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POGIL (Process Oriented Guided Enquiry Learning)- Innovative Teaching Method based on Constructivism and its Effect on Problem-Solving Ability of Middle-Stage Students

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Abstract
After the pandemic, the smooth continuation of the teaching-learning process is a challenge for all the stakeholders of education. POGIL is a method of constructivism where teachers guide students to gain possible learning outcomes. In the process of the POGIL method, a teacher/guide works as a facilitator divides the whole class into small groups, and provides a role for each student according to their ability. POGIL develops higher-order thinking skills among students. It needs synthesis, analysis of all possible solutions, and then selects the best solution for solving the problem. POGIL method is a useful method to develop 21st-century skills. The population of the current study was Middle stage students and the sample was 40 students from class 8th, which was selected through a purposive sampling technique in the intact condition of the classroom.

Keywords: Pandemic, POGIL, Constructivism, HOTS, 21st-century skills, Problem-solving ability.

INTRODUCTION

In 1994, POGIL was initiated within the chemistry department of a college in the United States. Although it was initially introduced in the field of chemistry, it has since expanded to encompass over a thousand different disciplines worldwide, spanning both high schools and colleges. POGIL relies on a structured process of guided inquiry, which includes cycles of exploration, concept development, and practical application. These cycles serve as the foundation for the thoughtfully crafted educational materials that students utilize to assist them in constructing fresh knowledge.

One of the student-centered learning models that can improve students' thinking skills is POGIL (Process Oriented Guided Inquiry Learning) (Artuz & Roble, 2021; Hein, 2012; Soltis et al., 2015). POGIL, a learning framework blending guided inquiry and cooperative learning, prioritizes the constructivist approach (Rodriguez et al., 2020; Simonson, 2019). It empowers students to hone process skills, develop cognitive capabilities autonomously, and cultivate positive attitudes. Additionally, the POGIL model is executed through a cooperative method, featuring small groups of 3 to 4 students assigned various roles.Learning activities with POGIL are oriented towards a more constructive and interactive concept discovery process, and each student has a role and contribution to capturing concepts (Kussmaul, 2018). The advantage of the POGIL model is that it can help students discover their knowledge and it is easy to

apply at all levels.

POGIL represents a collaborative approach to teaching and learning where students work together in groups to resolve challenges. In this methodology, the instructor assumes the role of a facilitator and organizes the entire class into smaller, diverse groups. POGIL fosters the development of essential skills such as problem-solving, critical thinking, effective communication, cooperation, and mutual assistance. It proves particularly effective in secondary-level classrooms, where class sizes are typically larger, making it challenging for the teacher to individually address every student's issues. This approach nurtures students' problem-solving abilities and contributes to their academic advancement.

POGIL, as an instructional approach centered on group dynamics, fosters a sense of collaboration among students. It ensures that every student has the chance to actively engage in classroom activities. In POGIL, the teacher organizes the entire class into small groups, typically composed of 5 or 6 students, and assigns roles based on their respective abilities, such as curriculum manager, listener, speaker, or observer. POGIL cultivates a spirit of cooperation within the classroom, providing an equal opportunity to all students, free from bias.

The foundation of POGIL is rooted in research findings that indicate:

(a) traditional lecture-style teaching is often ineffective for most students.

(b) students who are part of an interactive learning community tend to achieve greater success.

(c) knowledge is a personal construct.

Students derive more enjoyment from their learning experiences and develop a stronger sense of ownership over the material when allowed to construct their understanding. In this approach, the teacher assumes the role of a facilitator of student learning and contributes to the enhancement of their problem-solving skills.

21st Century Skills

Since 21st-century skills are comprehensive and multidimensional, it is not possible to make a standard definition for them. For this reason, many institutions and organizations have created some classifications about what 21st-century skills should be. Among various project studies and published reports aimed at identifying 21st-century skills, the Partnership for 21st Century Skills is the most widely accepted one and has the largest stakeholder network. The Partnership for 21st Century Skills expressed these skills as “problem-solving, innovation and creativity, cooperation, and communication skills within the scope of learning and innovation skills; information, media, and technology literacy within the scope of information, media, and technology skills; flexibility and adaptability; entrepreneurship and self-management; productivity and accountability; social and intercultural skills; leadership and responsibility skills within the scope of life and career skills”. 21st-century skills can be described as the skills that individuals are expected to have in the century that we live in. This expectation has led to the need to teach 21st-century skills to individuals. In parallel, teachers, education professionals, and business leaders have provided a framework for these skills (Bozkurt, 2021; P21 Leadership States, 2017). This framework, which was put forward as the 21st Century Learning Framework is aimed at students to acquire 21st-century skills by providing active participation in the learning process with the support systems of

a) Standards and assessments,

b) Curriculum & and Instruction

c) Professional Development

d) Learning Environments.

Higher Order Thinking Skill (HOTS)

Higher-order thinking skills (HOTS) refer to cognitive processes that involve critical thinking, problem-solving, analysis, synthesis, and evaluation of information. These skills go beyond basic memorization and understanding of facts and require a deeper level of mental processing. Higher-order thinking skills are considered essential for students to succeed in complex tasks, innovative problem-solving, and lifelong learning. Here are some key higher-order thinking skills:

Educational strategies that promote higher-order thinking skills often involve activities that encourage students to analyze, synthesize, and evaluate information rather than simply memorize facts. Examples include problem-based learning, case studies, debates, projects, and discussions that require students to apply their knowledge in real-world contexts. These skills are crucial not only for academic success but also for success in various professional and personal endeavors.

PROBLEM-SOLVING ABILITY

Education is a tool to create generations who are skilled in their fields (Sujana, 2019; Miftah Rahmah et al., 2021). The 21st.century education is a process to empower and develop all the potential that students have to form a better character (Rahayu et al., 2022). Education in this century requires a variety of abilities that must be mastered by students to become a successful person in life. One such ability is problem-solving (Siagan, 2019; Hulaikah, 2020).

Wagner identifies the problem-solving process as one of seven essential abilities individuals need to confront the challenges of both life and the professional sphere. Problem-solving ability are included in the way of thinking among the other three categories of the 21st-century ability: ways of working, tools for working, and the ability for living in the world (Care, 2015; López, 2021). Problem-solving ability is a series of actions to solve problems by using steps to produce an expected solution (Lin, 2019; Huang et al., 2020). The problem-solving ability must be owned by students in finding problems and finding solutions to a problem (Retnawati, 2018; Hutajulu, 2019; Sigit et al., 2019; Triani et al., 2019; Yayuk & Husamah, 2019)

Problem-solving ability pertains to an individual's capacity to resolve challenges encountered in their daily experiences (Intaros et al., 2014). It stands as a fundamental objective in teaching mathematics yet remains one of the most challenging to attain (Stacey, 2005). The existing problems in education in Indonesia include the low-test results of students in the TIMSS and PISA, which are caused due to the material, the process of teaching and learning, as well as the assessment, which are inaccurate (Putri & Zulkardi, 2017a; 2018; Zulkardi et al.,2000).

There is still room for enhancement in students' problem-solving skills. Through classroom instruction in mathematics problem-solving, students can significantly enhance their cognitive capabilities. Consequently, proficiency in problem-solving can serve as a yardstick for success in mastering mathematics (Mairing, 2016).

Utilizing problem-solving tasks as the primary educational focus in mathematics instruction within schools remains underutilized. They have become a hindrance to the enhancement of students' abilities within the school environment (Umar, 2016). Students's difficulties in formulating everyday problems into formal mathematical forms, understanding mathematical structures, and evaluating mathematical results in real-world contexts. This means low student learning outcomes in working on PISA questions (Jupri & Drijvers, 2016).

MIDDLE STAGE

According to NEP (2020)-The middle stage comprises three years of education. It builds on the pedagogical and curricular style of the preparatory stage. The introduction and discussion of abstract concepts are done in this stage. It helps prepare students across various streams.

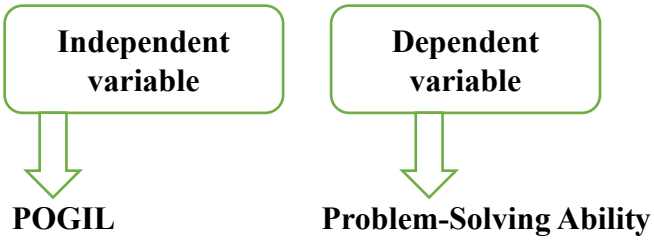
The middle stage will be from classes 6th to 8th (age group 11 to 14). It will comprise experimental learning in mathematics, sciences, social sciences, arts, and humanities. This educational level will prioritize critical learning objectives, marking a notable shift away from the traditional rote learning approaches that have prevailed in our educational system for a considerable time.

EMERGENCE AND JUSTIFICATION OF THE STUDY

POGIL is a combination of guided inquiry learning and cooperative learning (Sen et al., 2015). The learning method in POGIL emphasizes collaborative aspects of constructivism that are used in the cycle of exploration, concept discovery, and application of concepts during knowledge building (Rege et al., 2016; Trevathan et al., 2014). Avsec and Kocijancic (2014) inquiry-based learning is an inductive pedagogy that Kartono & Shora 557 International Journal of Instruction, July 2020 Vol.13, No.3 enables high-level reasoning skills to develop knowledge, high-level reasoning skills, and contemporary learning. Meanwhile, Kurniashih et al. (2019). Guided inquiry is one of the important components of the contextual learning model and constructivism that is developing rapidly in the reform of the educational process in Indonesia today.

POGIL is an instructional method rooted in constructivism, wherein students actively build their understanding and tackle problems collaboratively within their groups. The researcher has chosen this topic because it prioritizes the learner, making them the central focus of the learning process. In this teaching/learning approach, the teacher assumes a guiding role in the classroom, organizing students into diverse groups based on their abilities and assigning roles accordingly. Particularly in middle-level classrooms with extensive syllabi and limited time for addressing individual student doubts, educators might adopt a method like POGIL, which emphasizes the active construction of knowledge through group-based learning activities.

VARIABLES OF THE STUDY



DELIMITATION OF THE STUDY

- The present study is delimited to the 8th class
- The present study is delimited to the mathematics subject (Mathematical problem solving)
- The present study is delimited to the DEI board school (Timarni, MP)

OBJECTIVE OF THE STUDY

To find the effect of the POGIL method on the problem-solving ability of middle-stage students.

HYPOTHESIS OF THE STUDY

- "There will be no significant effect of the POGIL method on the problem-solving ability of middle-stage students."

RESEARCH METHOD OF THE STUDY

To fulfill the purpose of the present study the researcher used a pre-experimental research method.

RESEARCH DESIGN OF THE STUDY

The researcher used a Single group pre-test and post-test research design.

SAMPLING PROCEDURE

The population of the study-Middle stage students
Selection of school- Radhasoami Highschool Timarni Harda (MP) Purposively
Sample of the study- 40 students of 8^{th} grade (class selected randomly in the group of 3 classes 6,7,8)

TOOL FOR DATA COLLECTION

To fulfill the purpose of the present study the researcher used the Problem-Solving Ability Test of L.N. Dubey (2011),the questionnaire consists of 20 questions on mathematics.
Reliability: the reliability coefficient of the test was calculated by two methods in which .78 was the reliability coefficient in the Spearman-Brown formula (split-half method) while .76 was the Kudar-Richardson formula (Rational equivalent method).
Validity: The coefficient of validity was calculated by correlation the scores were .68 and .85 in the Group Intelligence test (R.K Tandon) and Test of Reasoning Ability respectively.

STATISTICAL TECHNIQUES

Descriptive techniques ⇨ Mean & S.D

Inferential techniques ⇨ **t-Test**

PROCESS / INTERVENTION OF THE STUDY

First researcher collected pre-test data from the group of the students and after collection, The researcher provided a 15-day intervention for the group in intact condition of the classroom. The researcher to fulfill the purpose of the study used the existing chapters of the mathematics textbook of class VIII and developed these chapters by the POGIL method and using collaborative learning. In the process, the researcher divided the whole class into 5 groups and solved their problem through group activity and the metacognition process. After completing the intervention, the researcher collected post-test data for the group of the student.

Fig. For classroom engagement

SIGNIFICANCE OF THE STUDY

- POGIL is an interactive process of refining one's understanding and developing skills for the workplace as a component of the student learning process.
- The ability to engage in these processes is crucial for students to succeed in active learning environments.
- Process Oriented Guided Inquiry Learning (POGIL) enhances the higher-order thinking skills of students.
- POGIL is an effective strategy that develops decision-making ability, and problem-solving abilities, promotes cooperative and collaborative learning, and group-based activity, and enhances social qualities and skills.

COLLECTION AND ANALYSIS OF DATA

First pre-test data were collected from the 40 students of class 8^{th} from the collected data mean and standard deviation were calculated after pre-test data collection the researcher gave the 15-day treatment through the POGIL method for the same class or group of 40 students then post-test data were collected. After collection of post-test data t -test was calculated.

Pre-Test data(N=40)	**Post-Test data(N=40)**	**t-test analysis**
M1=8.0256	M2=10.5897	Df=78
SD=2.7594	SD=2.5791	t=4.2934

Table 1. T-test calculation

t test calculated with the pre and post-test scores of the students of class 8th Pre-test data Post-test data. The calculated t value for the degree of freedom 78 was t=4.2934, (tcal> t tab) t value in the table is (t .001 =2.58 and .005 =1.96). So, the null hypothesis is rejected at a .001 level of significance.

FINDINGS AND CONCLUSION

After analysis of data, the researcher finds that the Null hypothesis of the present study is "There will be no significant effect of the POGIL method on the problem-solving ability of middle-stage students." Is

rejected at the .001 level of significance. So, the POGIL method enhances the Problem-solving ability of middle-stage students.

In the end, the researcher concluded that The POGIL method of teaching/learning is so effective for the development of 21st-century skills of the students. In the process of the POGIL method every student owner of their learning and works with collaboration, solves the problems of the group, and constructs their knowledge. POGIL is an active learning method where all the students actively participate in classroom activities. The POGIL method enhances the problem-solving ability of the students in the middle stage.

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