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# Analysis of Teacher Readiness, Science Process Skills (SPS), and Implementation of Process-Oriented Guided Inquiry Learning (POGIL) Model in Elementary Schools

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## Abstract

Low scientific literacy among Indonesian primary school students highlights an urgent need for instructional transformation. While previous research separate these elements, this study addresses a significant empirical gap by simultaneously examining multidimensional teacher readiness, conceptual knowledge of scientific process skills, and the actual implementation of the process-oriented guided inquiry learning model at the primary education level. Using a quantitative descriptive and correlational design, data were collected via questionnaires and tests from 121 primary school science teachers across 14 sub-districts in Bogor Regency. The results showed that while average teacher readiness reached the good category, teachers' conceptual mastery of scientific process skills remained deficient, with over 33% scoring in the low and very low categories. Regression analysis revealed that teacher readiness contributes a positive but low 7.1% to their skills knowledge, whereas teaching experience yields no significant impact. Furthermore, model implementation drops drastically from *73.6%* at the initial orientation stage to only *17.4%* during the core application phase. The primary barriers preventing full implementation are limited science learning media and a lack of practical hands-on training for process-oriented instruction. This study concludes that high affective and behavioral readiness does not automatically guarantee conceptual mastery of scientific inquiry. Consequently, content-specific inquiry skills must be treated as a distinct, mandatory dimension within teacher readiness frameworks, supported by strategic institutional allocation of concrete instructional aids and targeted professional workshops.


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## INTRODUCTION

Scientific literacy plays a crucial role in preparing students to apply knowledge, solve problems and make sustainable decisions in the global era. However, according to the 2022 PISA assessment reveals that Indonesian students generally perform at low-level cognitive abilities, only being able to interpret simple scientific data and phenomena (OECD, 2023). Textbook- and teacher-centered learning is blamed for this. Consequently, students tend to have misconceptions about scientific concepts and are unable to connect basic scientific concepts to actual phenomena (Fuadi, 2020; Widyaningsih et al., 2019). This situation highlights the urgent need for changes in science learning, especially at the elementary school level, which is a crucial phase in establishing the foundation of education. The quality of learning contributes significantly to the development of students' scientific literacy (Syofyan et al., 2025).

Science learning should be viewed as a unified whole, encompassing a body of knowledge, a way of thinking, and a method of investigation (Collete & Chiappetta, as cited in Wayan Suja, 2020). Therefore, science education aims not to saturate students with scientific facts, concepts, or principles, but rather to develop students' skills in identifying problems and finding solutions, prioritizing sustainability (Kemendikbudristek, 2022). Therefore, science learning emphasizes the process of discovery through scientific work skills, thinking habits, and developing problem-solving abilities. Student engagement is a key requirement in science learning.

Students process knowledge through experience and investigation, ultimately developing their problem-solving abilities and creativity as nurturant effects.

The science learning process in elementary schools requires teachers who are able to provide and manage science learning using approaches and techniques that enable students to experience all elements of science learning: process skills, scientific attitudes, and conceptual mastery. Teachers who possess knowledge and Science Process Skills (SPS) will provide authentic science research experiences that encourage students to think and act like scientists. Teachers' mastery of SPS is part of their professional role (Koomson et al., 2024).

Learning is essentially the process of developing new knowledge, skills, and behaviors in an individual as a result of their interactions with various information and the environment (Juhji & Nuangchalerm, 2020). Therefore, in science learning, the teacher's task is to facilitate the discovery process through learning experiences. Teachers, in addition to being able to convey material well, also help students explore scientific phenomena, facilitate scientific discussions, build cognitive structures, develop skills, and help improve problem-solving skills. Although teaching inquiry-based science requires teachers to spend more time preparing lesson plans and preparing learning tools and materials (Budiastra et al., 2019).

Students are not simply crammed with facts and concepts, but are trained to think critically, ask questions, and consider various possible answers to a problem. This is because science is not static but relative and can be refuted by new discoveries (Semiawan, 1992). Science Process Skills at the basic level provide students with opportunities to acquire exploration skills through observation, classification, interpretation, questioning, communication, and inference (Harlen, 1999; Semiawan, 1992; Samatowa, 2019; Wayan Suja, 2020). Process-based learning (hands-on activities) has been shown to improve science learning outcomes, literacy and thinking skills, and mathematics abilities (K. Ostlund, 1998).

Science Process Skills are scientific activities designed to contextualize knowledge through active student participation, enabling students to develop facts and concepts (Aini et al., 2023; Toyo et al., 2019). Students are equipped to become scientifically and technologically literate through the development of process skills, scientific attitudes, and mastery of essential concepts (Pradiyanasari et al., 2020). Active student involvement will enable students to have a complete, in-depth, and long-lasting understanding (Guido, 2021).

Researchers have conducted two previous studies. The first study showed that only 25% of respondents (elementary school teachers) actively engaged students in science learning. Meanwhile, 55% of teachers still used cognitive tests for assessment (S. Aisah & R.R. Agustini, 2024). The second study found that teachers' understanding of the Nature Of Science (NoS), which consists of products, processes, and attitudes, was still at a poor level (average test score of 46.7). This resulted in a lack of scientific attitudes in students (S. Aisah, 2020). Other studies have shown that even though lesson plans are integrated, implementation in the field is often suboptimal because teachers require more time in theory classes and lack stimulation for students to discover concepts on their own. Teachers tend not to integrate learning concepts with their applications in everyday life (Hidayah et al., 2023).

A number of teachers in Indonesia still do not meet the competency standards stipulated by law, while teacher readiness is influenced by teacher competence (Pribudhiana et al., 2021). Three important elements are essential in assessing teacher quality: 1) learning content demonstrates how to integrate learning with real-life contexts, making learning meaningful. Learning enables students to construct cognitive maps, enabling them to see the relationship between theory and practical events; 2) the learning process fosters student understanding through active creativity in the classroom; and 3) the learning context fosters students' practical skills (Pribudhiana et al., 2021).

Considering the vital role of teachers, teacher readiness, including emotional and attitudinal readiness, cognitive readiness, and behavioral readiness, are important factors in teaching and learning activities. Teacher readiness will influence student readiness, and school readiness influences teacher readiness (Mutiah et al., 2020). Readiness is an individual's ability to perform certain actions, such as learning, interacting with others, and facing new situations (Hurlock, 2017). Readiness is also a condition that enables a person to perform certain actions that can change behavior effectively and efficiently (Mangkunegara, 2000).

The Process-Oriented Guided Inquiry Learning (POGIL) model is an approach designed to enhance content mastery while helping students develop essential skills, such as teamwork, effective communication, information processing, problem-solving, and critical thinking. POGIL emphasizes the principles of constructivism, inquiry, cooperative learning, and the development of process skills. Core characteristics in POGIL emphasize content and process through team learning. Students work collaboratively to develop understanding through critical and analytical questions, discovering and deciding answers to a problem-solving question, reporting, metacognition, and individual responsibility (Hanson, 2013). The activities carried out are guided inquiries, and the teacher acts as a learning facilitator while facilitating student development

(Moog & Spencer, 2009). POGIL consists of three main stages: exploration, concept formation, and application (Samosir, 2022).

POGIL has a significant simultaneous effect on understanding science concepts, process skills, and critical thinking skills (Samosir, 2022; Idul & Caro, 2022). This is because POGIL requires students to construct their own knowledge concepts through exploration, concept formation, and application (RG Purnama & S. Rahayu, 2023). The syntax in the POGIL model makes students active, thus helping them think in a directed manner. Starting from learning to identify problems, exchange ideas in groups, to making hypotheses. POGIL provides opportunities for students to develop information processing skills, communicate and be able to master concepts, theories, principles and apply them in everyday life (Toyo et al., 2019).

Based on the above background, teacher readiness, teacher knowledge of Science Process Skills (SPS), and the implementation of the POGIL model will greatly determine the success of developing Science Process Skills in elementary school students. However, to date, there is a lack of empirical evidence addressing these factors comprehensively; no prior study has simultaneously examined all three variables (teacher readiness, SPS knowledge, and POGIL implementation) specifically at the elementary school level in Bogor Regency. This leaves a significant gap in understanding how these interrelated elements function together in a local primary education context. Teacher readiness is a multidimensional construct that is interrelated. In this study, Teacher Readiness is adapted from Maddox, N. et al. (2000), consisting of emotional and attitudinal readiness, cognitive readiness, and behavioral readiness. A comprehensive understanding of these three dimensions is key to measuring readiness holistically.

## RESEARCH METHODS

This study employs a quantitative descriptive and correlational research design. Descriptive statistics are used to analyze and obtain an overview of teacher readiness variables, teacher knowledge of the SPS, and the implementation of the POGIL model in science learning. Meanwhile, the correlational design is utilized to examine the predictive influence and linear relationship between teacher readiness (independent variable) and their SPS knowledge (dependent variable) through regression analysis.

The population in this study comprises elementary school teachers who teach science in Bogor Regency, Indonesia. A simple random sampling technique was utilized to select the sample from both public and private elementary schools (*Sekolah Dasar*) and Islamic elementary schools (*Madrasah Ibtidaiyah*). Out of the initial responses collected, a final sample of 121 qualified teachers from 14 sub-districts in Bogor Regency was selected based on their suitability with the predefined criteria. The detailed demographic distribution of these participants (academic qualifications, faculty background, and teaching experience) is displayed in Table 2.

Data were gathered using three validated instruments administered digitally via Google Forms: Teacher Readiness Questionnaire: Adapted from the indicators outlined by Maddox et al. (2000), this instrument measures three interconnected dimensions: emotive-attitudinal readiness, cognitive readiness, and behavioral readiness using a 1-to-5 Likert scale. The reliability yielded a Cronbach's Alpha of 0.926 (39 valid items). SPS Knowledge Test consists of 14 valid items with a Cronbach's Alpha reliability value of 0.760. POGIL Implementation Questionnaire: A closed-ended questionnaire used to document the extent to which teachers execute the three main stages of POGIL (exploration, concept formation, and application) along with its preparatory stage (orientation).

**Table 1.** Indicators and Descriptors of Teacher Readiness

| Indicator | Descriptors |
|---|---|
| 1. Emotive-Attitudinal Readiness | Emotionally ready to take responsibility for the learning process that will be implemented |
| | Enthusiasm in preparing and implementing the learning process |
| | Willingness to adapt to pedagogical developments |
| | Comfort and independence in carrying out duties as a teacher |
| | Appreciating the intrinsic value in teaching |
| 2. Cognitive Readiness | Possess the cognitive and critical thinking skills necessary to succeed as a teacher |
| | Be aware of your own strengths and limitations |
| | Easily connect theoretical/conceptual learning with real-world applications |
| | Awareness of personal values and willingness to improve one's capacity |
| | Able to integrate knowledge and skills related to concepts and materials from various disciplines |
| 3. Behavioral Readiness | Willing to work in partnership with colleagues and leaders |
| | Proficient in managing time to achieve goals that are in line with his duties |

## RESULT AND DISCUSSION

A total of 141 teachers completed the Google form, but this was narrowed down to 121. These 121 respondents were selected based on their suitability for the required criteria. The sample consisted of teachers teaching science subjects, either as classroom teachers or science subject teachers. Respondents were teachers from schools across 14 sub-districts in Bogor Regency. Twenty-one of these teachers were pursuing undergraduate degrees, while 99 teachers had a bachelor's degree, and one had a master's degree. Demographic distribution of respondents shown in Table 2.

**Tabel 2.** Demographic Distribution of Respondents

| Aspect | Responden's Profile | Frequency (N = 121) | Percentage (%) |
|---|---|---|---|
| Academic Qualification | Master | 1 | 0.8 |
| | Bachelor | 99 | 81.8 |
| | Undergraduate | 21 | 17.4 |
| Faculty | Science/education | 79 | 65.3 |
| | Other | 42 | 34.7 |
| Experience | < 5 years | 64 | 52.9 |
| | 6 - 10 years | 23 | 19.0 |
| | 11 - 15 years | 8 | 6.6 |
| | 16 - 20 years | 11 | 9.1 |
| | > 20 years | 15 | 12.4 |

This Teacher Readiness Questionnaire uses a Likert scale of 1 to 5 with a total of 39 statements. Based on a maximum score of 195 and a minimum score of 39, a range of 156 was obtained. Researchers categorized the Teacher Readiness variable into 5, so the interval between classes was 31. The results of the Teacher Readiness questionnaire are shown in Table 3.

**Table 3.** Teacher Readiness

| Interval | Category | Frequency | Percentage |
|---|---|---|---|
| 39 – 69 | Very Low | 0 | 0 |
| 70 – 100 | Low | 0 | 0 |
| 101 – 131 | Moderate | 13 | 10,7 |
| 132 – 162 | High | 83 | 68,6 |
| 163 – 195 | Very High | 25 | 20,7 |

The results of the SPS Knowledge test obtained mean test score of 59.61 with a standard deviation of 21.38. From these two scores, five categories were created, as shown in Table 4, which shows the results of the teacher knowledge test on the SPS.

**Table 4.** Results of Teacher Knowledge Test on the SPS

| Standard Category | ValueRange | Category | Frequency | Percentage |
|---|---|---|---|---|
| X < M – 1,5SD | X ≤ 27,5 | Very Low | 14 | 11,6 |
| M – 1,5SD < X < M – 0,5SD | 27,5 < X ≤ 48,9 | Low | 26 | 21,5 |
| M – 0,5SD < X < M + 0,5SD | 48,9 < X ≤ 70,3 | Moderate | 33 | 27,3 |
| M + 0,5SD < X < M + 1,5SD | 70,3 < X ≤ 91,7 | High | 40 | 33,0 |
| M + 1,5SD < X | X > 91,7 | Very High | 8 | 6,6 |

Based on Table 3 and Table 4, Teacher Readiness is in the moderate to very high category, while the results of the SPS test show that 60,4% of teachers are in the category of moderate to very low. In Hafizan's study, teacher overconfidence causes a significant difference between the perception that the teacher has the ability to master SPS and actual knowledge. Hafizan's study shows that in reality, teachers' conceptual knowledge and practical mastery of SPS are still at a simple to low level (Hafizan, et al., 2012). This will significantly hinder teachers in implementing inquiry-based science learning such as the POGIL model. Lack of conceptual knowledge regarding SPS causes teachers to not implement all basic SPS in science learning (N. Hasanah et al., 2020). Teachers significantly influence students' SPS acquisition (Adlaon & Ercillo, 2023). There is a positive correlation between teachers' understanding of SPS, teachers' attitudes towards science, and student achievement (Mumba et al., 2019). Based on teacher's experience, mean score of the Teacher Readiness and the SPS test can be seen in Table 5.

**Table 5.** Mean Score of Teacher Readiness and Teacher SPS Level Based on Teacher's Experience

| Experience | Frequency | Mean of questionnaire score | Category | Mean of test score | Category |
|---|---|---|---|---|---|
| ≥ 20 years | 15 | 155,7 | High | 57,33 | Moderate (12,4%) |
| 16 – 20 years | 11 | 157,6 | High | 72,73 | High (9,0%) |
| 11 – 15 years | 8 | 151,5 | High | 47,50 | Low (6,6%) |
| 6 – 10 years | 23 | 147,5 | High | 62,03 | Moderate (19,0%) |
| ≤ 5 years | 64 | 148,3 | High | 58,54 | Moderate (53,0%) |

Table 5 shows that teacher's experience does not affect the level of Teacher Readiness and the level of SPS Knowledge. Anuar and Tahar's study, which used a sample of 60 teachers teaching at the elementary level, showed that teacher's experience does not have a positive effect on readiness if it is not accompanied by training that can improve teacher knowledge and skills (Anuar & Tahar, 2020). Knowledge and skills are important aspects that support teachers' readiness to implement inquiry-based learning such as POGIL in science learning. Although according to Khery, et al., teachers' readiness is influenced by teacher's experience, this experience is balanced by teacher participation in the "*Guru Penggerak*" program and is also influenced by educational background (Y. Khery et al., 2024). Of the 121 teacher respondents in this study, 42 teachers (34.7%) did not have a background in elementary education or science education, even though they were teachers who taught science subjects. A background other than science education influences the profile of teacher's SPS. The low profile of teacher's SPS results in low student SPS (Setiawan & Sugiyanto, 2020).

To determine whether there is an influence of teacher readiness on mastery of the SPS, a regression analysis test was conducted on both variables. The results of the prerequisite test on the normality test using the One-Sample Kolmogorov-Smirnov Test obtained an Asymp Sig. (2-tailed) value of 0.083 > α (0.05), this indicates that the residual value is normally distributed. Meanwhile, in the linearity test, based on the Anova table, the Sig. value for Linearity is 0.006 < α (0.05), meaning that there is a linear relationship between the two variables. Meanwhile, the Sig. value for Deviation from Linearity is 0.870 > α (0.05), which means that there is no deviation from the straight line so that the relationship is truly linear. With both prerequisite tests fulfilled, it can be continued with linear regression analysis.

**Table 6.** Regression Analysis Test

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .267[a] | .071 | .064 | 3.116 |

a. Predictors: (Constant), Kesiapan

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 88.838 | 1 | 88.838 | 9.147 | .003[b] |
| | Residual | 1155.758 | 119 | 9.712 | | |
| | Total | 1244.595 | 120 | | | |

a. Dependent Variable: KPS

b. Predictors: (Constant), Kesiapan

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Std. Error | Standardized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|---|
| 1 | (Constant) | .489 | 2.809 | | .174 | .862 |
| | Kesiapan | .057 | .019 | .267 | 3.024 | .003 |

a. Dependent Variable: KPS

Based on the Model Summary table, a correlation value of 0.267 was obtained, indicating a low relationship between the two research variables (Sugiyono, 2022). The regression analysis reveals that Teacher Readiness only contributes 7.1% to teachers' SPS knowledge, indicating that the remaining 92.9% is influenced by other variables outside the scope of multidimensional readiness. This low contribution suggests that while emotional, cognitive, and behavioral readiness are essential foundations, they are insufficient on their own to guarantee high conceptual mastery of SPS.

A more dominant factor likely influencing this outcome is the teachers' formal educational background. As shown in the demographic data, 34.7% of the respondents do not possess a background in elementary education or science education. Previous research demonstrates that a non-science educational background significantly limits a teacher's baseline profile and mastery of SPS, which directly correlates with lower student outcomes (Y. Khery et al., 2024). Furthermore, the lack of professional development programs, such as specialized workshops and practical hands-on training, stands out as another crucial factor. This is strongly aligned with the findings from Table 7, where teachers explicitly identified the lack of training as a primary barrier to implementing process-oriented models (Anuar & Tahar, 2020).

Based on the ANOVA table, the output value of Sig. is 0.003 <α (0.05) and the calculated t value is 3.024 > t table 1.658. Therefore, it can be concluded that the regression model can be used to predict the effect of Teacher Readiness on SPS Knowledge. From the Coefficients table, the following regression equation is obtained: Y = 0.489 + 0.057X. The regression coefficient of this equation is positive, indicating that the direction of the influence of Teacher Readiness on SPS Knowledge is positive.

The implementation of the POGIL model was obtained from a closed-ended questionnaire. Teachers responded according to the conditions they had implemented in science learning. Figure 1 shows the number of teachers (%) who had implemented the POGIL stages in the science learning process.

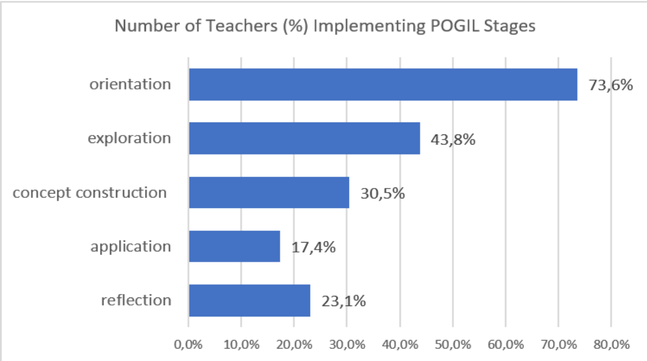


**Figure 1.** Number of Teachers (%) Implementing POGIL Stages in Science Learning

The orientation was carried out by the majority of teachers (73.6%). This stage is a preparatory stage before entering the core stage of POGIL. However, in the core stage of POGIL, the number of teachers who have carried out the exploration is 43.8%. In the concept construction only 30.5% and in the application the number decreases namely 17.4% of the 121 teacher respondents of the study. This means that POGIL has not been implemented by the majority of teachers in science learning. Based on the results of the test of knowledge of SPS (Table 4), 60.4% of teachers are in the category of moderate to very low. Teacher knowledge of SPS contributes to the implementation of POGIL in science learning. Based on the results of the closed questionnaire, only 24% of teachers provide investigation activities and provide cognitive process stimulation that guide students in building conceptual understanding.

In a closed-ended questionnaire, teachers were asked the question: whether the POGIL model could theoretically be applied to elementary science learning despite its practical difficulties. In response, 14% of teachers strongly agreed, 49% agreed, 25% moderately disagreed, and 12% disagreed. Collectively, these responses indicate that 63% of the teachers still experience difficulties in implementing POGIL in science instruction. The specific obstacles identified by the respondents are summarized in Table 7.

**Table 7.** Obstacles in Implementing POGIL Model

| No | Factors | Percentage |
|---|---|---|
| 1 | Limited media/teaching aids/facilities | 29 |
| 2 | Lack of teacher understanding | 19 |
| 3 | Lack of training/workshops | 19 |
| 4 | Large amount of material | 15 |
| 5 | Low teacher motivation/reluctance | 10 |
| 6 | Lack of student interest and motivation | 8 |
| | Total | 100 |

The primary obstacle to implementing the POGIL model in science learning is the limited availability of learning media or science demonstration. This is compounded by the pedagogical challenge regarding teachers' understanding of inquiry-based science, which ideally demands that students actively observe, investigate, and experiment to construct knowledge. Such constraints in facilities and pedagogical understanding represent classic barriers to inquiry-based frameworks (Muin et al., 2025). Furthermore, a lack of targeted professional development workshops restricts teachers' capacity to facilitate scientific investigations. This is crucial since structured teacher training programs are proven to significantly enhance teacher preparedness (Azam et al., 2023; Sarkar et al., 2020). Beyond institutional barriers, low teacher motivation and a reluctance to transition from conventional methods also contribute to the suboptimal implementation of POGIL.

Efficient implementation of inquiry models like POGIL heavily relies on the instructors' competence; science teachers with a profound understanding of Science Process Skills (SPS) are notably more adept at facilitating students' acquisition, development, and application of these skills during classroom activities. Consequently, a mastery of SPS by educators is foundational to delivering effective, efficient, and high-quality science education across all academic levels (Mushani, 2022). Therefore, teacher education programs must prioritize practical experiences that facilitate various scientific process skills rather than focusing solely on theoretical concepts (Ferreira et al., 2025). Ultimately, higher-order thinking skills cannot be taught directly; they must be cultivated through active practice within the learning process, positioning instructional quality as a decisive factor. The ultimate success of science instruction inherently depends on the strategic pedagogical choices made by teachers in the classroom (Wazni & Fatmawati, 2022).

## CONCLUSION

This study concludes that while elementary school science teachers possess "good" overall readiness, their actual mastery of Science Process Skills (SPS) is deficient, with 33.1% scoring in the low and very low categories. Regression analysis reveals that Teacher Readiness contributes a positive but low 7.1% to SPS Knowledge, and teaching experience shows no significant impact. Furthermore, POGIL implementation; 73.6% of teachers only reach the orientation stage, dropping drastically to 17.4% in the core application phase. The primary barriers preventing full implementation are limited science learning media (29%) and a lack of training in the form of direct practice of learning models that emphasize process skills (19%).

Theoretically, these findings imply that high affective/behavioral readiness does not automatically guarantee conceptual mastery of scientific inquiry; specific content-knowledge like SPS must be treated as a distinct, mandatory dimension within teacher readiness frameworks. Practically, this study underscores the urgent need for school to prioritize concrete science learning aids. Educational stakeholders prepare guidelines for inquiry-based practical learning and workshops to hands-on training that simulates core POGIL syntax.

This study is limited by its specific sample of 121 elementary teachers across 14 sub-districts in Bogor Regency. Future research needs to expand the geographic scope to diverse educational districts, and explicitly evaluate the impact of teachers' diverse academic backgrounds (science vs. non-science faculties) on their ability to adopt process-oriented models.

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