before data collection, the purpose and procedures of the study were clearly explained to the school authorities, teachers and students. It was made explicit that no private or personally identifiable information would be collected, and all responses would be treated with strict confidentiality. Participation was entirely voluntary, and students could withdraw from the study at any time without penalty. In addition, informed consent to participate in the study and for the resulting work to be published was obtained from all participants, ensuring that they were fully aware of their rights and the intended use of the data.

### **3.4. Research instruments**

The following research instruments were used in this study for data collection. The instruments were classified into two: stimulus and response instruments.

1. Stimulus Instruments:
  - i. Teachers' Instructional Guide on Making the Strange Familiar Model (TIGMSFM)
  - ii. Teachers' Instructional Guide on Conventional Method (TIGCM)
  - iii. Teachers' Performance Evaluation Sheet (TPES)
2. Response Instruments:
  - i. a. Students' Basic Science Creative Thinking Skills Test (SBSCTST)

- b. Students' Basic Science Creative Thinking Skills Rubrics (SBSCTSR)
- ii. Lawson's Classroom Test of Scientific Reasoning (LCTSR)
- iii. Basic Science Self-Efficacy Scale (BSSES)

**3.4.1** TIGMSFM was adapted from Gordon (1961) to form **Iyanda-Taiwo's Synectics Instructional Model (Making the Strange Familiar Model)**. The research tool was validated through the review of candidate's supervisor, three basic science teachers in junior secondary schools and some lecturers in the Department of Science and Technology Education, Faculty of Education, University of Ibadan, Ibadan. A detailed analysis of the research tool was performed, considering its alignment with curriculum goals, accuracy and usability. Ideas and feedback were used to refine and finalise the research tool. TIGMSFM is shown in the appendix.

**3.4.2** SBSCTSRS and SBSCTSR were self-developed by the researcher and it focused on 'five components of creativity' which are the characteristics of creative thinking skills (fluency, flexibility, originality, elaboration and metaphorical thinking). Before empirically testing SBSCTSRS assessment items and SBSCTSR, they were first assessed by the researcher's supervisor, three Basic science teachers and some lecturers in the Department of Science and Technology Education, Faculty of Education, University of Ibadan, Ibadan; to check for the aspect of content and the accuracy of items measuring indicators. The total mark obtainable is 20 which is 100%. The answers in the scope of creative thinking skill for each dimension were categorised by rating scale consisting of the following:

- i. **Very creative** ( $75 \leq x < 100$ ), i.e students can show the five aspects of creative thinking skills in problem solving;
- ii. **Creative** ( $50 \leq x < 75$ ), i.e students can show four aspects of creative thinking skills in problem solving;
- iii. **Fairly creative** ( $25 \leq x < 50$ ), i.e students can show three aspects of creative thinking skills in problem solving; and
- iv. **Less creative** ( $0 \leq x < 25$ ) i.e students can show two or one aspect of creative thinking skills in problem solving (Fitriani and Yarmayani, 2018).

The data was analysed using inter-rater reliability. The following inter-rater reliability coefficients were obtained: Fluency = 0.79, Flexibility = 0.76, Originality = 0.80, Elaboration = 0.76 and Metaphorical thinking= 0.78.

**3.4.3** LCTSR was adopted by the researcher. The test consists of twenty four (24) items divided into 12 multiple-choice style pairs. Only tasks 23 and 24 are independent and are therefore marked separately. Therefore, the maximum points that can be obtained are 13 points. From 0 to 4 concrete reasoning, from 5 to 10 transitional reasoning and from 11 to 13 formal reasoning are the categories that were used for grading. The research tool was revalidated by trial testing the assessment items on JSSII students who were not part of the sample of students selected to participate in the main study to ensure its reliability. The collected data were analysed using the Kuder-Richardson

formula (KR-20) where a reliability coefficient obtained was 0.80. The difficulty index between 0.45 and 0.62 was obtained while the discriminating index was 0.32 and above. This method of reliability is suitable for this research tool because of the unequal levels of difficulty and discrimination of the items.

**3.4.4** BSES was adapted by the researcher. The instrument in this research included twenty (20) items. The initial draft of 33 items was adapted from Schwarzer & Jerusalem (1995) on General Self-Efficacy Scale and Biology Self-Efficacy developed by Baldwin, Ebert-May & Burns (1999). To validate the measurement tool, the initial draft of thirty-three items was presented to the candidate's supervisor and lecturers who are professionals in measurement and evaluation, to determine the importance of the items in terms of the construction of the language, precise focus, clarity of purpose and appropriateness for the target population. Cronbach's alpha was used to establish the internal consistency of the tool. The reliability (Cronbach's alpha coefficient) of 0.84 was obtained and considered high enough for the research tool to be used for this study.

### **3.5 Procedure of Data Collection**

The pre-test was administered to the students who participated in the study by the participating teachers. The three instruments administered were: SBSCTST, LCTSR and BSES followed by the instructional intervention; the same instrument was then re-administered to the group to evaluate changes in their creative thinking skills in basic science.

### **3.6 Administration of Treatment**

During this phase, the interventions were applied to the teachers who were trained by the researcher using the instructional guide, while the basic science teachers assigned to the control group taught the students in a conventional way. The researcher provided adequate follow-up to ensure that the teachers strictly followed the instructions.

### **3.7 Methods of Data Analysis**

The data acquired from the quantitative phase of the study was analysed utilising descriptive statistics (frequency counts and percentages) and inferential statistics, specifically Analysis of Covariance (ANCOVA), with pretest scores serving as covariates. The Estimated Marginal Mean (EMM) was employed to identify the group with the highest mean score and to ascertain the amount of differences across groups exhibiting significant effects. All null hypotheses were assessed at a significance level of 0.05.

## **4.0 Results and Discussion**

### **4.1 Results**

**H<sub>01</sub>:** There is no significant main effect of treatment on students' creative thinking skills in basic science.

**Table 4.1: Analysis of Covariance of Post-Creative thinking skills Mean Scores by Treatment, Scientific reasoning ability and Self-efficacy**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1261.363	6	126.136	40.354	0.000	0.701
Intercept	972.689	1	972.689	311.185	0.000	0.644
Pre-Creative Thinking Skill	3.430	1	3.430	1.097	0.296	0.006
Treatment	492.155	1	492.155	78.726	0.000*	0.478
Treatment x Scientific Reasoning Ability	3.108	2	0.389	0.497	0.609	0.006
Treatment x Self-efficacy	8.827	2	2.207	1.412	0.246	0.016
Error	537.631	172	3.126			
Total	34359.000	183				
Corrected Total	1798.995	182				

a. R Squared = .701 (Adjusted R Squared = .684)

\*=Significant at P<0.05

Table 4.1 showed a significant main effect of treatment on students' basic science creative thinking skills  $F_{(1,172)} = 78.72$ ,  $p < 0.05$ , partial  $\eta^2 = 0.48$ ). This suggests that students' post-creative thinking skill mean scores differed significantly. Consequently, null hypothesis 1 was rejected. The Estimated Marginal Means of the treatment groups were carried out to ascertain the magnitude of the significant main effect across treatment groups, and the results are shown in Table 4.2.

**Table 4.2: Estimated Marginal Means for Post-Creative thinking skills by Treatment and Control Group**

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Making the Strange Familiar Model (MSFM) (Experimental Group)	13.97	0.32	13.34	14.59
Conventional Method (CM) (Control group)	9.98	0.50	8.99	10.98

Table 4.2 revealed that the students exposed to Making the Strange Familiar Model (MSFM) Experimental Group had the highest adjusted post-creative thinking skill mean scores (13.97), while the Conventional Method (CM) Control Group had the least adjusted post-creative thinking skills mean scores (9.98). This order can be represented as  $MSFM > CM$ .

**Ho2: There is no significant interaction effect of treatment and scientific reasoning ability on students' creative thinking skills in basic science.**

The result in Table 4.1 showed that there was no significant interaction effect of treatment and scientific reasoning ability on students' creative thinking skills in basic science ( $F_{(4,172)} = 0.497$ ,  $p = .006$ ). Thus, the null hypothesis 2 was not rejected.

**Ho3: There is no significant interaction effect of treatment and self-efficacy on students' creative thinking skills in basic science.**

The result in Table 4.1 shows that there is no significant interaction effect of treatment and self-efficacy on students' creative thinking skills in basic science ( $F_{(4,172)} = 1.41$ ,  $p = .016$ ). Thus, the null hypothesis 3 was not rejected.

## 4.2 Discussion of Findings.

### Main effect of treatment on students' creative thinking skills in basic science

The Making the Strange Familiar Model (MSFM) was shown to be most effective in enhancing students' creative thinking skills in basic science over and above Conventional Method. This may be due to the fact that, students are guided consciously to analyse connection between analogies by focusing on similarities and differences between analogies and develop imagination to produce innovative answers. More so, students were guided consciously to develop analogies that allow an emotional approach to solution rather than a rational approach in order to generate new ideas. This model disrupts the normal thinking of the students and enables them to connect irrelevant ideas in new unique ways oriented to problem stating and problem solving. The model also grabs students' attention and gets them participating. All students shares ideas and thoughts freely without hesitation or anxiety coming up with creative ideas. During this study, researcher observed that imagination became soar in the classroom. Students are able to develop their own analogy independently while working collaboratively.

The outcome of this research is in line with Valdez & Sobremisana (2020) that Making the Strange Familiar Model (MSFM) improves students' creative thinking skills in physics. The study of Kalantarnia *et al* (2020) is in agreement with this current result, in which they found out that Making the Strange Familiar Model (MSFM) improve students' creative thinking and problem solving skills in geometry. The finding is in concordance with the findings of Sedaghat, Darivash & Fooladi (2015) who reported that the use of Making the Strange Familiar Model (MSFM) improves students' creative thinking in composition.

### Two-way interaction effect of treatment and scientific reasoning ability on students' creative thinking skills in basic science

The results of the study showed that there was no significant interaction effect of treatment and scientific reasoning ability on students' creative thinking skills in basic science. This means that if the students' scientific reasoning ability is concrete or transitional or formal, it does not matter. If

junior secondary school students are exposed to the treatment they will perform better in term of creative thinking skills.

### **Two-way interaction effect of treatment and self-efficacy on students' creative thinking skills in basic science**

The results of the study showed that there was no significant interaction effect of treatment and self-efficacy on students' creative thinking skills in basic science. This means that a category of self-efficacy (whether low, medium or high) does not matter. When students are exposed to the treatment they will perform better in term of creative thinking skills.

## **5.0 Educational Implications**

The usage of Making the Strange Familiar Model in enhancing students' creative thinking skills in basic science in this research is a suitable model in teaching and learning process in basic science. This affirms that instructional model that focus on the use of analogy or metaphor from everyday life experiences of the students improves students' creative thinking skills in basic science. The study further showed that students had better creative thinking skills in basic science. This implies that when these models are adopted it is likely to enable students think divergently (i.e. think out of the box) and allow their mind to be free to generate new ideas and develop imagination to produce innovative answers.

The model is good for large class because it could engage every individual in the class. The model is also good for small groups and everyone has the responsibility to contribute ideas in the group. Making the Strange Familiar Model could be used to improve students' creative thinking skills in basic science regardless of their scientific reasoning ability and self-efficacy.

### **5.1 Limitations**

The following limitations in the course of the study are:

- i. The study is confined to Oyo South senatorial district only. Findings may not apply to other Senatorial District in Oyo state or other states in Nigeria.
- ii. There is short intervention duration (12 weeks). Learning gains from the innovative models may fade over time, since there is no long-term follow up.
- iii. The moderator categories are highly unbalanced and some cells of the  $2 \times 3 \times 3$  matrix are very small or empty. This limits the power to detect SRA and self-efficacy effects and bears directly on the non-significant findings for Ho2 and Ho3
- iv. Teachers may require specific training to effectively use the models; variation in teacher skills could confound results.
- v. The study is confined to pretest-posttest control group quasi-experimental research design.
- vi. Only two topics (Living things and Chemicals) in basic science were examined.
- vii. Only six schools were purposively selected and six intact classes were randomly assigned to treatment and control groups.

### **5.2 Suggestion for Further Studies**

Based on the limitations of the study, the following suggestions were made for further study:

- i. Similar research may be done in other subjects such as Chemistry, Biology, English, Mathematics, Geography etc.
- ii. Moderating variables such as problem-solving ability, critical thinking skills and metacognitive skills may be used as moderating variables in further studies.
- iii. Similar research may be done in other senatorial district or other states in the country.

### **5.3 Conclusion**

Based on the result of the study, it can be concluded that the treatment had effect on students' creative thinking skills in basic science. It was also observed that students in Making the Strange Familiar Model (MSFM) had the highest adjusted mean score in their post-creative thinking skills in basic science than Conventional Method (CM). This suggested that the treatment was more suitable for this set of students in improving their creative thinking skills in basic science. Scientific reasoning ability and self-efficacy had no significant interaction effect on students' creative thinking skills in basic science. Based on the research findings of this study, Making the Strange Familiar Model could be used to optimise students' creative thinking skills in basic science regardless of their scientific reasoning ability and self-efficacy.

### **5.4 Recommendations**

In light of the outcomes of this study, the following recommendations are therefore made:

- i. Making the Strange Familiar Model which enhanced junior secondary school students' creative thinking skills in basic science in this research, teachers are implored to use the model in the teaching and learning process in any subject at any level of education to increase students' creative thinking skills during educational activities.
- ii. Opportunities should be given to junior secondary school basic science students regardless of their scientific reasoning ability and self-efficacy when using Making the Strange Familiar Model, as nature of the model is enhancing enough to produce significant effects on students' creative thinking skills in basic science.
- iii. Basic science educators should be allowed to attend in-service training (e.g. workshops, conferences and seminars) in order to update their knowledge and skills in the use of this innovative teaching model and use it in classroom regularly.
- iv. Teachers in the training institutions should be trained to use analogies during training in various subjects in order to make abstract concepts more familiar. Such analogies may be incorporated in the curriculum.
- v. Government should utilise the services of various bodies such as Science Teacher Association of Nigeria (STAN); All Nigeria Conferences of Principals of Secondary Schools (ANCOPSS); National Union of Teachers ((NUT); and Faculties/ Institutes of Education in the universities to organise in services training programmes, workshop, conferences and seminars for in-service basic science teachers on the use of Making the Strange Familiar Model in teaching and learning of basic science.

## 6. Appendices

### Appendix A: Instructional Guide for Iyanda-Taiwo's Synectics Instructional Model (Making the Strange Familiar Model)

The steps that were followed in Making the Strange Familiar Model (MSFM) are:

#### Step 1: Introduction and Substantive Input (20mins)

- a. Teacher writes topic of the lesson and objectives for the day on the board.
- b. Teacher asks questions based on the students' prior knowledge, builds rapport on their responses and divides the class into five-person groups based on ....(random/mixed gender) so as to share ideas with one another.

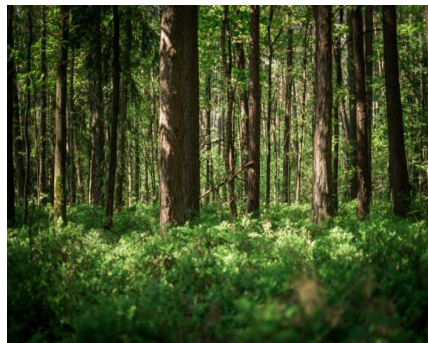
**For example:** Name two living things each, found on land, inside water and in the sky.

- c. Teacher then provides information on the topic and presents 'Synectics Trigger mechanism' (i.e. images) to jumpstart analogical reasoning in students.

**For example:**



OCEAN (FIG.1)



RAINFOREST (FIG.2)



DESERT (FIG.3)



POND (FIG.4)

- d. Students observe to understand several pictures display by the teacher and the teacher ensures participation of every student.

## **Step 2: Direct Analogy (10 mins)**

Here, teacher suggests TWO direct analogies and students explore it further.

**Note:** Direct Analogy is a comparison between two things which do not have to be exactly the same but just to transpose the state of an object or condition and view it in a new way.

**For example:** Of different examples of aquatic and terrestrial habitats (springs, streams, ponds, lakes, rainforest, grassland etc), teacher picks **two** and suggests their direct analogies

- 1. A pond is a lot like aquarium because both have organisms living there and both water bodies are stagnant.**
- 2. A rainforest is a lot like hair because both have different height.**

Then, teacher further asks the student to describe the TWO analogies (**pond** and **rainforest**) since she has explain the topic to them.

## **Step 3: Personal Analogy (10 mins)**

- Students assume themselves as an analogy mentioned in step 2.
- Students explain how they feel when they assume themselves as the selected words/analogy/concept.

**For example:**

**Be like a pond. How do you feel? Describe your feeling when you have organisms (such as fishes, snails, worms, plants e.t.c) living inside you? How do you feel when you dry up during dry season? How do you feel when sunlight easily penetrates through you to the bottom because you are very shallow?**

**Likely Answer from students:** I feel like I am protecting a community. I feel like a dwelling place for these organisms. I feel sad because organisms living inside me will die as well. I feel good because oxygen concentration will be high; organisms living inside me will have access to oxygen.

**Be like a rainforest. How do you feel? How do you feel when you support plants and animals species than any other ecosystem? How do you feel when you are featured with heavy annual rainfall, broad evergreen leaves and buttress roots?**

**Likely Answer from students:** I feel like a great dwelling place where diversity of organisms abide. I feel blessed or special.

c. Teacher listens to students' views.

**Step 4: Comparing Analogy (5 mins)**

Students explain the points of similarities in the example using the chosen analogies.

**For example:**

Analogies	Similarities
Pond and rainforest	A pond is a lot like rainforest because: <ol style="list-style-type: none"> <li>i. both are dwelling place (habitat) for organisms to live.</li> <li>ii. both have moderate temperature, enabling plants and animals to survive.</li> </ol>

**Step 5: Explaining Differences (5mins)**

Students identify the points of differences in phase 4.

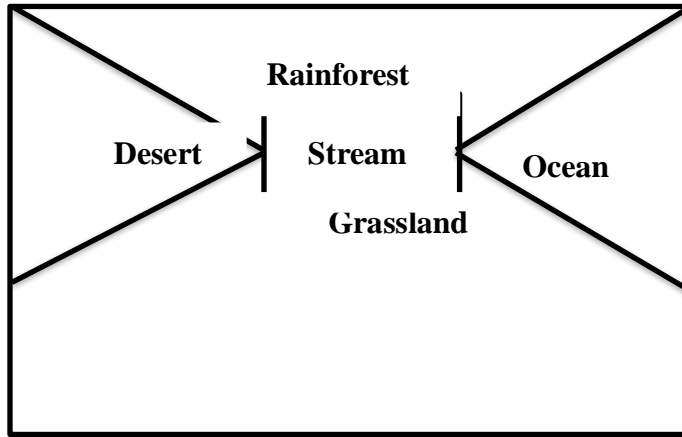
**For example:**

Analogies	Differences	
Pond and rainforest	Pond	Rainforest
	<ol style="list-style-type: none"> <li>1. It is an aquatic habitat.</li> <li>2. It is a small habitat.</li> <li>3. Small plants present in pond are scattered with absence of broad evergreen leaves and buttress roots.</li> </ol>	It is a terrestrial habitat. It is a large habitat. Trees found in rainforest are of different height and are compacted together with presence of broad evergreen leaves and buttress roots.

**Step 6: Generating Analogy (20 mins)**

- a. Students generate their own direct analogies.
  - b. Students show similarities and the differences between the analogies chosen using Synectics Graphic Organiser to do their tasks.
  - c. Students are asked to arrange words in each of the four quadrants at random.
  - d. Students place the analogy they want to explore in the centre of the box.
  - e. Students are required to finish this sentence stem in each of the quadrants: The word in the box is a lot like the item in the quadrant because...
- Sentence Stem:** A \_\_\_\_\_ is a lot like a \_\_\_\_\_ because...
- f. Each group representative present their ideas to the class.
  - g. Teacher shares random examples of students' analogies with the entire class.

For example:



1. A stream is a lot like a rainforest because both have organisms living there.
2. A stream is a lot like a desert because both have plants and animals living there.
3. A stream is a lot like grassland because both have organisms living there.
4. A stream is a lot like an ocean because both are aquatic habitats.

Analogy	Differences	
Stream and Rainforest	<b>Stream</b> i. It is an aquatic habitat.	<b>Rainforest</b> It is a terrestrial habitat.
Stream and Desert	<b>Stream</b> i. It is an aquatic habitat.	<b>Desert</b> It is a terrestrial habitat.
Stream and Grassland	<b>Stream</b> i. It is an aquatic habitat.	<b>Grassland</b> It is a terrestrial habitat.
Stream and Ocean	<b>Stream</b> i. It is a small water body.	<b>Ocean</b> It is a large water body.

**Step 7: Evaluation and Summary (10 mins)**

- a. The teacher entertains questions and responds to enquiries from the students.
- b. Teacher assesses the class by asking the students questions.
- c. Group differences among the students are reconciled.
- d. Teacher gives the students assignment in order to have feedback.

**Appendix II: Teachers’ Instructional Guide on Conventional Method (TIGCM)**

The steps that were followed in Conventional Method are:

**Step 1:** The teacher writes the lesson's topic on the chalkboard and then poses questions that draw on the students' prior understanding. **(10 mins)**

**Step 2:** The teacher offers the students with the lesson's materials and discusses the topic with them. **(20 mins)**

**Step 3:** The teacher allows the students to ask and answer questions. **(5 mins)**

**Step 4:** The teacher copies note for the students. **(20 mins)**

**Step 5:** Teacher evaluates the class by asking the students questions based on the stated objectives by calling on any of the students to provide an answers. **(10 mins)**

**Step 6:** Teacher summarises the lesson by going over the salient points in the topic taught while the students listen and copy into their notebooks. **(10 mins)**

**Step 7:** The teacher gives the students assignment in order to have feedback. **(5 mins)**

### Appendix III

#### STUDENTS' BASIC SCIENCE CREATIVE THINKING SKILLS RATING SCALE (SBSCTSRS)

Indicator	Score	Descriptors
<b>Fluency</b>	4	Provide more than three ideas/answers that are relevant to problem solving.
	3	Provide three ideas/answers that are relevant to problem solving.
	2	Provide one idea/answer that is relevant to problem solving.
	1	Provide some ideas/answers that are not relevant to problem solving.
	0	Not answering or giving a wrong answer
<b>Flexibility</b>	4	Perceives and approaches the problem in a number of different interesting ways and show a peculiar ability to shift categories or change direction of thought in a number of times.
	3	Approaches the problem in an interesting way and show adequate ability to shift categories or change direction of thought in a number of times.
	2	Approaches the problem in an interesting way and show a difficulty in shifting between categories or change direction of thought
	1	Approaches the problem but cannot be understood.
	0	Not answering or giving a wrong answer
<b>Originality</b>	4	Provide clever or unique ideas/answers in their own way that are logical, relatively new and more relevant to the given problem
	3	Provide clever or unique ideas/answers in their own way that are logical, relatively new but seemingly relevant to the given problem
	2	Provide ideas/answers in their own way that are logical, relatively new but not relevant to the given problem

	1	Approaches the problem but cannot be understood.
	0	Not answering or giving a wrong answer
<b>Elaboration</b>	4	Elaborate the situation correctly and add details to ideas.
	3	Elaborating the situation correctly but not detailed.
	2	There is a mistake in elaborating the situation and still not detailed.
	1	Approaches the problem but cannot be understood.
	0	Not answering or giving a wrong answer
<b>Metaphorical thinking</b>	4	Able to connect two absolutely diverse ideas with each other and give three unique perspectives to it.
	3	Able to connect two absolutely diverse ideas with each other and give less than three interesting perspective to it.
	2	Able to connect two absolutely diverse ideas with each other but show a difficulty in shifting between categories.
	1	Unable to connect two absolutely diverse ideas with each other.
	0	Not answering or giving a wrong answer

**Source: Author's compilation**

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