



Impact of five-stage teacher training program for teaching with problem-based tasks on mathematics teachers' belief and practice

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Abstract

It is imperative that educators be adequately equipped to develop and execute problem-based tasks (PBT) through a comprehensive teacher training program. The retention of training outcomes among educators remains a challenge for the current teacher training model. This study examines the impact of five-stage teacher training programs on the beliefs and practices of teachers. The program utilized a quasi-experimental design over a six-month period, with a focus on (1) the beliefs of teachers regarding the implementation of PBT and (2) the practices of teachers in utilizing PBT. These variables were evaluated through training worksheets and questionnaires that were distributed both before and after the program. The experimental group consisted of 49 educators, while the control group consisted of 27 educators. The experimental group was involved in the program's five stages: recognizing PBT, analyzing PBT, prototyping PBT, implementing PBT, and evaluating PBT. Comprehensive interviews were conducted with nine teachers at the conclusion of the program to evaluate the program's impact on their ability to devise and implement PBT. The questionnaire was completed voluntarily by the control group, which did not participate in the program. The significance of differences in teacher beliefs was evaluated using the Mann-Whitney U test. The research results revealed significant discrepancies between the experimental and control groups in two aspects: the characteristics of PBT and the belief in its implementation in classroom instruction. The research also underscored the discrepancies in task design between the novice teacher and the senior teacher.

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Introduction

The teacher training program is a crucial element in

improving the quality of education and is essential in forming the beliefs and practices of teaching educators (Avalos, 2011; Korthagen et al., 2006). The teacher

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training program must enhance the quality of education and alter the attitudes and behaviors of educators. The teacher training program is vital for enhancing educational quality and is fundamental in shaping the ideas and behaviors of educators. The teacher training program must improve educational quality and modify educators' attitudes and behaviors. These programs are essential in equipping instructors with the resources needed to meet the changing demands of modern education, including utilizing problem-based tasks (PBT) (Suryanti et al., 2022). While previous studies have examined the challenges of PBT adoption, limited research has focused on teacher training programs specifically designed to address these challenges, particularly in the context of Indonesia.

PBT is an essential instrument for involving students in the resolution of real-world issues through collaborative and active learning strategies. Research suggests that educators often face challenges in the effective execution of instructional strategies due to inadequate practical skills and a deficiency in confidence regarding the methodology (Ertmer & Glazewski, 2015; Hmelo-Silver, 2004). Ertmer and Glazewski (2015) discovered that, notwithstanding their training, numerous educators demonstrated a deficiency in confidence when implementing PBT within their classrooms. Hmelo-Silver (2004) observed that the beliefs and instructional methods of educators are shaped by their experiences and understanding of PBT, potentially hindering the successful application of this educational strategy. This research assesses a carefully designed five-step (recognition, analysis, prototyping, implementation, and evaluation) PBT training program aimed at enhancing educators' skills and reinforcing their confidence in the proficient application of PBT. This five-step PBT teacher training program is essential as it offers a systematic and incremental framework that fosters both theoretical comprehension and practical implementation, enabling educators to progressively cultivate their confidence and proficiency in effectively applying PBT within their classrooms. This study investigates secondary mathematics educators in Indonesia, a group that often faces unique challenges arising from limited resources and insufficient opportunities for professional growth.

Literature Review

Teacher belief and practice of PBT

Teachers hold beliefs concerning the student

learning process, teaching objectives, and their role in the classroom, significantly shaping their instructional approach. Extensive research has demonstrated that teachers' instructional practices are notably influenced by their beliefs and principles regarding teaching and learning (Basckin et al., 2021; Dong et al., 2020; Ertmer et al., 2012; Reichert et al., 2021; Suryanti et al., 2022). For instance, educators who endorse that students effectively acquire knowledge through direct experience and exploration are predisposed to employ problem-based teaching strategies (Ertmer et al., 2012). The teacher's beliefs wield considerable influence over the application of problem-based teaching practices. However, it is imperative to consider additional factors, such as a teacher's inherent inclination toward traditional teaching methods, which may impede the adoption of problem-based tasks (Suryanti et al., 2022).

Teachers who want to apply new teaching strategies, such PBT, and overcome opposition to change must be well-prepared. Administrative problems and classroom management related concerns could aggravate the inclination to apply traditional teaching strategies. To change these habits, teachers need ongoing, thorough training that combines theoretical involvement with critical thought. Effective use of PBT depends on an atmosphere marked by openness and continuous support, which consists of peer cooperation and mentoring. The research done by Sullivan et al. (2015) is a shining example of good professional development applied in line with PBT. Teachers in this study took part in planned professional development courses giving reflective practices and group planning top priority. They created thorough mathematical goals and shared their knowledge on their application in the classroom environment. This joint approach boosted instructional methodologies and confidence in the facilitation of PBT, hence increasing student involvement and better learning results.

Design for the Five-Stages Teacher Training Program

The standard critique of professional development research emphasizes the need for clearer structure and substance. The study explores professional development programs, incorporating Theory of Mind (TOM) and Self-Determination Theory (SDT) concepts, which are essential components for high-quality development. Combining these ideas improves deep learning and long-term teaching practices. Research has demonstrated that combining these ideas improves deep learning and long-term changes in teaching practices (Desimone, 2009; Mezirow, 2018). Here, we outline the substance

and sequence of activities for each phase of professional growth.

Phase I (recognizing mathematical tasks). The initial stage of PBT involves selecting mathematical tasks that align with students' cognitive development and learning needs. Teachers analyze various activities to determine their effectiveness in fostering problem-solving skills and conceptual understanding. This phase emphasizes designing tasks that gradually increase in complexity, ensuring students build confidence while engaging in meaningful mathematical thinking (Wellman, 2011).

Phase II: Analyzing tasks. The task analysis phases are components of the cognitive task analysis (CTA) theory, which gained popularity through the works of (Cooke, 1994; Chipman et al., 2000). These stages aim to outline strategies for elucidating the cognitive structures and processes involved in performing a task. At this step, the teacher must examine five different sorts of tasks. Below is an example of an assignment evaluated by the teacher (Figure 1)

Stage III, In this stage, prototype tasks are executed, followed by the formulation of a Problem-Based Task (PBT) framework. Teachers collaborate to analyze outcomes, assess challenges, and develop support strategies, ensuring alignment with school curriculum.

Stage IV, teachers implement PBT activities, focusing on acquiring and executing design knowledge. They identify requirements, resources, and evaluate plans. They use Brown's (2004) taxonomy to assess standards and adapt questions. Observations focus on implementing PBT in educational institutions, with a shift towards documentation.

Stage V (Reflecting). This research incorporates Jay & Johnson (2002) typology, which combines the ideas of Dewey (1933) and Schön (1983), categorizing

professional development programs into three stages: problem identification, examination from various perspectives, and evaluation. This research, conducted through a focus group discussion, aims to develop a novel viewpoint on PBT. Research Question (RQ):

RQ 1: Does a meaningful teacher training program impact teachers' beliefs about PBT?

RQ 2: Is there an impact of meaningful teacher training programs on teacher's practice of PBT?

Methodology

Design

The professional development initiative took place in East Java province from July to December 2023 to align with Indonesia's national policy requiring the implementation of a problem-based learning (PBL) approach. Despite this policy, numerous educators encounter difficulties in the design and implementation of project-based learning in their instruction. The program was implemented in two districts: Gresik and Jember, to address this gap. Teachers participating in this optional professional development program 49 teachers—25 from Gresik and 24 from Jember—participated in a thorough training program spanning five separate phases: recognizing, analyzing, prototyping, implementing, and evaluating instruction based on Project-Based Learning (PBL). The control group comprised 27 educators from Gresik who did not participate in direct training; instead, they were provided with general guidelines for the development of performance-based assessments across five mathematical domains: algebra, geometry,

PBT	Straight forward tasks
Rectangle ABCD has a length of 15 cm and a width of 8 cm. Draw any quadrilateral that has the same perimeter as the rectangle Check the area of the quadrilateral that you produced Compare the area of the quadrilateral that you produced with the area of the rectangle ABCD; what do you get? Check the shape of the objects produced; which has the most significant area?	Rectangle ABCD has a length of 15 cm and a width of 8 cm. Find the length of the diagonal BD
Instruction for teacher: Identify the two types of tasks regarding: The scope of Geometry that can be learned by students when completing tasks Prerequisite knowledge needed by students to complete tasks The possibility of students' difficulties in completing tasks Alternative scaffolding that can be given to overcome these difficulties	

Figure 1 Example task for analysis activity

measurement, statistics, and number theory.

We employed a quasi-experimental design that incorporated a non-equivalent control group to ensure comparability between the groups. Instructors having past knowledge of PBL ideas who showed a readiness to engage were sought using the purposive sampling technique. Although randomization was not practical given the voluntary character of the program, matching methods were used to ensure that both groups displayed similar teaching backgrounds, years of experience, and subject matter competence. In order to control for extraneous variables, both groups administered the Teacher Belief and Practice questionnaire both prior to and subsequent to the program, thereby evaluating any alterations in their instructional beliefs and practices. Data triangulation was conducted through classroom observations and teacher interviews to validate the self-reported responses obtained from the questionnaires. The involvement of the Secondary School Curriculum Assistant Team in Gresik, along with the Middle School Curriculum Instructor in Jember, provided structured support for the implementation process, thereby ensuring uniformity across the various research sites.

Participants

The experimental cohort consisted of 25 educators from Gresik Regency and 24 educators from Jember Regency, who were selected through purposive sampling based on their willingness to participate and their experience in the implementation of problem-based tasks (PBT). A total of 49 instructors engaged in a training program comprising five structured phases, which were conducted over a duration of six months: recognition, analysis, prototyping, implementation, and evaluation. Teachers in the control group received direction on the construction of performance-based activities across five mathematical domains: algebra, geometry, measurement, statistics, and number theory even though they were not included within the training program. Encouraging their voluntary engagement in the autonomous design and implementation of PBT, the main author extended formal invitations to 35 mathematics teachers from high schools in Gresik Regency. A total of 27 teachers consented to participate, establishing the independent teacher group. The group autonomously designed and implemented PBT, while collaborating with the first author for guidance and feedback. The purposive sampling method was selected to guarantee that participants possessed prior exposure to PBT concepts and demonstrated motivation to participate

in structured training or independent implementation.

Data Collection

The data collection procedure in the two districts of East Java—Gresik and Jember—spanned a duration of six months, from July to December 2023. Official clearances were sought from local education authorities and school officials and school administrators to guarantee ethical compliance and seamless execution before data collecting. Prior to their involvement in the study, participating educators provided written consent after being informed about its objectives, methodologies, and confidentiality protocols. In order to accommodate the preferences and schedules of the educators, the questionnaire was disseminated both online and in a face-to-face manner. Educators were allotted a week to complete the surveys, accompanied by subsequent reminders disseminated through email and direct communication to mitigate the incidence of incomplete responses. When replies were discovered to be lacking, teachers were contacted to fill in the blanks, therefore maintaining the integrity of the data. To maintain the integrity of the data quality, responses that were unfinished despite several follow-up efforts were not included in the final analysis. Three primary instruments are employed to data collection about teacher belief and practice of PBT:

Teacher belief and practice of PBT's questionnaire

Measurement of Teacher Belief in using PBT: A Statement Comprises 12 statement items, each rated on a scale of 1 to 5, with one representing “Strongly Disagree” and five representing “Strongly Agree.” Five statements measure the statement that measures practice in PBT: 1) Utilizing PBT for learning that facilitates reasoning, 2) Utilizing PBT to establish connections between different representations, 3) Utilizing PBT during practice sessions, and 5) Reflecting on the frequency of PBT usage. The response categories for Scales (2), (4), and (5) are as follows: “Rarely,” “Once or Twice per Semester,” “Once or Twice a Month,” “Once a Week,” and “Almost every lesson.” The percentage of PBT usage is assessed using a 5-point Likert scale to evaluate Scales (1) and (3). The content validity was determined through evaluations performed by three experts in mathematics education, who appraised the clarity and relevance of each item. A preliminary study involving twenty educators was undertaken to enhance the questionnaire and elucidate any potential ambiguities. An exploratory factor analysis (EFA) was performed to ascertain construct validity,

thereby confirming that the items corresponded with the designated dimensions of teacher beliefs and practices. The instrument demonstrated robust internal consistency, as evidenced by Cronbach's alpha reliability coefficients ranging from 0.76 to 0.87.

Assessment checklist of PBT design

This checklist was guided by the PBT framework (Suryanti et al., 2022). Consequently, two primary components are employed to evaluate the PBT designs that the teacher has developed during the training activities. These components are Context (In alignment with the curriculum's learning objectives and student experience (relatedness)) and Task design (Cognitive levels C4, C5, or C6 are indicated by question sentences and Cognitive levels C4, C5, or C6 are indicated by question sentences (Essential questions))

Semi-structure interview

The semi-structured interview aims to investigate the teacher's belief in the design and implementation of PBT. The interview will consist of five questions, including the teacher's rationale for designing PBT (whether to modify or create new tasks), their purpose, and the scaffolding design they implemented for students who could not complete the tasks.

Data Analysis

Teacher Practices and Beliefs Data from the questionnaire was descriptively analyzed using SPSS 32.0. The objective of descriptive analysis is to establish a profile of teachers' beliefs and practices before and after their participation in the training program. The Mann-Whitney U test was then used to evaluate the variations in teacher opinions between the experimental and control groups in order to enable inferential analysis. The non-parametric test was selected since the belief scores fell short of the required normalcy assumptions for parametric tests such as ANOVA. Especially in cases when the data are ordinal or do not follow a normal distribution, the Mann-Whitney U test is a strong statistical tool used to assess the presence of a statistically significant difference between two independent groups. It is therefore especially relevant for the study of Likert scale-based questionnaire responses. The non-parametric character of the dataset makes the Mann-Whitney U test a more suitable option even another analysis. The teacher practice data against PBT is descriptively analyzed qualitatively using the checklist. Furthermore, NVivo

Software was employed to systematically manage, code, and analyze qualitative data from interviews. Additionally, the researcher confirms the descriptive and inferential analysis results by triangulating interview data with quantitative data. This study is subject to certain limitations, notably geographic constraints, as the sample was exclusively comprised of educators from Gresik and Jember. This limitation may affect the generalizability of the findings.

Furthermore, the five-step teacher training program, encompassing the phases of recognition, analysis, prototyping, implementation, and evaluation, facilitated a systematic assessment of each stage's learning development and the effectiveness of teachers. The inquiries and discussions conducted prior to training facilitated an evaluation of educators' initial perceptions of PBT during the recognition phase. Educators engaged in case studies and reflective exercises throughout the analysis phase, during which their analytical abilities were assessed through written reflections and discussions with peers. During the prototype stage, educators developed lesson plans aligned with PBT, which were subsequently evaluated for compliance with PBT guidelines using established rubrics. The implementation phase required teachers to evaluate their lesson plans in actual classroom environments using peer feedback sessions and observations to gauge their effectiveness. To evaluate the development of their ideas and pedagogical strategies over the assessment period, teachers answered post-training questionnaires, interviewed, and practiced self-awareness. This all-encompassing evaluation system methodically tracked teachers' development, therefore encouraging continuous improvement all along the training process.

Results

Subject Characteristics

The experimental and control groups differ in teaching experience. The experimental group consists of 26 teachers (68%) with less than five years of experience, mostly novice educators. In contrast, the control group has a more balanced experience level, with 44 percent having five to ten years of teaching experience, suggesting greater familiarity with various teaching methods. Both groups mainly hold Bachelor's degrees in Mathematics Education (76% in the experimental group and 81% in the control group), ensuring similar academic

backgrounds. These differences in experience may affect how effectively teachers implement PBT. Details are summarized in Table 1.

Impact of Teacher Training Program on Teacher Belief

Significant changes in the teacher's belief in PBT were observed in the experimental group. Figure 2 illustrates the questionnaire results that the participant completed before and after participating in the program. The component "The Most Effective Method of Teaching

Mathematics is to Begin with Simple Problems and Progress to More Complex Ones" demonstrates some consistency among participants. Failure to comply with this requirement may lead to students' loss of confidence and the occurrence of errors. The participant believes that the most effective method of teaching mathematics is to begin with a fundamental problem and progress to more complex ones. This belief is in accordance with the scores of participants who disclosed their beliefs before and after participating in the program (4.5 and 4.3, respectively).

Nevertheless, substantial alterations were observed

Table 1 Characteristics of the experimental group and control group subjects

Charateristics		Experimental group		Control group	
		N	Percentage	N	Percentage
Gender	Male	18	47%	10	37%
	Female	20	53%	17	63%
Educational background	Bachelor in mathematics education	29	76%	22	81%
	Mathematics	9	24%	5	19%
Mathematics teaching experience	Less than five years	26	68%	5	19%
	5 – 10 years	5	13%	12	44%
	10 – 15 years	3	8%	8	30%
	Over 15 years	4	11%	2	7%

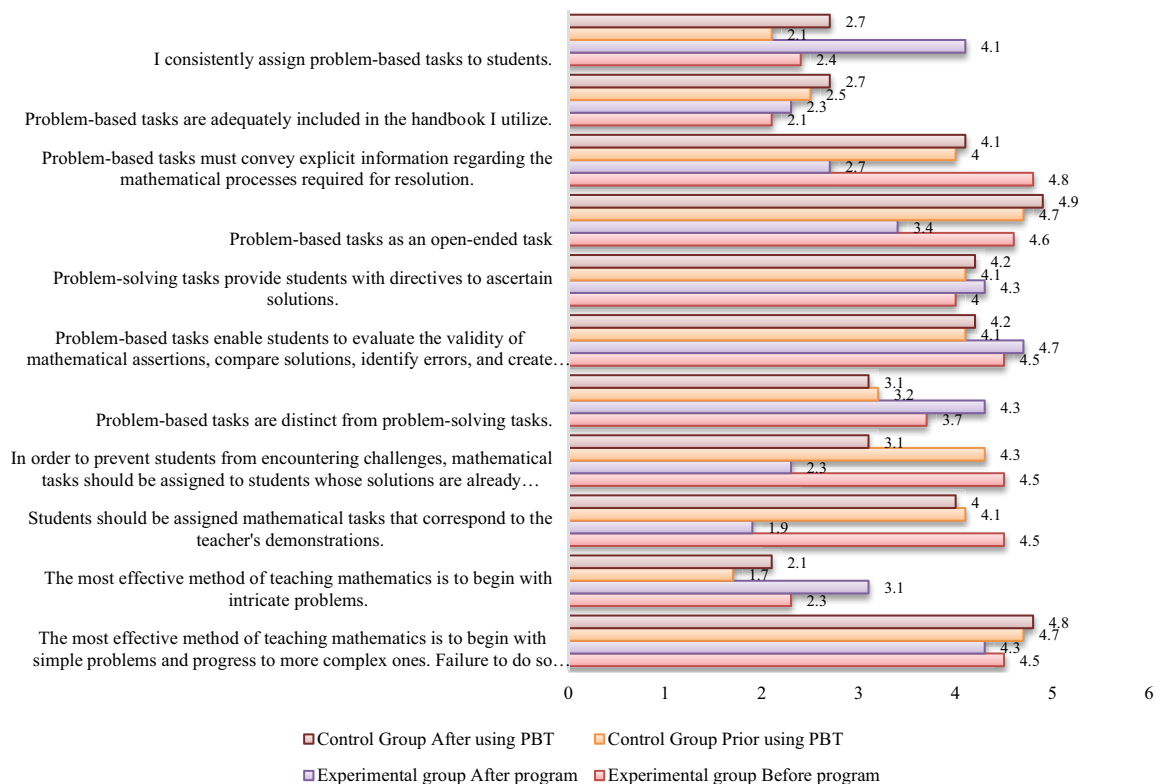


Figure 2 Teacher belief transformation

in other components more closely associated with the implementation of PBT. The conviction that students should be assigned mathematical assignments that correspond to the teacher's demonstrations is one of the most significant changes. Participants in the experimental group generally endorsed this methodology before beginning the program, with an average score of 4.5. This score decreased to 1.9 after the program was completed, indicating a substantial decrease in confidence in the learning characteristics that underpin PBT. The subsequent transition occurs in the PBT characteristic component "problem-based tasks must convey explicit information regarding the mathematical processes required for resolution" before the participant's program tends to concur with a score of 4.8 and then shifts to disagree with a score of 2.3. This change demonstrates a substantial transformation in confidence regarding the characteristics of PBT. Participants in the experimental group exhibited a high level of confidence in a more structured approach, as they tended to believe that PBT must provide clear instructions regarding the mathematical procedure required to solve the problem before the program. Their score of 4.8 indicated this belief. Participants' confidence in consistently using problem-solving strategies in their classes increased after the program, as they realized the importance of experimenting without excessive intervention. They were more self-assured and prepared to integrate PBT into their daily routines, demonstrating a significant decrease in conviction

The control group exhibits some of the same consistency as the experimental group, specifically the component: "The most effective method of teaching mathematics is to begin with simple problems and progress to more complex ones. Failure to do so may result in students making errors and losing confidence." Before the independent learning program on PBT, this belief was firm, with a score of 4.7. It remained consistent after the program, with a minor change to 4.8. This demonstrates that the control and experimental groups continue to maintain the conviction that the gradual approach to mathematics education, which involves the progression from basic to more intricate problems, is the most effective approach for fostering student confidence and minimizing their errors.

Nevertheless, the control group does not exhibit any substantial changes in specific components that contribute to the application of PBT. The control group showed no significant changes in their beliefs or practices regarding PBT. For instance, in the "Problem-Based Tasks must convey explicit information regarding component the

mathematical processes required for resolution" section, they tend to agree with a score of 4, indicating that they continue to believe that the problem-based task must include explicit information about the mathematical process necessary for its resolution. This contrasts with the experimental group, which experienced a substantial increase in confidence in this area following the program.

The control group's beliefs and practices did not alter primarily because they did not receive structured PBT instruction. Without exposure to the program's concepts, these instructors were unable to critically evaluate or improve their current teaching methods. Their dependence on traditional methodologies, along with a lack of professional growth and reflective practice, led to a stagnation in their teaching strategies. Furthermore, the lack of collaborative interactions with peers in the experimental group hampered their ability to gain insight into effective PBT implementation. This reliance on traditional teaching approaches harmed their confidence and capacity to incorporate PBT into their practices, in striking contrast to the experimental group, which displayed a strong commitment to novel teaching methodologies. Additionally, is the control group's uncertainty regarding the consistency of implementing PBT in their classroom. The control group still appears confined to a more conventional teaching approach. Unlike the experimental group, it lacks confidence in incorporating PBT as an essential component of its teaching methods, which demonstrates a higher commitment to following the program.

Different Significance Tests Using Mann Whitney U test

Based on the findings of the descriptive analysis, the results from the Mann-Whitney U test reveal two significant components of belief between the control group and the experimental group. These two components pertain to PBT traits and the conviction to implement PBT in daily instruction. Regarding PBT's attributes, precisely 'Problem-Based Tasks Must Convey Explicit Information Regarding the Mathematical Processes Required for Resolution,' the control group exhibits a greater tendency to concur with elevated scores. In contrast, the experimental group demonstrates notable changes post-training program, resulting in diminished scores. The Mann-Whitney U test ($p < .05$) confirms this difference, suggesting that after the training, teachers in the experimental group increasingly embraced the idea that PBT should encourage student exploration rather than provide explicit instructions. This shift aligns with constructivist learning principles, reinforcing

that effective PBT implementation fosters independent problem-solving. The belief component on the usage of PBT, assessed via the statement ‘I routinely give problem-based activities to study,’ reveals a significant disparity between the two groups. The experimental group exhibited increased confidence in implementing PBT in class post-program, but the control group maintained uncertainty and demonstrated a lower score. The Mann-Whitney U test ($p < .05$) validates this result, indicating that participation in the training program significantly enhanced teachers’ readiness to integrate PBT into their instruction. This finding supports the effectiveness of the five-step training model, demonstrating that structured professional development can positively influence teachers’ beliefs and teaching practices. The test outcomes are displayed in Table 2.

Impact of meaningful teacher training program on teacher task practice

The teachers reported that they rarely applied PBT before participating in the program. Of the five components of Utilising PBT for learning that facilitates reasoning, 2) Utilising PBT to Establish Connections between Differentiation, 3) Utilising PBT During Practice

Sessions, and 4) Utilising PBT to Enhance Individual Learning Usage almost receive an average similar score, which ranges from 2 to 3, which indicates “Once or Twice per semester.” This information is based on the questionnaire. These findings suggest that, despite the theoretical comprehension of the advantages of PBT, its practical application remains restricted. This low average score confirms that PBT is employed infrequently, at most once or twice during a single semester, and is not an essential component of the educator’s instructional approach.

This study investigates the causal relationship between the training program and changes in teachers’ beliefs and practices while also integrating its findings with relevant theoretical frameworks. The training program is founded upon constructivist learning theory, which asserts that educators actively construct knowledge through experiential learning and reflective practice. The five-step training model—comprising recognition, analysis, prototyping, implementation, and evaluation—methodically guides educators from theoretical understanding to practical application. The causal analysis is enhanced through a comparative assessment of the experimental and control groups. The findings of the Mann-Whitney U test indicate significant

Table 2 Test results reflecting varied teacher beliefs experimental and control groups

Component	Group	<i>M</i>	Mann Whitney U test	<i>p</i>
The most effective method of teaching mathematics is to begin with simple problems and progress to more complex ones	Experimental group	4.3	523.00	.121
	Control Group	4.8		
The most effective method of teaching mathematics is to begin with intricate problems.	Experimental group	3.1	476.00	.107
	Control Group	2.1		
Students should be assigned mathematical tasks that correspond to the teacher’s demonstrations.	Experimental group	1.9	643.00	.059
	Control Group	4		
In order to prevent students from encountering challenges, mathematical tasks should be assigned to students whose solutions are already included.	Experimental group	2.3	517.00	.067
	Control Group	3.1		
Problem-based tasks are distinct from problem-solving tasks.	Experimental group	4.3	546.00	.104
	Control Group	3.1		
Problem-based tasks enable students to evaluate the validity of mathematical assertions.	Experimental group	4.7	712.00	.102
	Control Group	4.2		
Problem-solving tasks provide students with directives to ascertain solutions.	Experimental group	4.3	476.00	.107
	Control Group	4.2		
Problem-based tasks as an open-ended task	Experimental group	3.4	643.00	.058
	Control Group	4.9		
Problem-based tasks must convey explicit information.	Experimental group	2.7	487.00	.017
	Control Group	4.1		
Problem-based tasks are adequately included in the handbook I utilize.	Experimental group	2.3	620.00	.104
	Control Group	2.7		
I consistently assign problem-based tasks to students.	Experimental group	4.1	540.00	.004
	Control Group	2.7		

disparities in beliefs and practices, suggesting that structured training interventions may lead to quantifiable alterations. The qualitative interview data elucidate the rationale underlying these changes, demonstrating that educators engaged in hands-on, problem-based activities developed a deeper comprehension of pedagogy and enhanced self-assurance.

Moreover, the teacher adheres to the program for six months and observes its effect on Teacher Task Practice, assessed by the tasks formulated by the teacher throughout the program. The subsequent three PBT samples were created by a teacher group categorized according to teaching experience: the novice teacher group (less than five years), the intermediate teacher group (5–10 years), and the senior teacher group (more than 15 years).

Task design by a novice teacher

An instance of the PBT design created by the novice teacher group is illustrated in [Figure 3](#). This group of novice teachers is proficient in designing PBT according to the established standards. The primary criteria in PBT are the problem setting and the essential question presented to students. The four activities in this PBT fulfill the essential question criteria, promoting students' critical thinking and reasoning skills.

During the discussion and presentation session, the researcher confirmed to the novice teacher group the PBT

A total of six runners have varying finish times. It is widely recognized that the average time for the six runners to reach the finish line is 96 seconds. Therefore,

1. Is it possible for an athlete to travel a distance exceeding 96 seconds?
2. Is it conceivable that the runner who completes the race in the shortest time is less than 90 seconds?
3. Is it possible for a runner to complete the race in exactly 96 seconds?
4. Are the subsequent racers unquestionably champions if the five runners achieve a time of less than 96 seconds?

Please express your answer!

Figure 3 PBT design created by novice teacher

design they created:

"Learning achievements in statistical elements, including being able to understand the average meaning ..., not understand the Bloom version, but understanding the Witghin framework, one of which is predictive, namely, students can predict data if knowing the average of a set of data ..." (NF)

Then, in relation to the reason they tend to select their tasks based on their learning achievements rather than modifying the existing assignment documents:

"The tasks in the school book, almost all of them are routine tasks ..., do not match the learning achievements ..." (ZR)

"From learning achievements ... it is easier to make problem immediately -based assignments as authentic proof of students to achieve learning achievements..." (NF)

Task Design by Intermediate Teacher

[Figure 4](#) illustrates a PBT developed by the intermediate teacher cohort, comprising educators with 5–10 years of teaching experience. This task design also satisfies the PBT requirements. The problem's context aligns with the curriculum. Activities spanning from tasks a) to tasks e), promote critical thinking and student reasoning, while fulfilling the criteria for the essential question.

Teacher groups with this level of competence tend

A craftsman specializing in aquariums receives orders to produce a variety of blocks, each with a volume of 12 liters.

- a. Assist the artisans in creating a feasible design for the aquarium size.
- b. Select the maximum size of the aquarium that you can suggest to the artisans to facilitate the construction of the actual aquarium.
- c. Select the appropriate aquarium size if you possess a fish that measures 8 cm.
- d. Select the most suitable aquarium size if the aquarium is to be placed on a table that measures 50 cm x 30 cm.

Figure 4 Task design by intermediate teacher

to create tasks based on learning outcome rather than modifying the current task documents in the textbook. During the discussion and presentation session, researchers examined the PBT design created by this group of medium teachers.

“This task is designed to practice students’ critical thinking skills, so the questions given must be essential (AA)

“In the first assignment, it starts from a simple one to deliver to the second and third tasks ...” (RR)

“Students require training in literacy and numeracy; problem-based tasks are particularly effective in offering a genuine context for learners...” (NH)

Then, in relation to the reason they tend to select their tasks based on their learning achievements rather than modifying the existing assignment documents:

“The task in the textbook is not challenging...” (NH)

The clarifying results indicates that participants possess a robust foundation in PBT design.

Task Design by Senior Teacher

Figure 5 illustrates the results of the PBT random within the senior teacher cohort. This group of senior teachers tends to create tasks that differ from those designed by novice and intermediate teachers. This PBT design offers a more straightforward framework and delineates its task activities.

The senior teacher group tends to create PBT and modify the tasks included in the textbook. During the discussion and presentation session, the researcher investigated the task:

“Usually in the worksheet students are told to immediately determine which wakes up, by being given pictures ...” (AM)

“This assignment is different; students are directed to find their relationship between two buildings, and then in the second assignment, they will think creatively to

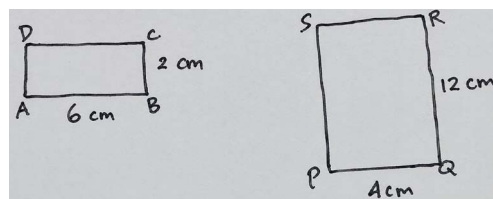
produce other buildings with the same relationship.”

“In the assignment, the third student is challenged to think the opposite ... this will provide much experience to students ...”

Discussion

We have verified that the five-stage training program significantly influences teachers’ beliefs and practices. Initially, the finding indicates that the training program enhances teacher belief in PBT’s characteristics and willingness to implement them. The results of this study are consistent with previous research that illustrates the influence of specialized teacher training on instructional beliefs and practices. Chakraborty and Biswas (2020) demonstrated that well-organized professional development initiatives significantly bolster educators’ confidence and their capacity to implement student-centered learning approaches, such as problem-based tasks. Explicit training in problem-based teaching significantly increases teachers’ capacity to encourage inquiry-based learning, according to the study by Swan et al. (2013). This outcome validates our findings since it shows that the five-stage training program helps teachers to become more confident in the features of PBT and in their capacity to apply these techniques properly. Furthermore, our findings coincide with those of Milner and Scholkmann (2023), which showed that active learning approaches underlined in teacher training programs foster positive opinions on the incorporation of problem-based teaching. The results of (Kraft-Terry & Wiebe, 2022), which show that teachers undergoing PBT training move from direct instruction to guided exploration, match the decrease in the dependability on explicit mathematical instructions. This change makes it easier for students to learn how to solve problems on their own.

Rectangles ABCD and PQRS are provided.



a. Examine the correlation between PQRS rectangles and ABCD rectangles.

Figure 5 Task design by senior teacher

Still, different answers are given to some questions. According to Bosica et al. (2021), training courses help teachers learn a lot more about the theory behind PBT. However, time and institutional limits still make it hard to use PBT consistently in the classroom. This is quite different from our results, in which teachers showed more eagerness to include PBT into their daily teaching strategies. Although professional development improves teachers' opinions, Anderson et al. (2022) noted that its long-term viability depends on constant support and extensive use all over the university. This raises a potential barrier that might compromise the ongoing success of our training program.

Secondly, regarding the disparity among teacher groups in the design of PBT, senior teachers decided to modify existing assignment documents, while second, beginner and intermediate teachers developed tasks based on the desired learning outcomes. The variations in PBT design techniques across teachers with various degrees of experience match the body of evidence on subject matter knowledge (SMK) and pedagogical content knowledge (PCK). Senior teachers' inclination to change current assignment materials instead of creating new problem-based activities is consistent with Hashweh (2005) observations, which show that experienced teachers are prone to draw upon their established pedagogical repertoire, modifying previously used instructional materials to fit new contexts instead of building tasks from the outset. The research conducted by Blömeke, (2024) and Stahnke and Blömeke, (2021) reinforces this trend, suggesting that experienced educators generally prioritize efficiency and practicality in their lesson planning, often depending on established resources rather than pursuing innovative instructional methodologies.

In contrast, the methodology employed by novice and intermediate educators—formulating tasks that are grounded in specified learning outcomes rather than modifying pre-existing assignments—corresponds with research that underscores the significance of teacher creativity in the process of lesson planning. Less experienced teachers, despite their more weak pedagogical content knowledge (PCK), according to Chan and Yung, (2018) show more inclination to adopt creative and student-centered teaching practices. Their eagerness to learn new approaches instead of depending on past teaching experiences drives this attitude. Hennessy (2014) and Wolff et al. (2016) similarly observed that novice educators, despite their limited classroom experience, exhibit a heightened enthusiasm for developing tasks that are congruent with curriculum objectives and the learning requirements of students. This

substantiates our findings that novice and intermediate educators participating in this study exhibited a greater propensity to develop new performance-based tasks (PBT) in alignment with anticipated learning outcomes.

Still, much research shows data that refute this claim by implying that teacher experience by itself does not define instructional creativity. Regardless of teachers' level of experience, Gerhard et al. (2023) showed that the combination of pedagogical content knowledge (PCK) and technical pedagogical knowledge (TPK) significantly influences their instructional decisions. The study revealed that educators possessing a high degree of digital literacy, irrespective of their experience, were more inclined to create original PBT materials instead of merely modifying existing ones. This indicates that elements beyond simple teaching experience, including adeptness with technological resources and participation in professional development concerning curriculum design, may likewise affect the degree to which educators devise innovative problem-based tasks.

Conclusion and Recommendation

Professional development programs that emphasize problem-based tasks substantially positively influence the beliefs and practices of teachers who implement PBT. Recognizing, analyzing, prototyping, implementing, and evaluating were the stages of training that were most effective in enabling instructors to adopt the PBT-based approach. The design process varies between novice, medium, and senior instructors, with senior experience influencing assignment selection. Collaboration between medium and senior instructors is crucial for enhancing task design, incorporating creativity, task analysis expertise, and senior experience in modifying assignments for class context.

Conflict of Interest

The authors declare that there is no conflict of interest.

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