



Gendered Participation in Elementary Science Learning: Understanding Stereotypes and Lived Experiences

Fitria Khusnul Khotimah¹, Welius Purbonuswanto^{1*}

¹ Universitas Sarjanawiyata Tamansiswa, Indonesia.

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Corresponding Author:
Welius Purbonuswanto
zaldimarta44@gmail.com

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Abstract: In many elementary classrooms, boys and girls often engage in natural science in different ways. This study explores how students, teachers, and parents perceive these differences in South Klaten, Klaten, Central Java through a qualitative phenomenological approach. Data were gathered through interviews, participant observation, and student journals involving 30 students, 10 teachers, and 10 parents. The findings show the common view that girls tend to prefer biological topics that involve patience and verbal explanation, while boys are more drawn to experiments and physical science tasks. Thematic analysis identified three key points: differences in the understanding of science concepts based on gender, the influence of gender stereotypes on motivation and participation, and the role of the social and cultural environment in shaping students' views of science. The study concludes that perceived gaps in science learning reflect social construction rather than innate ability and encourages classroom strategies that reduce stereotype reinforcement and expand opportunities for participation.

Keywords: Elementary school; Gender differences; Gender stereotypes; Local culture; Understanding of science concepts

Introduction

Gender-based disparities in science learning have emerged as a recurring concern in Indonesian primary education because they influence confidence, participation patterns, and long-term access to STEM. Domestic evidence repeatedly shows patterned differentiation: girls are associated with verbal or theoretical fluency while boys are positioned toward experimentation and tool-based manipulation (Novanto et al., 2023; Putra, 2018; Sari et al., 2021). This tendency corresponds with earlier work that identified male privilege in practical physics tasks and girls' preference for ecological-reasoning formats (Yunas et al., 2018). Classroom norms reinforce the pattern: boys operate apparatus and perform demonstrations, while girls are assigned supporting or clerical labor (Fajri et al., 2024; Kristiyasari et al., 2018; Todorović et al., 2023).

These behavioural differences also materialize as emotional asymmetry. District-level monitoring reports declining confidence among female students during

physics and biology demonstrations (Prahmana et al., 2021; Rejeki et al., 2025; Tamba et al., 2021). Interviews from Surakarta and Bandung further show that public error in physics triggers self-monitoring and withdrawal among girls (Kasmiasi, 2024; Permatasari et al., 2017; Sriwarthini et al., 2023). Aceh and Makassar studies connect these reactions to family expectations, gendered labour, and stereotype policing (Azis et al., 2018; Hasni, 2024). Meanwhile, curriculum bias can magnify the inequality: Surabaya and North Sumatra evidence indicates textbook and teacher preference reinforcing male spatial reasoning and female accuracy-based assignments (Damanik et al., 2023; Muhammad et al., 2017; Putra, 2018; Tamba et al., 2021).

A second stream of domestic research examines performance patterns. Yogyakarta and Central Java suggest male dominance in physics manipulation and higher female performance in ecological reasoning (Maulidah et al., 2021; Paidi et al., 2020; Sari et al., 2021). Surabaya and Denpasar indicate that data-based assignments reward female neatness and perseverance

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(Putra, 2018; Todorović et al., 2023). Project-based approaches temporarily equalize participation in Bandung and Malang (Liccardo et al., 2025; Permatasari et al., 2017), and cooperative learning expands space for girls discourse in Aceh (Hasni, 2024). Yet a persistent theme remains: female anxiety intensifies when experimentation becomes public, apparatus-based, or error-exposed (Prahmana et al., 2021; Rejeki et al., 2025; Sriwarthini et al., 2023).

Global findings mirror this pattern. U.S. studies show elementary-level girls performing well in biological reasoning but withdrawing under stereotype pressure in physics (Jones, 2021; Sagala et al., 2019). Korean and Japanese evidence underlines patriarchal instructional framing and masculinisation of robotics and technical innovation (Lee, 2022; Tanaka, 2022). Chinese and Indian studies associate stereotype threat with motivational paralysis during scientific risk-taking (Chen et al., 2023; Gupta, 2020). Vietnamese and Mexican studies emphasize parental endorsement as decisive for girls' confidence (Martínez et al., 2020; Nguyen, 2023). European and Australian work suggests that inclusive curricula enhance scientific self-efficacy and ethical reasoning for girls (Brownlee et al., 2022; Kim, 2021; Martinez, 2022; Rossi, 2023; Silva, 2020).

Across all contexts, affect mediates participation. Studies in Java highlight stereotype-based speech inhibition, emotional caution, and perceived illegitimacy of girls classroom talk (Sriwarthini et al., 2023; Widodo et al., 2024). Rural cases in Bandung and Malang show cooperative learning neutralising gendered power temporarily, although the mechanism is unclear (Nugraha, 2022; Lestari, 2021). Meanwhile, imagery analysis in Indonesian science textbooks shows that masculine visual metaphors secure normative scientific identity (Dewi, 2020)

Despite this large body of work, critical gaps remain. Most domestic studies are urban, leaving rural Central Java under-analyzed. Nearly all research quantifies performance rather than exploring lived experience. No prior study triangulates children, teachers, and parents to examine how confidence, permission, anxiety, and speech regulation interact. Although some mention Javanese culture, none explain how politeness codes, agricultural labour, or emotional sanctioning regulate scientific participation. Prior interventions rely heavily on structured experiments rather than meaning-making. These omissions justify a qualitative turn.

The present research adopts phenomenological design in rural Central Java to interpret how children construct meaning in science activities, how parents and teachers reinforce stereotype expectations, and how risk-taking is negotiated in classroom practice. Classic developmental frameworks from Piaget (1972) and

Vygotsky (1978) remain relevant for explaining cognitive scaffolding during hands-on inquiry, while feminist theory (Tong, 2009) contextualizes stereotype policing. The aim is not measurement, but explanation: how gender operates as an embodied, affective, and cultural experience in science learning.

Method

This study examined elementary school students' subjective experiences of gendered participation in science learning using a qualitative phenomenological approach. This design was selected to capture how social contexts, cultural expectations, and gendered assumptions shape students' meaning-making in science classrooms—an interpretive depth that cannot be obtained through quantitative comparison (Creswell, 2017). The study was conducted over six months (January-June 2024) and relied primarily on interview-based data supported by observation and documentation.

Research Design

The phenomenological design focused on describing the essence of students lived experiences when encountering science learning in gendered classroom situations. Rather than aiming to provide a comprehensive overview of achievement in physics, biology, or chemistry, the design prioritised how participants interpret confidence, hesitation, encouragement, and exclusion during science activities.

Phenomenological reduction guided the analysis by suspending researcher assumptions and concentrating on recurring experiential meanings. The perspectives of students, teachers, and parents were incorporated not for breadth of subject coverage, but to illuminate shared experiences of expectations and participation in science lessons. The emphasis was depth rather than scope, with subjective interpretation and emotional response treated as core analytical units.

Research Location and Subjects

The study was conducted in 19 public elementary schools in South Klaten District. The rural context provides variation in socioeconomic background, which supports exploration of gendered learning experiences in a localized environment. Participants were students in Grades 4-6 (ages 10-12). Purposive sampling sought variation rather than academic stratification, students were selected based on willingness to articulate learning experiences, variation in participation style during science activities, and representation of different gender identities. The sample consisted of 30 students (15 boys and 15 girls) supported by 10 science teachers and 10 parents to enable triangulation.

Data Collection Technique

Primary data were obtained through semi-structured interviews conducted individually and in small groups. Open-ended questions explored emotional and cognitive responses. Participant observation provided approximately 20 hours of immersion in science lessons to record gendered interactions, participation patterns, and verbal expressions. Documentation was gathered from student journals and classroom artefacts to support data triangulation. Collection occurred in iterative phases: initial interviews, confirmatory observations, and follow-up interviews.

Research Instruments

The main tool was an interview guide developed from constructivist and gender theory, covering social (family/teacher impact), affective (motivation and stereotypes), and cognitive (conceptual understanding). Expert review ensured content suitability. A short observation checklist was used only to support descriptive notes on visible participation, not for statistical measurement. Field notes, memo writing, and audio recording supported reflective engagement. NVivo assisted transcription and coding.

Research Procedures

Following ethical approval from local education authorities and a university ethics committee, consent and parental assent were secured. Recruitment involved an initial survey and school liaison. Data collection proceeded through in-depth interviews (45-60 minutes), classroom observations, and triangulation discussions with teachers and parents. Bracketing was conducted prior to interviewing and again during coding through analytic memo writing to minimise assumption-based interpretation. Data collection ceased when thematic saturation prevented the emergence of new experiential meanings.

Data Analysis

The data analysis employed a phenomenological procedure that comprised the following steps: transcription of observation notes and interviews, horizontalization to treat all statements with equal value, reduction into meaning units, clustering meaning units into experiential themes, and essence description

to articulate shared meanings across participants. NVivo assisted in organising text segments and visualising patterns. Interpretation remained iterative, with reflective bracketing accompanying coding and theme development.

Validity and Reliability

Credibility was strengthened through methodological triangulation (interviews, observation, documentation) and source triangulation (parents, teachers, and students). Member checking allowed participants to review emerging themes. An audit trail documented analytical decisions. Bracketing was maintained throughout the research cycle to suspend personal judgement. Thick description supports contextual transferability.

Research Ethics

Ethical safeguards included informed consent, assent for minors, confidentiality, and secure data storage. Participants remained anonymous, and sensitive disclosure such as gender-based exclusion triggered referral to school support services.

Result and Discussion

The findings show that gendered expectations shape how students participate in science lessons rather than indicating inherent differences in scientific ability. Across interviews and observations, boys tended to describe science learning as an opportunity to try things out, whereas girls described science as an activity that required careful verbal explanation or accuracy. These meanings appeared in students’ emotional reactions more than in cognitive outcomes, suggesting that understanding is mediated by confidence, social positioning, and peer judgement.

Theme 1: Differences in Understanding of Science Concepts Based on Gender

To illustrate these experiential patterns, Table 1 presents a descriptive matrix of how boys and girls narrated their comfort, hesitation, and positioning when approaching science concepts. The table captures differences in the tone of engagement, where boys often align science with physical action, and girls align it with explanations rather than comparative performance.

Table 1. Comparison of Understanding of Science Concepts Based on Gender

Aspects of experience	Male students (observed meaning)	Female students (observed meaning)	Supporting notes
Engagement with tools/experiments	Show initiative volunteer to handle materials, associate trying with confidence	Prefer assisting, observing or documenting	Boys described “wanting to try first”
Comfort with theoretical science	Shift quickly to action than verbal explanation	More verbal in describing scientific processes and terminology	Girls narrated comfort “explaining slowly”

Aspects of experience	Male students (observed meaning)	Female students (observed meaning)	Supporting notes
Emotional response in science	Treat mistakes as exploration	Express concern about judgement and social teasing	Girls linked mistakes with embarrassment, several journals contain self-doubt statements
Classroom positioning	Expected by peers to lead demonstrations	Expected to support, organise or summarise	Observed teacher instructions reinforced these roles

Theme 2: The Influence of Gender Stereotypes on Motivation and Participation

This theme concerns how gender stereotypes influenced students’ motivation and willingness to speak in science settings. Girls repeatedly described worrying about being wrong or being laughed at,

especially in tasks coded as experiments or demonstrations. Boys narrated experimentation as a form of play and social leadership. Table 2 summarises these experiential meanings, showing that internalised messages guide participation more than test-based achievement.

Table 2. Influence of Stereotypes on Motivation and Participation

Stereotype	Male Students (motivation & participation)	Female students (motivation & participation)	Data source
Experience of exclusion or discriminatory comments	Mentioned by 2 students who described teasing as normal	Mentioned by 10 students who described teasing as discouraging	Interview
Willingness to speak in group discussions	Mentioned by 11 students narrated speaking without waiting to be invited	Mentioned by 5 girls described waiting to be called before speaking	Observation
Negative stereotype themes in journals	Twice occurrences in boys’ journals	Nine times across girls’ journals	Journal analysis

Theme 3: The Role of Social and Cultural Environment in the Formation of Understanding

This theme highlights how family routines and cultural expectations inform students’ views of science learning. Rather than improving or limiting conceptual

mastery, cultural narratives influenced who felt entitled to act and who felt obligated to support. Table 3 shows examples of how parental guidance, household labour, and collective norms shape different forms of comfort in learning situations.

Table 3. Influence of social and cultural environment

Environmental factors	Male students	Female students	Impact on science understanding
Family support for experimentation	7 out of 10 parents	3 out of 10 parents	Boys are more encouraged to pursue practical physics
Use of Javanese culture	4 students	8 students	Women are more involved in biology
Family support code in journal	6 times	3 times	Lack of teaching materials for women

Discussion

The discussion connects the findings with relevant theories and prior studies on gender, classroom participation, and science learning in South Klaten. The students’ accounts indicate that participation in science is shaped more by confidence, social permission, and cultural expectations than by differences in cognitive ability. Boys often describe experimentation as a space where errors are acceptable and even playful, while girls express a stronger awareness of being judged during public demonstrations. These patterns suggest that participation is organized by gender expectations.

Constructivist perspectives contribute to the interpretation of these findings. Vygotsky emphasizes that learning emerges through participation and social interaction, which helps explain why boys perceive experimentation as a form of leadership (Vygotsky,

1978). Piaget’s developmental ideas support the way students link comfort to familiar activities (Piaget, 1972). Phenomenology draws attention to the emotional quality of these accounts. Feelings of fear, hesitation, or confidence represent lived meaning. Butler’s concept of gender performativity is relevant here because students perform gender expectations through action (Butler, 1990). Boys perform assertiveness and girls perform caution as part of the everyday routine of classroom interaction more than as an expression of biological tendency.

The findings are consistent with Indonesian and international research. Previous Indonesian studies report that boys receive stronger encouragement for active learning, while girls tend to adopt supportive verbal roles (Sari et al., 2020; Lee, 2022). This study contributes a rural Central Javanese setting where family

labour patterns, politeness norms, and community cooperation influence how children position themselves in science. Parental encouragement for boys to handle tools in agricultural work can reinforce a sense of entitlement to experimentation. Girls, in contrast, receive messages that link precision, neatness, and avoidance of mistakes with feminine behaviour. These findings align with literature suggesting that ecological background shapes comfort in particular scientific domains (Wulandari et al., 2021; Nguyen, 2023).

Motivational interpretations can be viewed through self-determination theory. Girls' narratives in this study indicate that limited autonomy, waiting for approval before speaking, apologising before contributing, or withdrawing from demonstrations can reduce intrinsic motivation. Boys experience autonomy as permission to act, which is consistent with studies showing that social endorsement increases exploratory behaviour in scientific tasks (Chen et al., 2023).

From an instructional perspective, the patterns identified in students' narratives point to several classroom adjustments. Teachers can reduce stereotype-based gatekeeping by distributing practical roles more evenly, providing emotional safety for errors, and avoiding the practice of assigning girls to supportive functions. Research on gender-responsive pedagogy recommends counter stereotype modelling, structured turn taking in group work, and the use of classroom materials that are not framed through binary expectations (Prastyo, 2022). In rural settings, cultural routines such as agricultural activities or cooperative labour can be reframed as shared scientific inquiry rather than as gendered obligation. This approach can encourage wider participation among boys and girls.

Methodologically, the study remains bounded by qualitative scope. The analysis draws from a small purposive sample in a single rural subdistrict and focuses on meanings. Qualitative research does not seek statistical generalisation, and interpretations are co-constructed by the researcher and participants even when bracketing and triangulation are applied. Future studies may examine how beliefs develop across grade levels, conduct closer analyses of classroom discourse, or combine mixed methods to explore how participation changes when classroom climates become more inclusive.

Conclusion

This study shows that gendered experiences in science learning among elementary students in South Klaten arise from differences in confidence, social expectations, and cultural interpretations more than from academic ability. Boys narrated experimentation as a socially acceptable space to act and take risks, while

girls described hesitation, fear of being judged, and limited autonomy when learning was public. Family routines and Javanese norms of caution and politeness reinforced these participation patterns and helped position science as a gendered activity. These qualitative themes support constructionist perspectives because gendered responses to science were formed through interactional norms rather than through innate difference. At the instructional level, the findings encourage teachers to rotate practical roles, offer emotional safety around error, and frame local cultural practices as shared inquiry instead of gendered obligation. The study reflects experiences within a small rural setting and is not intended for statistical generalization, but it identifies participation barriers that future research may examine across grade levels or through mixed methods to inform gender-responsive practice.

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Author Contributions

Research design and development: F.K.K. and W.P.; conceptualization and formulation of the research framework: F.K.K.; methodological design and formal analysis: F.K.K.; software support, data curation, and visualization: W.P.; data interpretation and manuscript refinement: F.K.K. and W.P.; final approval and assurance of research integrity and accuracy: F.K.K. and W.P.

Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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