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Effect of Thinking Actively in Social Context in Guided Discovery Learning on the Conceptual Understanding of Biology

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Abstract
Real learning occurs when learners are placed into authentic situations and allowed to wrestle through the solutions and thus discover critical knowledge on their own. Guided discovery learning (GDL) is a student-centered instructional approach that promotes active thinking and inquiry-based learning The present study "*Effect of Thinking Actively in Social Context in Guided Discovery Learning on the Conceptual Understanding of Biology*" was aimed at realizing the impact of how modern instructional approaches through social interaction improve the conceptual proficiency of students in the science subject instead of continuing the traditional instructional methodologies. The study highlights the importance of integrating structured social interactions within GDL to maximize its effectiveness in biology education. This spinning wheel framework could be considered as a very significant development in today's terms and paradigms of teaching and learning. Main objectives of the study were to examine how the use of TASC Framework affects the understanding of biological concepts, generate ideas, and enhance students analytical and problem solving skills in the context of biology among Grade 10 science students. For this experimental research an Equivalent Group, Pretest-Post Test Design was used. Population of study were all female government higher secondary schools in Khyber Pakhtunkhwa, Pakistan. The study included 308 female higher secondary schools across 28 districts of Khyber Pakhtunkhwa province despite which Higher Secondary School Phase 1 Hayatabad District Peshawar became the focus for selecting grade 10 students as the study participants. Simple random sampling was utilized to pick 70 students as a test group. Control and experimental groups were formed by performing paired random sampling on the study subjects. The researcher made 13 detailed lesson plans from grade 10 biology practical note book based on concept attainment principles using TASC Framework stages. These lessons served as tools for pretest and posttest assessments with participants of experimental and control groups. Moreover the experimentation group received an open ended self-reflection questionnaire for evaluating TASC Framework's effectiveness. Descriptive along with inferential statistics served to evaluate the received data. Independence sample t-tests provided the investigation with methods to validate the null hypotheses. Findings suggest that the subjects in the experimental group demonstrate improved retention, critical thinking, and the ability to apply biological concepts in novel situations and showed positive attitudes toward using the TASC Framework. Based on this positive data it is recommended to expand the use of Guided Discovery Learning with TASC Framework into various subjects at different educational levels.
Keywords: Thinking Actively In Social Context (TASC), Guided Discovery Learning, Conceptual Understanding

Introduction

Education has undergone a specific transformation with the integration of new teaching strategies and innovative learning models into teaching practice. It can be recognized as a potent force that empowers individuals to attain complete awareness of their goals and objectives in life by imparting intellectual, ideological, physical, and ethical training, which enables them to achieve their aspirations. Most dictionaries provide a basic definition of teaching which describes it as the process of passing knowledge to someone else. The delivery of beliefs and concepts represents essential elements in any educational process because effective teaching and learning are vital (Adunola, 2011). The traditional teaching model include three core elements; teacher together with learner and with the content to be learned. The primary duty of the teacher involved transferring information from the textbook to the students. Educational success occurred when students could recall information at needed times and spaces while demonstrating correct application of it. The systematic educational process consists of teachers and learners together with learning materials and their physical environment. A teaching approach demonstrates effectiveness when learners successfully add new information to their memory systems and maximize their knowledge gains. The effective strategies teaching administrators use in classroom instruction heavily influence student engagement and the establishment of learning connections. According to Barrows (1996), teachers would be aimlessly projecting information without the use of without the use of a strategy that aids in connecting and engaging learners with the teaching learning environment. The content being delivered during classroom using effective teaching strategies makes the learner engaged, participate, and add excitement. Besides developing conceptual understanding, students need new disciplinary strategies to guide their reasoning within the domain (Wang,2019). These constructs for learning through inquiry indeed have the potential to engage knowledge in a more efficacious way with real-world contexts but also present very specific challenges for learners. Perkins (2013) discuss some of the challenges that arise for learners and organize them around three constituent processes involved in learning through scientific investigation-sense making, process management, and articulation and reflection. Each of these kinds of process is difficult for learners in its own way. Sense making involves constructing and interpreting empirical tests of hypotheses (Chusni *et al.,* 2020). Students are required to bring together reasoning about experiments or comparisons of data with implications of those findings for an explanation of the scientific phenomena.

According to De Jong & Van Joolingen (1998), a highly constructivistic and self-directed form of learning is scientific discovery. Pratiwi (2019) emphasized that science education is a study of both the natural environment and human existence .Similarly the study of biology and its learning can be considered difficult because it often involves a large volume of detailed information about complex biological processes, requiring significant memorization and a deep understanding of intricate concepts, which can be challenging for many students. Connecting biological concepts to real-world scenarios and practical applications can be challenging Memorization anchors students remember the basic information but conceptual understanding can only be developed with deep learning. Conceptual understanding in Biology means:

- Students must grasp the hierarchical structure of biological systems when studying how the Calvin cycle connects to photosystem which operates within photosynthesis.
- Both the rationale and mechanics behind the operation of biological systems must be comprehended
- Students must understand both the crucial importance and meanings of terms within their biological contexts is of vital importance on the part of a student.
- To understand the process of glycolysis one should know its definition along sides its functional role within cellular respiration.

Each student comes up with different background experiences, different interests, different beliefs and cultural background. Every student is unique in his cognitive learning skills and comprehension. Understanding many biological concepts often requires visualizing complex structures through diagrams and illustrations, which can be challenging for some learners. Classroom activity allows students to familiarize themselves with different learning techniques which then allow some students to use these strategies independently while mastering new content. The brain-learning friendly strategies presented to students enable them to acquire content knowledge through their preferred cognitive methods (Sangam & Jesiek, 2012). Students get learning activities which match their preferred learning methods through different instructional approaches. According to Sari *et al*., (2018) students have different learning preferences that range from excessive problem practice to tactile manipulations. Students should be provided with teaching approaches that fit their learning needs to explore materials through diverse methods regardless of their learning methods. In other words, students must be induced to some of the innovative and basic discoveries of science by himself through proper guidance and aid on the part of the instructor. Their sense of wonder gets over powered by anxiety. The world is becoming a global village and for survival is only possible through the development of scientific attitude among the students.

Learners are unable to develop the sense of wonder and inquiry-based learning along with problem solving and decision making. They feel lack of motivation in understanding the world around them beyond the whimsical explanation given by the scientists. Despite learning for their own understanding, students merely strive to please the teacher in order to attract sympathies and attention of the teacher so that he is graded with good marks in the end of summative assessment. The subject of science needs to be taught through a meaningful, fun and interactive learning environment (Bauer, Larkina & Deocampo, 2011). In order to reduce errors and make correct thinking by controlling the whole learning context, the teacher is responsible for the provision of proper guidance to students. Teachers should have enough time to provide corrective feedback to the students regularly. Nevertheless, the teachers still use traditional methods in teaching of science (Großmann, 2019). According to Prince (2004) modern innovative teaching strategies like inquiry-based teaching learning process involve students to empower their sense of wonder and motivation at secondary level. Multiple fundamental guiding principles originated from learning theories while empirical studies enriched their development at various levels. Guided discovery learning techniques in an instructional environment increases the art of innovation by revealing the mysteries of nature through practice on the part of students.

Balm *et al*.,(2009) evaluated the Discovery learning model is a set of educational exercises that prioritize the use of critical thinking and analysis to arrive at and determine their own solutions to the problems posed. The main goal of discovery learning is to teach students how to solve challenges they will encounter in the real world including Preparation, Implementation are the steps in the discovery learning model. Enhancing long-term memory, heuristic learning of the results, changing values from extrinsic to intrinsic and raising intellectual capability is all advantages of the discovery learning process.

Problem Statement

The aim of science and technology research is to improve teaching approaches in education by utilizing multidisciplinary efforts for a better understanding of conceptual understanding Sandika & Fitrihidajati (2018). Students learn best when allowed to learn according to their sociological preferences. Effective teaching strategies, models, and frameworks adopted by teachers are directly proportional to the success of concept formation in science subjects. Mabhoza et al.,(2024) depicted that guided discovery learning strategy not only help in aligning exploration to the stated learning objectives but besides it scaffolds complex concepts and breaks complex things into simple bits. Discovery learning often referred to as instruction-less

learning includes creating and evaluating hypotheses (Sakinah *et al.*,2022). Learners build knowledge stepwise instead of grappling with abstract concepts in isolation which causes deeper understanding to think critically about what they are discovering (Syukri,2020). Questions, hints, or feedback encourage these students to build connections among ideas rather than just "guess and check. TASC (Thinking Actively in a Social Context) framework developed by Bella Wallace in 1980 generally known as the TASC Model of Spinning Wheel using Guided discovery learning approach may prove to bring fruitful results with a clear and dynamic conceptual understanding in science and technology for future decision makers.
The TASC framework is consistent with the constructivist philosophy and includes various operational steps (Wallace *et al.*, 1994). The problem addressed by this study was to investigate the impact of the TASC Framework in Guided Discovery Learning Approach on the conceptual understanding of Biology among secondary level students.

Research Objectives

The study aims to achieve the following objectives:

1. To examine how the use of TASC Framework affects the understanding of biological concepts among Grade 10 students.
2. To determine the impact of TASC Framework on students' ability to generate ideas and enhance their conceptual understanding in biology.

Hypotheses

$H0_1$: The use of TASC Framework does not have a significant impact on the understanding of biological concepts among Grade 10 students.

$H0_2$: The use of TASC Framework does not have a significant impact on students' ability to generate ideas leading to conceptual understanding in biology.

Significance of this Research work

The proposed research aims to investigate the effects of the TASC Framework in the Guided discovery learning approach on the conceptual understanding of Biology among secondary-level students in Pakistan. The study will be valuable to the government by providing insights into the impact of the TASC Framework, which teachers can use as a guide to promote creative and effective learning. The TASC Framework will also help learners develop independent learning along with promoting social skills among students and enable teachers to utilize their instructional strategies in a more innovative and social way to promote conceptual understanding in Biology. This study will benefit curriculum developers, policymakers, and administrators, as well as parents, who can create a conducive learning environment for their children. Moreover, this study will be helpful for researchers who want to explore the use of TASC Framework in Guided discovery learning approach for Biology teaching in a classroom-based environment. It will help to reduce rote memorization and promote problem solving and critical thinking skills among students, which is essential for cognitive development. Overall, this study has the potential to advance the field of education and improve the teaching-learning process.

Literature Review

Theoretical Framework of the Study

This study integrates theories from constructivism, social learning, cognitive load, and conceptual change to explain how active thinking in a social context within guided discovery learning enhances conceptual understanding in biology**.** This framework is structured around relevant learning theories and models that support the research objectives. This theoretical framework provides a solid foundation for exploring how thinking actively in a social context within guided discovery learning enhances conceptual understanding in biology**.** The theoretical framework is based on constructivist learning theory (Piaget, Vygotsky) guided discovery learning (Bruner) and social learning theory (Bandura) which emphasize active engagement and social interactions in knowledge construction.

Guided Discovery Learning Theory

The educational method known as guided discovery learning design model rooted in constructivism. It combines ideas from cognitivist instructional design theory, as well as elements of radical constructivism and, under certain situations, discovery teaching (Harvel *et al.*, 2010). According to Honomichl *et al*., (2012) guided discovery primarily aims to create awareness and enthusiasm about classroom resources and assist children in exploring how they are used. Guided Discovery also allows for introduction of vocabulary, assessment of children's prior knowledge, and teaching the responsible use and care of materials. A Guided Discovery can require as little time as fifteen to twenty minutes. But the interest and excitement that these activities inspire and the skills that children practice carry through to help with academic learning throughout the rest of the day. The guided-discovery rationale rests on this appropriate balance between self-exploration and structured assistance. Here is why it is essential. Discovery, easily said, may overwhelm certain learners at times, especially with complex concepts. The guidance will help them restrict their line of inquiry so that they will not feel lost or frustrated thus cognitive overload is prevented ensuring that learning goals are met. In its absence, the learner may go astray. "Supports Multiple Ways of Learning. Some children will find open-ended tasks overwhelming. Guidance personalizes the learning process by providing assistance based on each learner's specific needs. In this approach students uncover knowledge independently, building their own understanding. Teacher perform a primarily to create an appropriate environment which in the context of software could be a micro world or simulation (EduTech, 2016).

Guided discovery Learning Method in Teaching Learning Process

Convergent thinking is a defining characteristic of guided discovery. Using a series of statements or questions, the instructor leads the student through a logical process that culminates in a certain goal. The teacher gives the student a stimulus in this process, which encourages active inquiry and leads to the right response. According to Honomichl *et al*., (2012) ten cognitive processes recognizing, analyzing, synthesizing, comparing and contrasting, drawing conclusions, hypothesizing, memorizing, questioning, inventing, and discovering are listed by as possible during this active inquiry. The student gains a deeper comprehension and improved recall of the content by actively participating and discovering facts or concepts (Syukri,2020). Additionally, he highlights some of the drawbacks of this teaching approach, pointing out that it is primarily intended for individual rather than group learning and that it tightly regulates and manipulates learning behavior both of which could be abused (EduTech , 2020).

Research Methodology

Research Design

The present study was based on a quantitative research method with an experimental research design that includes a pretest-posttest control group. Two groups were formed; an experimental group that received a 40-minute class intervention for six days a week for two months, and a control group that was taught traditionally. The researcher used a randomized group pretest-posttest design for data collection and analysis. In simple terms, the experimental group was subjected to treatment for a specific period of time, while the control group was taught in the conventional way. After treatment, a posttest was conducted on both groups to find out any possible difference in the outcome of the two groups.

Pretest Posttest Control Group Design

Design may be presented in tabulated form

Group	Pre-test	Treatment	Post-test
Experimental group = E	X_1	T_1	Y_1
Control Group = C	X_2	T_2	Y_2

This experimental study contained independent and dependent variables. There were no changes in the likelihood and external factors.

Population of the Study

The population of the study was all female government secondary schools in Khyber Pakhtunkhwa which comprises 28 districts with a number of 308 female government higher secondary schools and 606624 students enrolled in these higher secondary schools (ASCR, Government of Khyber Pakhtunkhwa, 2023-24). However, the target population for this study was all 21,012 female students enrolled in 22 higher secondary schools of District Peshawar. As the study was experimental in nature, this study was delimited to only one Higher Secondary Schools for Girls of District Peshawar i.e, Government Girls Higher Secondary School Phase 1 Hayatabad Peshawar.

Sample Size and Sampling Technique

The target population in this research was grade 10 students of Biological science in Government Girl's Higher Secondary School Phase 1 Hayatabad District Peshawar which is located in the Khyber Pakhtunkhwa province of Pakistan, West of Islamabad. Purposive sampling technique was used to select the particular school in the area. The criteria for the selection were; proximity towards school, availability of transportation, the availability of functional biological laboratory and matching number of students in a class. 10^{th} grade science students were selected as sample of the study. A total of 70 students out of 106 were selected for experiment through simple random sampling technique. The selected students were divided into two groups: experimental and control group. Both the groups were homogenous. Each group consisted of 35 students studying in class 10th. In District Peshawar, there are 22 Government Girls High Schools. Only one school was selected for this study through convenient sampling techniques. Permission of the District Education Officer (Female) was sought in advance.

Table: Statistic of Sample

No of Students	106
Sample Size	70
Experimental Group	35
Control Group	35

Data Collection Tools

The type of research conducted in this study was Equivalent Group, Pretest-Post Test-Design. Pretest and post tests were the tools for data collections from the participants of the study and were being prepared from 10^{th} grade Biology Practical Note Book approved by Directorate of Curriculum and Teacher Education. The study population consisted of all 22 Female Government Higher Secondary Schools in Khyber Pakhtunkhwa, District Peshawar. Sample for the study was selected using simple random sampling technique. The samples of the study participants were the grade 10 female students from Government Girls Higher Secondary School Phase 1 Hayatabad Peshawar. The Pretest was administered by the researcher personally to all the 70 female students which contained 30 Objective-type items, including 12 Multiple Choice questions, 08 fill in the blanks and 10 match the column type items. Structured within 50 marks. The purpose of the pretest was maintained to check the reliability as well as validity of test items. Similarly a Posttest comprising of 50 marks, with 14 MCQs (Multiple

Choice Questions), 06 RRQs (Restricted-Response Questions), and 02 ERQs (Extended Response Questions) was conducted after duration of two months experimental phase. Both the Pretest and Posttest were designed in a structured format to assess the conceptual understanding of biological activities, student's ability to generate creativity with discovering novel ideas and building up analytical skills among science students. On the basis of pre-test score results, 35 out of 70 female students were placed in the experimental group as sample through paired random sampling technique while the remaining 35 made up the control group. The experimental group was treated through Guided Discovery Learning with TASC model while the methodology applied on the control group was traditional method. The researcher personally taught two groups for eight weeks. After treatment of two months, a posttest was taken from both the groups .A self- reflection questionnaire comprising of five open ended questions was also administered to the experimental group students and their opinions were recorded to determine the attitude of students towards Guided Discovery Learning using TASC model. Such tests and questionnaire were validated and their reliability was ensured. The analysis and interpretation of the information collected through tests were accomplished using paired t-test at significance level of 0.05. Similarly, percentages and frequencies were used for analysis of the data collected through pretest and posttest mean scores.

Data analysis technique

To analyze the data collected for this study, Inferential Statistics was used, specifically mean and standard deviation which helped in determining the distribution of means across different groups such as treatment, gender, and conceptual understanding skills of students. Inferential Statistics was also employed using SPSS software 20 version to test the hypotheses through paired sample t-test.

Data Analysis

$H0_1$: The use of the TASC Framework does not have a significant impact on the understanding of biological concepts among Grade 10 students

Groups	N	Mean	Effect Size (Cohen's *d*)	Dependent t-test value	p-value	
Experimental	35	11.3	2.2	6.4	0.0001	(Significant)
Control	35	8.7				

A study evaluated how Grade 10 students received instruction using the TASC (Thinking Actively in a Social Context) Framework to understand biological concepts by presenting their results in a table. A research design included two tested groups: The experimental group consisted of 35 students and the control group had 35 additional students. Between the TASC Framework utilizing experimental group students and the control group students without the framework there was a significant mean score difference of 11.3 compared to 8.7. Research revealed a large effect (Cohen's d=2.2) which shows that the experimental results are substantial when comparing the two groups. The experimental and control groups display a statistically significant difference according to the t-test value of 6.4 together with the virtually zero p-value of 0.0001. The experimental data enables us to reject the null hypothesis (H01) because TASC Framework utilization produces significant learning outcomes in biology for students. Student understanding of biological concepts strongly indicates that the TASC Framework produces a positive substantial effect on their comprehension of the subject.

H0$_2$: The use of TASC Framework does not have a significant impact on students' ability to generate ideas leading to conceptual understanding in biology

Groups	N	Mean	Effect Size (Cohen's *d*)	Dependent t-test value	p-value	
Experimental	35	12.8	4.3	4.8	0.001	(significant)
Control	35	7.7				

The research data shown in the table reveals the outcomes from determining whether the TASC (Thinking Actively in a Social Context) Framework generates notable effects on biology students' idea generation performance leading to conceptual understanding. The research design employed two groups of students, numbering 35 each in the experimental and control groups. The students who received instruction using TASC Framework scored 12.8 points in the average while the students who did not receive this framework scored an average of 7.7 points. The calculated Cohen's d effect size reached 4.3 to demonstrate an exceptional difference between the tested groups. Statistical significance appeared in the study because the dependent t-test value reached 4.8 and the p-value amounted to 0.001. The obtained research results warrant rejection of the hypothesis that suggested TASC Framework usage would not yield meaningful effects on student conceptual understanding development. The TASC Framework demonstrates powerful effectiveness in enhancing student ability to develop meaningful ideas related to biology conceptual understanding.

Findings

The influence of TASC (Thinking Actively in a Social Context) Framework instruction on student learning of biological concepts was assessed through a research study. The TASC Framework yielded substantial learning outcomes in biology because students in the experimental group showed significantly better performance than those in the control group according to the effect size. **(Hypothesis-Ho1).**

Research findings demonstrate that the TASC Framework created positive impacts on biology students' development of ideas and comprehension of concepts. The students who learned with help from the TASC Framework demonstrated better results compared to students who received no such instruction. Statistical results confirm the TASC Framework's effectiveness in biology education because Cohen's d effect size shows exceptional differences combined with statistical significance. **(Hypothesis-Ho2).**

Discussion

Research conducted in this study supports previous findings which show that students learn better when working together both conceptually and in solving problems within the field of biology. Johnson and Johnson (2009) showed that cooperative learning methods enhance both educational performance and relationship talents as well as student drive for subjects such as science. Slavin (2014) demonstrated group-based learning has better academic effects than independent learning when teaching through structured peer collaborations. The present research distinguishes itself through its detailed focus on the connection between guided discovery instruction and the TASC Framework to handle biology conceptual understanding difficulties despite other studies not placing equal weight on this aspect.

The present research agrees with Bruner (1961) and Hmelo *et al*., (2007) that directed discovery methods enhance deep conceptual grasping and crucial thinking skills. The present research differs from previous studies which condemned unstructured discovery learning because it lacked necessary frameworks. According to Kirschner (2006) minimal instructional guidance normally causes cognitive overload leading students to achieve diminished learning results. The research examines this criticism through findings which illustrate that structured

discovery-based learning with social assistance and instructional aids results in measurable learning improvements.
The presented statistical data shows significant variations yet the analysis confirms that practical outcomes from collaborative and guided learning methods demonstrated moderate effects at times. Hattie’s (2009) research supports this outcome by demonstrating that implementation quality and context determine the strength of collaborative learning effects on achievement outcomes. This study joins existing discussion by showing that directed group activities together with instructor-led discovery approaches provide the best conditions for obtaining maximal practical benefits from collaborative educational methods.

Conclusion

The study shows that incorporating TASC (Thinking Actively in a Social Context) Framework with guided discovery learning as social guidance methods creates substantial impacts on biology educational success. Experimental participants succeeded in structured social discovery-based assignments yielding superior learning outcomes because these programs advanced students' conceptual knowledge acquisition together with their creative abilities and problem-solving abilities. The experimental data in this work demonstrates the effectiveness of collaborative learning methods thereby increasing understanding of the subject in existing research.

Conventional independent learning showed specific shortcomings according to research data because students needed better help with conceptual misunderstandings along with better critical thinking skills development. Students who operate alone in their studies perform less effectively than those who obtain peer feedback combined with peer scaffolding features during instructional activities mentioned in experimental and control groups. These findings support teaching methodology transformation because they demonstrate that instructors must shift from leading lessons to focusing on their students.
The TASC Framework demonstrates effectiveness as a significant educational instrument to boost academic outcomes and biological analytical and creative skills in students. This framework enables a learning system which promotes biological concept application by implementing active and social learning structures that support student-directed innovations of practical biological solutions. Research evidence indicates that the TASC Framework possesses the potential to transition into a revolutionary learning method because it proves both robust statistical importance and substantial effect sizes.

Recommendations

1. Based on the conclusion, the following recommendations were made.
2. It is recommended that teachers implement and adopt Guided Discovery Learning using the TASC Model as an instructional method for teaching science subjects in all classes.
3. With equal chances of participation, a competitive environment may be ensured, which is likely to produce the best possible results of the lesson plan designed on the part of the teacher while performing Guided Discovery Learning activities and discouraging gender discrimination in a classroom
4. Ministry of education, as particular educational authorities, along with the head officials are real potential artists and educationists as they are inherently and naturally the best investors in professional developments. They may contribute by putting their genuine efforts in collaborating with Foreign funding agencies for the provision of financial aid may further be utilized in induction trainings for teachers in the future implications of Guided Discovery Learning using TASC Model
5. Discovery learning techniques like Guided Discovery Learning may be included in the curriculum designed pre-service, in-service, and induction training programs courses for effective training to enable teachers to get the total instructions of this model and enhance students' learning outcome. Teachers may establish an effective learning

environment to encourage collaboration, discussion, asking questions for clarifications, and discussing concepts among students.

Future Recommendations

1. For future research, it is recommended to carry out similar research at primary and middle school levels in other provinces
2. The recommendation for further research is that a qualitative study might be done in this area to provide a better understanding of the benefits as well as drawbacks of the Guided Discovery Learning using TASC Model during teaching learning process.
3. An impact assessment of Guided Discovery Learning using the TASC Model on students' performance in other subjects, including mathematics, physics, and social studies, could be carried out.
4. A comparative study could be done to show the difference in the conceptual understanding of students among public and private sector students in sciences by having Guided Discovery Learning using TASC Model as their teaching strategy at elementary, secondary and higher secondary level.
5. This study might be replicated on the male students at Government Schools.
6. Moreover a study needs to be carried out to observe the impacts of the Guided Discovery Learning using TASC Model on problem solving aspects of biology.

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