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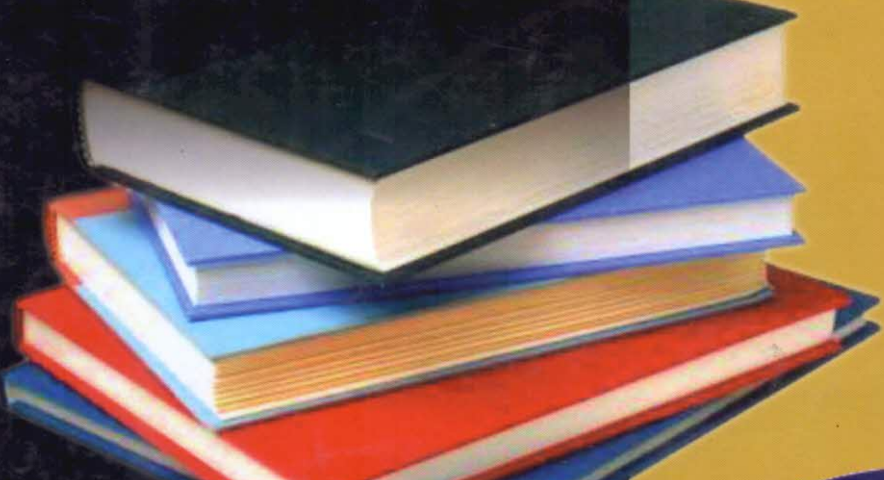

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# FOREWORD

I consider it a befitting honour to have the medium of this special edition of the ***Journal of Curriculum and Instruction*(JCI)** to reflect on my sojourn at the University of Ilorin, Ilorin, Nigeria, for about 42 years. This is a Journal, which I participated in founding and naming, and thereafter serving as its Foundation Managing Editor.

I wish to thank God, the Almighty, sincerely, for the decision He inspired me to take to work with the University of Ilorin. I am happy I do not have any reason to regret this important life decision. I am grateful to the founding fathers of the University for the singular decision to appoint me at the rank of Assistant Lecturer in Education on 13 September 1976, and for providing me opportunity for the needed training, which enabled me to rise through the ranks and become a Professor of Science Education on 1 October 1998.

As I retire from the services of the University of Ilorin, I wish to admonish the academic and non-academic staff left behind to continue to uphold the high standard of operations for which our Department is noted. Academic members of staff should please continue to engage in original research works that could be published in high impact journals, like an online JCI, good teaching, using innovative teaching strategies, and community development, which would solve specific problems in the society. It is also important to have an early specialization in specific areas of research by which colleagues would be known nationally and internationally.

Incidentally, this special edition of the JCI contains papers on topics that are of interest to me, such as computer studies and entrepreneurship that are trending in science education at this time. In addition, the papers are widely spread over the major subjects that constitute science education, viz: biology, chemistry, and physics. All the papers contain pieces of information that are beneficial to science educators in Nigeria and beyond.

I wish to thank Dr. Mulkah A. Ahmed, the Head of Department and Professor Esther O. Omosewo, the Editor-In-Chief and Managing Editor, respectively, at this auspicious time, for facilitating the production of the special edition of the JCI to mark my exit from the Department and the University.

**Professor Isaac Olakanmi Abimbola**
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21 June 2018

## EDITORIAL

Members of the Editorial Board of the ***Journal of Curriculum and Instruction***, JCI, are happy to publish another special edition of the Journal, so soon after Volume 10, Number 2, of 2017, which was dedicated to Professor Michael OlubusuyiFajemidagba on his retirement from the services of the University of Ilorin.

This special edition of JCI, Volume 11, Number 1 of 2018 is published in honour of Professor Isaac Olakanmi Abimbola, a foundation member of the Department, and a member of the Editorial Board of the Journal who is retiring from the services of the University of Ilorin, Ilorin, Nigeria, on 2 August 2018.

Professor Abimbola is leaving behind a legacy of distinct areas of research in student learning, related to misconceptions and alternative conceptions (or misunderstood) in biology, history and philosophy of science, use of innovative instructional strategies involving analogies, metaphors, and lately, study technology instructional and learning strategies. We shall continue to remember him for his legacy books—Principles and Practice of Instruction, Philosophy of Science for Degree Students, History of Science for Degree Students (with Esther O. Omosewo), Preparation of Lesson Plans, Learning How to Learn for Perfect Understanding, Methods of Teaching Science, Basic Technology, and Computer Studies (with others), A Practical Guide to Research Project Reporting, and Biology Teaching Methods,

He shall be remembered for the high standards he set for himself in the conduct of his life activities, as exemplified in his integrity, forthrightness, organization, thoroughness, warm interpersonal relations, and so forth.

Some of the papers published in this edition include some research areas that are of interest to the honouree. These include areas such as computer studies curriculum, philosophy and curricula, problems of chemistry teaching, biology process skills, curriculum implementation, and secondary school students' performance, and entrepreneurship education. Useful recommendations were made for specific stakeholders that could serve to improve science education in Nigeria. We commend this edition of JCI for the reading pleasure of science educators and teachers.

**Esther O. Omosewo, PhD**
Professor of Physics Education
Managing Editor,
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# EFFECTS OF PUZZLE BASED STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' SCIENCE PROCESS SKILLS IN BIOLOGY IN OYO STATE

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**Abstract**

*Senior secondary school (SSS) students' science process skill in Biology in Oyo State seems not to be encouraging, a trend attributed partly to persistent usage of teacher-centered instructional methods. This necessitates the adoption of students-centered instructional strategy such as the Puzzle Based strategy. The effectiveness of this instructional strategy in the teaching of Biology has however not been properly documented. This study, therefore, investigated the effects of Puzzle Based strategy (PBS) on students' science process skills in Biology in Oyo State. The moderator effects of studentsself efficacy was examined. The study adopted a pretest-posttest, control group, quasi experimental design. Four intact classes of SSS II student participants were randomly assigned as follows: PBS (200) and control (187) groups. The five instruments used were Science Process Skills Rating Scale (r = 0.76),Students' Self-Efficacy Scale(r=0.80) instructional guides for, PBS (π =0.83) and conventional (π =0.85) strategies, lastly Evaluation sheets for Teachers Performance on the Strategies. Two null hypotheses were tested at 0.05 level of significance. Data were analysed using Analysis of Covariance.There was significant main effect of treatment on students' science process skills (F (1,369,). =29.397;P< .05, =.137). Puzzle Based Strategy group had the adjusted post test mean science process skill scores ( $\acute{X}$ = 12.43) while students in the Modified Conventional Strategy group had adjusted mean Modified Convention Strategy*

*Score ( $\acute{X}$ = 6.24).PuzzleBased strategy enhanced student's Science process skill in Biology in Oyo State. Therefore, these strategy should be adopted in teaching Biology to Senior secondary schools students.*

Keywords: *Puzzle Based Strategy, Students' Science Process Skill, Biology, Senior Secondary School.*

**Introduction**

Federal Ministry of Education (2013) stated the following objectives in its curriculum for Biology: understanding of the structure and function of living organisms as well as appreciation of nature, acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology, acquisition of necessary scientific skills for example observing, classifying and interpreting biological data, relevant knowledge in Biology needed for future advanced studies in biological science, acquisition of scientific attitude for problem solving, ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health and economic problems.

The Science Process Skills are the foundation of problem solving in science and the scientific method. They are the skills that, facilitates learning in physical sciences, ensure active students participation, have students develop the sense of undertaking responsibility in their own learning, increase the permanence of learning, and also have students acquire research ways and methods, that, is, they ensure thinking and behaving like a scientist. They are inseparable in practice from the conceptual understanding that is involved in learning and applying science. While the process skills are viewed as central to elementary school science education and important enough to be taught in their own right, they are often combined with science content, enabling children to learn both science process and content at the same time-in a seamless learning experience.

For instance, children may practice the skill of observation while identifying the properties of rock. Learning science goes beyond scientific knowledge acquisition since it includes the acquisition of cognitive skills such as the science process skills. They are an important method in teaching science lessons and also the building-blocks of critical thinking and inquiry in science. Learning science lessons by apprehending requires using science process skills.

Having science process skills acquired, at the same time, means preparing future scientists, having scientific literacy acquired, that is, enabling students to use science information in daily life (personal, social and global). Science process skills are based on scientific inquiry and teaching science, by inquiry involves teaching student's science process skills as well as critical thinking and scientific reasoning skills used by scientists. They are acquired through training and direct experiences (Njoku, 2002). They are intellectual skills with learned capabilities which scientists used as self-management procedure in carrying out their scientific activities. Njoku (2002) explained that, these science process skills are cognitive and psychomotor skills which scientists use in problem identification, objective inquiring, data collection and analysis. These skills are retained after the cognitive knowledge of science has been forgotten.

The Science Process Skills, according to Wetzel, (2010), are the methods used by students to conduct investigations and understand how we know about the world in which we go beyond the textbook and supplementary the core-content within textbooks with hands-on, mind-on activities. It also means using your course content as a means for exposing students to the real process skills are separated into two categories; Basic and Integrated (Weatzel, 2008). The five basic science process skills which we are of interest in this study are as follow: Observation which involves using the five senses to find out information about objects: an objects' characteristics, properties, similarities and other identification features. Recording which involves the process or art of writing down and storing information for official purpose or for awarding marks to an object. Drawing which involves the art or skills of making pictures, plans e.t.c. using a pen or pencil. Manipulating Apparatus which involves handling or treating materials and equipment skillfully, effectively and safely. This skill is manifested in arranging equipment and materials needed to conduct an investigations; handling chemicals in a safe manner; understanding sterile techniques etc. Labeling which involves the act of using line to indicate the name or identify objects or parts of a diagram. The skills help to ensure that students make the connection between science processes involved within an investigation and science content (Karen, 2009).

Puzzles-based instructional strategy gives a Multi-sensory instruction which combines the use of Intuition and Puzzle to create the optimal setting identified by Maal, 2004. The puzzle-based instructional package aims to encourage science students to think about how they frame and solve problems (not those encountered at the end of some textbook chapters) (Nicholas, 2010), the goal is to enhance student critical thinking and their problem solving skills. ACM. According to ACM, (2006) most of the students never learn how to think about solving problems throughout their education period, they are faced with the problem of applying the material from each chapter to solve few problems provided at the end of each chapter. They concluded that it is not surprising that students are not well prepared for framing and addressing real work with instruction from textbooks because many educators are interested in teaching thinking skills rather than teaching independent thinking or independent problem solving.

Scotts (2006) emphasized that teaching with puzzle made of wood or very heavy cardboard help young children aged 1-8yrs learn motor skills and hand-eye coordination as they fit the pieces of puzzles together; logic puzzles are used to teach logical thinking skills, deductive and inductive reasoning, spatial concepts, motor coordination and planning of advance gambits. Physical puzzles are especially good for tactile learners who often cannot absorb traditional educational methods.

Experts have identified the importance and usefulness of puzzles in teaching and learning processes. Evidence has also shown that puzzle-based instructional packages in teaching and learning of science education in Korea Universities improved understanding of abstract concepts and develop problem-solving abilities in students (Anany and Mary 2008) also remark that puzzle-solving is an active type of learning as it engages students with materials more than passive type of review does. They further stressed that the use of puzzles make learning more exciting and easy for learners, thereby leading to the achievement of desired learning outcomes. Conventional Strategy is the strategy mostly used in Nigerian schools. It is a traditional teacher expository strategy. The teacher dominates the class and "gives out" the facts to the students while the students in turn listen and digest the knowledge (Osokoya, 2006).

There are reasons listed by Ogundiwin (2013) which make teachers refuse to change their conventional teaching style, namely:

(a) Lack of infrastructural facilities;
(b) Overloaded curriculum;
(c) Lack of training programmes/workshops; and
(d) Lack of skills in handling difficult concepts.

Wagner (2005) defines self-efficacy as the person's belief in his or her ability to succeed in particular situations. According to Pajarez (2006), students who are confident in their academic capabilities are intrinsically motivated, monitor their work time more effectively, are more efficient problem solvers, show more persistence and are likely to achieve their academic goals than those who are not confident of their academic abilities. Students with low self-efficacy believe they cannot be successful and thus make little effort and consider challenging task as threats that are to be avoided. They therefore have low aspirations which may results in deficient science process skills.

**Statement of the Problem**

Biology is a major subject required for admission into tertiary institutions for professional courses in this field. However, the poor science process skills of students in Biology are of great concern to Science educators, researchers and relevant stakeholders in education. One major cause has been attributed to the inefficient teaching strategy used by the teachers. There is need for the introduction of teaching strategy that would improve the science process skills in Biology. This study investigated the effects individualised instruction strategy on the students' science process skills in Biology. The study further explored the extent to which the moderating effect of students' self-efficacy on the students' science process skills in Biology.

**Hypotheses**

The following null hypotheses were tested in this study at $p<0.05$ level of significance:

$HO_1$: There will be no significant main effect of treatment on students' science process skills in biology

$HO_2$: There will be no significant main effect of gender on students' science process skills in biology

**Methodology**

This study adopted pretest, posttest, control group, quasi-experimental design. Two hundred and forty participants consisting of senior secondary school two (SSII) students from intact classes were randomly selected from two Local Government Areas of Oyo state. The schools were randomly assigned the experimental and control group

**Research Instrument**

Five instruments used for this study were;

1. Science process skills Test (BAT)
2. Students' Self-Efficacy Scale (SSES)
3. Teachers' Instructional Guide on Puzzle Based instruction strategy (TIGPBI)
4. Teachers' Instructional Guide on Conventional Lecture Method (TIGCLM)
5. Evaluation Sheet to Assess Teachers' Performance

(ESAT)

**Science Process Skills Test in Biology (SPST)**

(SPSTB) was adopted by the researcher to measure students' science process skills. The questionnaire will consist of two sections.

25 multiple choice items. Each item will have one correct option and three distractors making four options. All the questions will be answered by the participants.

**Table 1**

*Specification of SPST*

| *Skills* | *Number of items* | *Total* |
|---|---|---|
| *Observing* | 6, 9, 10, 26, 27, 28 | 6 |
| *Relationship* | 7, 14, 30 | 3 |
| *Identifying and controlling variables* | 2, 13, 20, 21, 22, 23 | 6 |
| *Formulating hypothesis* | 8, 15, 19, 24, 29 | 5 |
| *Operational definitions* | 1, 12, 17, 25 | 4 |
| *Graphing and interpretation of data* | 4, 11, 16 | 3 |
| *Experimental design* | 3, 18 | 2 |
| *Total* | 30 | 30 |

Validity and Reliability of Science Process Skills Test in Biology (SPSPT) This instrument will be subjected to face and content validity by giving copies to experts in education, science education and biology education. These experts will be asked to determine its suitability for the targeted population in terms of clarity, breath and language. The reliability co-efficient of the instrument will be determined using Kuder–Richardson formula 20. The difficulty and discriminating indices of each of the test items will be computed to further validate the instrument.

**Students' Self-Efficacy Scale (SSES)**

This instrument was designed to measure the students' Self Efficacy in Biology. This instrument consists of twenty (20) items graded based on four point Likert scale ranging from Strongly Agree, Agree, Disagree and Strongly Disagree. The positive statements were graded 4,3,2,1, respectively while the reverse was the case for the negative statement. To modify the instrument for the purpose of this study, the undecided column was cleared out in order to commit students to either the High or Low side of the issues.

**Validity and Reliability of SSES**

In order to validate the modified instrument, it was given to three experts in the department of Teacher Education for their expert advice in respect to the language level, suitability and over all face validity of the instrument. Correction was thereafter be made based on their input. The instrument was also be given to my supervisor who read though to make the final modifications. The instrument was then administered to 30 SS II students who were not part of the main study. The reliability coefficient of the instrument was calculated using the Cronbach alpha and the value was determined as 0.80.

**Teachers' Instructional Guide on Puzzle-Based Learning Strategy (TIGPS)**

**Preparation phase (EXPERIMENTAL GROUP)**

Step 1:

1. The students are positioned by the computer they are to work with
2. Students are given the package to work with
3. Students are instructed on how to work with the package.
4. The teacher moves round the classroom to monitor the participants. Introduction phase of the content involves
5. Teacher attracts students' attention to activate their background knowledge on the topic to be considered.

Presentation phase:

6. Students identify the key words and sub-concepts using ecology and genetics puzzles clues.
7. Teacher prod students with more questions using the environmental puzzle clues to generate additional information on topic.
8. Students' view on the concept are clarified using the ecology and genetics puzzle.

Evaluation phase:

9. Teacher assesses students for more critical analysis on the content using the ecology and genetics puzzle clues.
10. Students practice individually
11. Students develop a deep understanding of the topics they study and improve their thinking abilities.
12. Students are given homework or assignment to further practicethe skill developed.

Conceptual .framework for developing and evaluating puzzle in .Science Education according to Maldonado (2005) was utilized. TIGPB was given to experienced Biology teachers in senior Secondary School and University lecturers in Department of Teacher

Education and Science unit to examine its content and face validity. The recommendations given were used to reconstruct the guide and the inter-rater reliability was then estimated using Scott' $\pi$ . The inter-rater reliability indexwas determined as 0.83.

### *Teachers' Instructional Guide on Conventional Strategy (CONTROL GROUP)*

. The treatment for each lesson is in form of lecture.

1. The instructor presents the lesson in form of a lecture
2. Teacher writes the topic for the lesson on the chalkboard
3. Teacher states the objectives for the lesson
4. Teacher outlines the content of the topic on the chalkboard
5. Teacher explains the content, making use of the information provided by the researcher in handling each topic
6. Students listen to the teacher and write down chalkboard summary.
7. The Teacher allows students ask questions on areas of the topic that are not clear to them.
8. Teacher answers the students questions
9. Teacher summaries the lesson
10. Teacher gives students home assignment

### *Validation of Teachers' Instructional Guide on Conventional Strategy*

*The instrument was validated using the Pi's statistical measure. The reliability was determined as 0.85*

**Evaluation Sheet for Assessing Teachers' Performance on the use of the Strategy (ESATPS)**

This is the guidelines for evaluating performance of the trained teachers on the effective use of the packages, i.e.

a. Puzzle-Based Learning Instructional Strategy (PBLIS).

b. Modified Conventional Instructional Strategy (MCIS).

The rating scale that is made up of two sections:-

**Section A** – This consists of the personal data of the trained teacher containing name, school, period, class taught, date and the summary of the concept discussed in the class.

**Section B** - This consists of items to be evaluated. The items are placed on a 5-point likert type rating scale ranging from Very Good (VG), Good (G) Average (AV) Poor (P) and Very Poor (VP).

The scoring of ESATP is as follows:

| | |
|---|---|
| Very Good (VG) | - 5marks |
| Good (G), | - 4 marks |
| Average (AV) | - 3 marks |
| Poor (P) | - 2 marks |

Very Poor (VP). - 1 mark

**Validation of ESATP**

The instrument was trial tested to ensure its reliability. For the purpose of validation, expert's attention was drawn to ascertain the appropriateness of the concepts and methods to the target population. The observations and comments of these experts were taken into consideration while preparing the final draft.

**Research Procedure**

The researcher made use of the regular subject teachers in administering the treatment. The treatment took 11 weeks as stated below:

**Table 2**

*Research Procedure*

| S/N | WEEK | ACTIVITIES |
|---|---|---|
| l. | 1st Week | (i)Took permission from the school authority<br>(ii) Selected and trained the research assistants (Biology Teacher) |
| 2. | 2nd Week | (i)Administered the Self efficacy questionnaires<br>*(ii) Conducted pretest on Science Process Skills Test in Biology (SPST)for both experimental and control groups* |
| 3. | 3rd-10th Week | Commenced treatment for both groups |
| 4. | 11th Week | Conducted posttestScience Process Skills Test in Biology (SPST)for both groups |

**Data Analysis**

Analysis of Covariance (ANCOVA) of inferential statistics was used in testing the hypotheses using the pretest scores as covariates and Estimated Marginal Mean was computed to show how the groups performed.

**Results:**

$HO_1$: There is no significant main effect on the treatment on students' science process skills in Biology.

**Table 3**

*Summary of ANCOVA of post-test by Treatment, and Self efficacy on Science Process Skills*

| Source | Sum of Squares | DF | Mean Square | F | Sig. | Eta Square |
|---|---|---|---|---|---|---|
| **Main Effect:** | 6033.809 | 18 | 335.212 | 10.910 | .000 | .347 |
| **Pretest Science process skill** | 1198.833 | 1 | 1198.833 | 39.019 | .000 | .095 |
| **Treatment groups** | 903.210 | 1 | 903.210 | 29.397 | .000* | .137 |
| **Self efficacy** | 41.726 | 2 | 20.863 | .679 | .508 | .004 |
| **Treatment group x Gender** | 171.991 | 4 | 42.998 | 1.399 | .234 | .004 |

| | | | |
|---|---|---|---|
| **Explained** | 6033.809 | 18 | 335.212 |
| **Residual** | 55249.000 | 369 | 30.724 |
| **Total** | 17401.779 | 387 | |

Significant at $P<0.05$

Table 3 Revealed that there was significant main effect of treatment on students' science process skills ($F(1,369,)=29.397; P<.05$, =.137) Hypothesis 1 was therefore rejected. This implies that there was significant difference in the science process skills of students exposed to the treatment.

**Table 4**

*Estimated Marginal Means of Post Test Practices Score By Treatment And Control Group.*

| | Mean | Std. Error | Upper Bound | Lower Bound |
|---|---|---|---|---|
| **Puzzle Based** | 12.43 | 1.29 | 13.44 | 11.42 |
| **Modified Conventional** | 6.24 | 1.66 | 6.77 | 5.71 |

Table 4 revealed the students in the Puzzle Based Strategy group had the adjusted post test mean science process skill scores ( $\acute{X}$ = 12.43) while students in the Modified Conventional Strategy group had adjusted mean Modified Convention Strategy Score ( $\acute{X}$ = 6.24).

$HO_2$: There is no significant main effect of Self efficacy on students Science Process Skills. Table 3 revealed that there was no significant effect on parent educational background on participant's science process skills. ($F(2,369)=.679; P>0.05$, = .004)The effect size of 0.4% was negligible. Therefore, hypothesis 2 was not rejected

**Discussion**

There were significant differences in the effect of treatment on students Science Process Skills exposed to Puzzle-Based learning. This finding shows that Puzzle-Based learning enhanced students' Science Process Skills over and above the Modified Conventional strategy. These may be attributed to the nature of the Puzzle-Based learning developed and implemented in the course of the study in which the learners were allowed the freedom to engage in various learning activities that enabled them to construct their own knowledge of the concepts selected for the study as they individually or in their groups use their thinking skills to recall facts, observe, collect and group objects and resources in the environment as well as defined, explained and debated on issues. They also evaluated, summarized and drew conclusions on the lessons all by themselves with minimal teacher interference. These real life activities must have enormously influenced and as such impacted their environmental achievement.

Puzzle-based strategy when compared with Modified Conventional Strategy by Anany,(2008) in analysis of algorithms showed that Puzzle-Based strategy was more effective. The findings further shown that there was better improvement in the Science Process Skills of the participants treated with Puzzle-Based strategy than their counterparts treated with conventional method in algorithms. Wlodkowski,(2008) emphasized that using critical thinking motivational strategy such as Puzzle-Based strategy for every course will enhance concretely the sense of self-efficacy of learners and make clearly visible the actual work expected of them.

**Implications for Findings**

The exposure of the learners to Puzzle-Based learning strategy has been found to positively affects the enhancement of students' Science Process Skills. The findings have therefore revealed importance of using teaching strategy that are participatory and learner centered where learners are trained to take control and direct their learning processes for effective learning.

**Recommendations**

In the light of the results and discussion, the following recommendations are made:

Puzzle-Based learning strategy should be adapted as viable strategy for study Biology as they involve the students in monitoring their learning process. Teachers of biology must endeavour to match teaching strategy with the manner in which students receive and process information.

**Conclusion**

This study is in line with the work of researchers who believe that strategy learning improves skill acquisition (Ogundiwin,2013). Puzzle-Based learning strategy develop science process skill. Also, the strategy encouraged students to take control of their le-rning (as they are learner centered strategy) thus making students more critical in their thinking when compared with the traditional conventional teaching method which emphasized teacher activity over pupil involvement.

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