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# A Contextual Project-Based Instructional Design Model Construction and Validation to Develop Students Creativity

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**Abstract**

At SMA Pangudi Luhur St. Yosef Surakarta, students really struggle with showing creativity in math, especially when it comes to the System of Linear Equations in Three Variables. Its kind of a big deal because the way classes are taught, mostly just mechanical stuff, and the topic itself is so abstract, it makes kids get stuck in their thinking, like they cant be flexible or come up with original ideas easily. They have trouble with fluency too, I guess thats part of it. This study was about creating a new way to teach, called Contextual Project-Based Learning model, to fix those issues. It seems like a good fit since it ties math to real life. They used Research and Development method to build it from scratch. To check if it works, they got six experts to validate it, two on instructional design, two on math content, and two practitioners in education. The analysis was quantitative, using Aiken's V index for agreement. The model ended up integrating seven pillars, like constructivism, inquiry, questioning, learning community, modeling, reflection, and authentic assessment, right into the learning steps. The results were pretty solid, with an overall Aiken's V of 0.92, which means very valid. Design got 0.93, content 0.92, and practitioners 0.90. It feels like this high validity shows the model can connect abstract math to everyday reality in a structured way. I think its recommended to use this as an intervention to boost creative thinking in students. Some parts might need tweaking in practice, but overall it looks feasible.

**Keywords:** contextual project-based learning (CoPjBL), mathematical creativity, expert validity.

## 1. Introduction

The demands of 21st century education emphasise the mastery of higher-order thinking skills, with creativity being one of the core competencies that students must possess in order to face global challenges (Rotherham & Willingham, 2010; Trilling & Fadel, 2009). In mathematics learning, creative thinking skills are essential for solving complex and non-routine problems, but the reality in the field shows that these skills are often neglected (Kartikasari et al., 2016; Yuliyanto et al., 2021). Based on observations and preliminary studies at Pangudi Luhur St. Yosef Surakarta High School, particularly in Grade X, it was found that students experienced significant difficulties in understanding the material on Systems of Linear Equations in Three Variables because the learning process tended to be procedural and detached from real-world contexts. (Redish, 1994) states that the cognitive implications in science and mathematics learning require a connection between abstract concepts and students' mental experiences for learning to be meaningful. However, the dominance of conventional methods results in low student engagement and minimal space for creative exploration, thereby weakening students' conceptual understanding (Metaputri & Garminah, 2016; Sari & Harjono, 2016). (Liu et al., 2025) add that without adaptive learning design interventions, the gap between students' abilities and curriculum demands will widen. Therefore, a paradigm shift in learning is needed from teacher-centred to an approach that empowers students to construct their own knowledge (K & Suharto, 1985).

As a solution to this problem, integrating a contextual approach with project-based learning (Contextual Project-Based Learning or CoPjBL) is considered strategic in bridging the abstraction of Systems of Linear Equations in Three Variables material with the reality of students' lives. Contextual learning enables students to connect academic content with the context of their daily lives, which theoretically can increase motivation and knowledge retention (Fazriatun et al., 2023). On the other hand, project-based learning provides a platform for students to apply this knowledge in producing real products through a series of investigations (Totten et al., 1991). (Savin-baden & Major, 2004; Tan, 2003) emphasise that problem- and project-based learning can stimulate higher-order cognitive abilities, including problem solving and creativity. In the context of Systems of Linear Equations in Three Variables material, this model will facilitate students in collaboratively modelling real problems into mathematical equation systems. (Prof. Dr. H. Punaji Setyosari, 2016) emphasises the importance of research and development methods in creating learning strategies that are not only theoretical but also practical. Thus, the application of the CoPjBL model is expected to create a learning environment conducive to the growth and development of student creativity at Pangudi Luhur St. Yosef Surakarta High School.

However, the development of learning models is not sufficient at the implementation level alone; a rigorous construction and validation process is required to ensure the feasibility and effectiveness of the model. Instructional design research requires internal and external validation to ensure that the components of the developed model meet the criteria for content and construct validity (McKenney & Reeves, 2014; Schratz, 2020). According to (Cates, 2011; Pivec & Panko, 2011), a good instructional design model must be built on a solid theoretical foundation and undergo systematic expert testing. (Nieveen, 2007) adds that the quality of educational products is determined by their validity, practicality, and effectiveness. Therefore, this study focuses on the construction and validation of the CoPjBL instructional design model using the Research and Development (R&D) procedure. The validation process involving subject matter experts, design experts, and education practitioners is crucial, as emphasised in the studies by (Hunaidah et al., 2018; Pengembangan, 2023), to produce reliable learning instruments and tools before they are widely applied. This article aims to describe the construction process and validation results of the model to provide a tested framework for developing student creativity.

**Creativity in Learning System of Linear Equations in Three Variables**

Creativity in mathematics is a multidimensional cognitive construct that goes beyond mere routine computational skills, encompassing aspects of fluency, flexibility, and originality in problem solving (Yuliyanto et al., 2021). In the 21st-century skills paradigm, (Rotherham & Willingham, 2010; Trilling & Fadel, 2009) emphasize that students are not only required to “know” mathematical facts, but must also be able to use that knowledge adaptively to create innovative solutions. However, the development of creativity is often hampered by the misconception that mathematics is an exact science with rigid, single procedures, thus closing the space for divergent thinking (Simms, 2016). (Dumont & Willis, 2008) in Torrance’s theory of creativity highlights that without challenges that trigger imagination, students' creative potential will remain latent and undeveloped. Therefore, the urgency of developing creative thinking becomes vital, given its function as the foundation for complex problem-solving skills in the future (Bell, 2010).

The challenges in developing creativity become increasingly apparent and specific in the System of Linear Equations in Three Variables at the secondary school level. This material is highly abstract because it involves the manipulation of variables $x, y,$ and $z$ that often have no direct physical reference in students' minds (Prof. Dr. H. Punaji Setyosari, 2016). Based on (Redish, 1994), students' failure to understand abstract material is often caused by the absence of a “mental bridge” connecting mathematical formalism with their real-world experiences. (Pendidikan et al., 2025) found that students often experience difficulties in the mathematical representation stage, which is converting contextual problems (stories) into appropriate mathematical models. As a result, students tend to mechanically memorize the steps of elimination and substitution without understanding the logic behind them, which automatically disables their ability to find alternative solutions (flexibility) (Metaputri & Garminah, 2016). Without a deep understanding of the concepts as described by (Xing et al., 2025), students will not be able to reach the cognitive level of creating in Bloom's taxonomy.

The problem of abstracting material is exacerbated by the dominance of conventional teacher-centered learning approaches in many schools, including Pangudi Luhur St. Yosef High School in Surakarta. The expository method and routine drilling exercises that are commonly applied often fail to provide a challenging learning environment for the growth and development of wild and creative ideas (Omoniyi et al., 2025; Sari et al., 2017). (K & Suharto, 1985) criticized that monotonous learning strategies cause students to become passive and just wait for instructions, so that the initiative to explore problem-solving strategies becomes minimal. In these conditions, students become accustomed to well-structured questions that have one correct answer, even though creativity actually develops through ill-structured questions that are open-ended and complex (Tan, 2003).

The gap between the ideal demands of creativity and the reality System of Linear Equations in Three Variables learning creates an urgency to reconstruct the learning design. Table 1 below illustrates the significant differences between current learning conditions and the learning characteristics needed to facilitate creativity. If this gap is not addressed through valid model interventions, such as Contextual Project-Based Learning, students' higher-order thinking skills will continue to lag behind (Fazriatun et al., 2023). (Kartikasari et al., 2016) emphasize that it is necessary to construct a learning design model that is deliberately designed to validate students' creative thinking processes through expert and practitioner validation. Thus, overcoming the challenge of creativity in System of Linear Equations in Three Variables is not just a matter of changing teaching methods, but transforming the learning ecosystem from knowledge reproduction to creative idea production.

**Table 1.**
*Shift in Learning Paradigm*

| Componen | Conventional Learning (Current Situation) | Contextual Project-Based Learning Model (Development Target) |
|---|---|---|
| Characteristics of Material | Abstract, symbolic, and focused on algorithmic procedures (elimination/substitution). | Concrete, applicable, and focused on mathematical modeling of real-world problems. |
| Learning Approach | Teacher-Centered: Teachers dominate knowledge transfer (expository). | Student-Centered: Students actively construct knowledge through investigation. |
| Project Design | None/Minimal: Limited to solving routine story problems in workbooks. | Authentic: Collaborative projects solve environmental/social problems. |
| Learning Context | Textual: Isolated within the classroom and textbooks. | Contextual: Connected to students' daily lives and experiences. |
| Teacher Role | Instructor: Provider of material and evaluator of correct/incorrect answers. | Facilitator & Partner: Guides the inquiry process and encourages students' creative ideas. |

## The Contextual Project-Based Learning Model

The Contextual Project-Based Learning (CoPjBL) model is an integrative pedagogical intervention that synthesizes the principles of Contextual Teaching and Learning (CTL) with Project-Based Learning (PjBL) to overcome the weaknesses of conventional learning. The philosophical basis of this model is rooted in social constructivism theory, in which knowledge is not transferred passively, but is actively constructed by students through interaction with real social and physical environments (Prof. Dr. H. Punaji Setyosari, 2016; Trilling & Fadel, 2009). Within the CoPjBL framework, the contextual component serves to build meaningfulness by linking academic material to students' real-world situations, as emphasized by (Johnson, 2002) to strengthen long-term memory retention. Meanwhile, the project component provides an operational vehicle for students to investigate the problem in depth and produce tangible products as representations of their understanding (Thomas, 2000). The synergy of these two approaches is considered strategic in developing 21st-century skills, particularly creativity, as it requires students to navigate complex and open-ended (ill-structured) problems (Bell, 2010; Rotherham & Willingham, 2010). Thus, CoPjBL is not merely a combination of methods, but rather a learning ecosystem designed to transform students from recipients of information into creators of knowledge.

Specifically in Systems of Linear Equations in Three Variables mathematics learning, the contextual aspect in CoPjBL plays a vital role as a “cognitive bridge” that overcomes the abstraction of mathematical variables. (Serin, 2019) argue that contextual project-based mathematics learning helps students see the relevance of mathematics in everyday life, which directly increases intrinsic motivation. When students are faced with real-world problems, for example, calculating production costs in local entrepreneurship using Systems of Linear Equations in Three Variables they are forced to engage in mathematical modeling processes that require high-level reasoning (Simms, 2016). (Redish, 1994) mentions that the process of linking mathematical formalism with real-world experiences is key to building a solid and flexible knowledge structure. (Fazriatun et al., 2023) in their research also prove that contextually valid learning tools can significantly reduce student misconceptions. Without a relevant context, Systems of Linear Equations in Three Variables material will only be seen as meaningless symbol manipulation, which hinders the emergence of creative ideas (K & Suharto, 1985).

Furthermore, project elements in CoPjBL serve as the main catalyst for stimulating creativity indicators: fluency, flexibility, and originality through different cognitive processes embedded in each learning phase. In the Inquiry phase, students are engaged in open-ended problem-solving situations that require them to explore data, formulate assumptions, and propose multiple possible solution pathways before determining a final mathematical model. This condition stimulates divergent thinking and supports fluency, defined as the ability to generate numerous relevant ideas in response to a problem (Wallach & Torrance, 1968).

Flexibility is primarily facilitated through collaborative activities within the Learning Community phase. As students discuss and compare various solution strategies, they are encouraged to reconsider their initial approaches and adapt their thinking when encountering alternative perspectives. This aligns with the view of Bereiter and Scardamalia (Bereiter & Scardamalia, 2014) that collaborative discourse enables knowledge building through the refinement and expansion of ideas.

Originality is most strongly developed in the Modeling phase, where students are required to transform their mathematical solutions into self-designed representations or products. Since project-based learning does not limit students to a single correct answer or fixed procedure, students are encouraged to produce novel and meaningful outcomes (Savin-baden & Major, 2004; Tan, 2003). Empirical evidence by Maskur (Maskur et al., 2020) further supports that problem-solving activities in project-based learning environments are positively correlated with improvements in students' mathematical creative thinking skills. Therefore, project design in CoPjBL must ensure sufficient complexity to stimulate creativity, rather than merely engaging students in simple procedural tasks (Asriadi & Istiyono, 2020).

In order for this CoPjBL model to be implemented effectively and accountably, its construction process must undergo rigorous theoretical and empirical validation using research and development (R&D) procedures. An instructional design model must not only be attractive, but must also meet the criteria of content and construct validity as required by instructional design experts (Richey et al., 2010). (Kartikasari et al., 2016) emphasize that internal validation through expert review or the Delphi technique is necessary to ensure logical consistency between the learning syntax and the desired creativity development goals. (McKenney & Reeves, 2014) add that the quality of educational interventions is determined by validity (theoretical feasibility), practicality (applicability), and effectiveness (impact on learning outcomes). The validation instruments developed, as studied by (Pengembangan, 2023), are crucial measuring tools to ensure that the resulting CoPjBL model is truly ready to be implemented to develop student creativity.

The following is Table 2, which summarizes the hypothetical syntax of the CoPjBL Model and its relationship to the development of student creativity indicators.

**Table 2.**
*The Syntactic Relationship between the Model and the Development of Creativity Indicators*

| Phase | CoPjBL Model Syntax | Student Activities in Learning | Indicators of Creativity Developed |
|---|---|---|---|
| 1 | Contextual Stimulation | Observe real phenomena/environmental issues involving three-dimensional variables. | Curiosity & Sensitivity to Problems |
| 2 | Project Design | Design problem-solving strategies and develop team work schedules to model problems into Systems of Linear Equations in Three Variables | Flexibility: Designing various alternative strategies. |
| 3 | Inquiry & Construction | Collect field data, perform mathematical calculations, and develop draft solutions/products. | Fluency: Generating many ideas/supporting data. |
| 4 | Product Creation | Finalizing the mathematical model and solution into a solution-oriented product (report, poster, or prototype). | Originality: Producing unique and new work. |

| | | | |
|---|---|---|---|
| 5 | Evaluation & Reflection | Presenting the results, receiving feedback, and reflecting on the effectiveness of the solution created. | Elaboration: Detailing and refining ideas. |

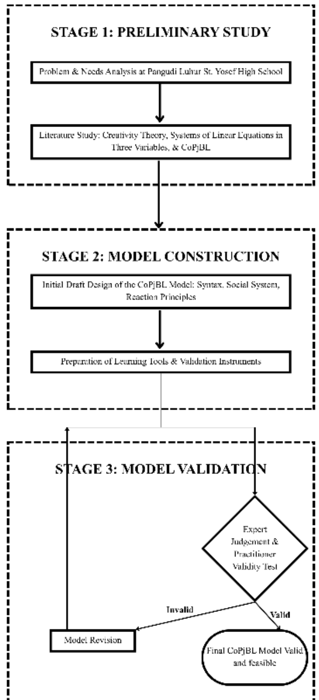
Source: Synthesized and developed from the theories of (Johnson, 2002; Thomas, 2000; Wallach & Torrance, 1968)

## 2. Methods

The proposed model adopted a Research and Development (R&D) approach based on the Borg and Gall procedural model (Gall et al., 2003). The original Borg and Gall model consists of ten systematic steps; however, in this study, the procedure was adapted and condensed to focus specifically on the construction and theoretical validation of the instructional design model. The adapted R&D procedure was organized into three main phases: (1) Preliminary Study, which involved literature review and field analysis to identify instructional needs and creativity gaps; (2) Model Construction, which focused on designing the hypothetical CoPjBL model including its syntax, social system, principles of reaction, and support system; and (3) Model Validation, which involved expert judgment by instructional design experts, subject matter experts, and education practitioners. This adaptation was conducted to ensure feasibility and alignment with the research objectives while maintaining the core principles of the Borg and Gall R&D framework.

The model validation phase employed a structured expert judgment instrument to assess the content and construct validity of the proposed CoPjBL model. The validation instrument was developed in the form of a questionnaire using a five-point Likert scale ranging from 1 (very inappropriate) to 5 (very appropriate). Different validation sheets were designed for each group of experts according to their areas of expertise. Instructional design experts evaluated the theoretical and philosophical rationale of the model, the coherence and sequencing of the learning syntax (seven CTL pillars), the social system and principles of reaction, and the adequacy of the support system. Subject matter experts assessed the accuracy and depth of the mathematical content, contextual relevance, construction of project problems, and clarity of mathematical language and symbols. Education practitioners focused on the practicality of implementation, suitability to student characteristics, clarity of instructional guidance, and feasibility of authentic assessment. The results of expert assessments were analyzed quantitatively using Aiken's V index to determine the validity level of each assessed aspect.

**Figure 1.**
*R&D Research Procedure Flowchart*




## 3. Result and Discussion

### The Challenge of Creativity in Learning System of Linear Equations in Three Variables

Based on preliminary studies conducted in the 10th grade at Pangudi Luhur St. Yosef Surakarta High School, the main findings show that students' mathematical creativity profiles in System of Linear Equations in Three Variables material are still in the low category. This was identified through the results of an initial diagnostic test that measured three main indicators of creativity, namely fluency, flexibility, and originality, in which the majority of students were unable to meet the minimum criteria for creative thinking. Classroom observations show that students tend to be passive and only wait for instructions from the teacher in solving problems, without any initiative to find other alternative solutions. This condition indicates that students' cognitive abilities are still limited to the level of procedural understanding and have not reached the stage of higher-order thinking skills. This empirical fact confirms that there is a serious gap between the curriculum requirements, which expect 4C competencies (critical thinking, creativity, collaboration, communication), and the reality of students' abilities in the field. In line with the opinions of (Rotherham & Willingham, 2010), this skills gap often occurs when learning in schools fails to provide adequate cognitive challenges for students to practice thinking outside the box.

The data collected through initial ability tests among the students has been given in Table 3, which gives a detailed analysis of the students' achievements on the creativity dimensions. From this table, it is apparent that the "Originality" dimension has the smallest achievement percentage, only 35%, which indicates that only a few students are able to provide original, unusual methods or answers. However, the "Flexibility" dimension comes at 42%, establishing that a few students can easily change the method of reaching a solution once they encounter a dead end. On the other hand, the "Fluency" dimension comes at 55%, but this, too, shows that the students lack the ability to generate as many ideas as possible within a given small amount of time. Additionally, a mean class score of only 44 on mathematics learning, as confirmed by the average class score, clearly reveals that the impact of mathematics learning on the creative ability among students has not been successful.

**Table 3.**
*Percentage of Achievement of Student Creativity Indicators (Preliminary Study)*

| No. | Creativity Indicator | Average Score (%) | Category | Field Findings Description |
|---|---|---|---|---|
| 1 | Fluency | 55% | Fair | Students are able to answer routine questions, but have difficulty when asked to come up with more than one solution. |
| 2 | Flexibility | 42% | Poor | Students are fixated on one method (usually the mixed method) and become confused when asked to use the determinant or graph method. |
| 3 | Originality | 35% | Very Poor | Students' answers are uniform, following the teacher's example; almost no students modify the solution steps in their own way. |
| Class Average | | 44% | Less Creative | Dominance of convergent thinking (one correct answer). |

A detailed analysis of the component of fluency of thought shows that students are used to a drilling method of learning or problem-solving mechanically. Research findings from some of the students interviewed reveal students' fear of getting errors when they attempt to give an answer not identical with what is demonstrated on the board by the teacher. Thus, students' flow of thoughts is suppressed as they are more intent on recalling the elimination and substitution method of procedure than grasping the concepts. According to (Wallach & Torrance, 1968), fear of risk-taking acts as a substantial factor for suppressing creative thoughts while in formal schooling. So far as students are presented only with a chance to reproduce what has been equated with knowledge by teachers, students' work memory ability is fully depleted for memorizing whereas actual thoughts are demanded to be generated. Thus, a relaxed and open learning system is required where students' flow of thoughts could run smoothly with no pressure of strict standardization of responses being imposed.

The most crucial problem was found in the aspect of flexibility, where students showed high cognitive rigidity or inflexibility when faced with System of Linear Equations in Three Variables contextual story problems. Students were able to solve systems of equations if they were in a standard form $(ax + by + cz = d)$, but they failed completely when asked to model real-world problems (such as book and pencil price packages) into mathematical form. This finding is in line with the research by (Pendidikan et al., 2025), which highlights the weakness of students' mathematical representation skills due to learning that is detached from context. Students do not have a diverse "toolbox" of strategies; they only have one 'hammer' (memorization method) and consider all problems to be "nails." (Redish, 1994) explains this phenomenon as a failure to build a mental bridge between physical knowledge (real context) and symbolic knowledge (mathematics). Students' inability to view problems from various perspectives is the main obstacle to the development of mental flexibility in mathematics.

Upon analysis of the process of learning in the classroom, the largely dominant role of teachers (teacher-centered classes) is found to be one of the significant factors for the stagnation of creativity among students. In the process of observation of classes, it was found that teachers dominated the class with the explanation of topics and model questions for 70% of the class time, with students merely copying and listening. This mode of teaching is actually effective in covering the whole curriculum, but it is found least effective in developing critical and creative thinking capabilities. This mode of teaching is criticized by (K & Suharto, 1985) because it makes students objects rather than subjects in the process of acquisition of knowledge. Moreover, there are no challenging tasks like group discussions or open problem-solving sessions in the classes. Hence, students are never trained or taught to defend their creative thoughts. In actuality, creativity is found within the context of social interaction and dialectics between students when they are solving problems together.

Secondly, there are methodological issues associated with the abstract content of System of Linear Equations in Three Variables, but there is a more specific difficulty associated with the students in the 10th grade when they are still dealing with the transition from concrete to abstract notions. Many students complain about the fact that they cannot grasp the meanings of the variables $x, y,$ and $z$, they compute and that everything becomes a senseless occupation of writing and rewriting symbols because they don't actually understand the meanings of the computations they make. Without a sound conceptual approach to what the calculations mean, students would never be able to develop or manipulate concepts to originate something novel. As said by (Liu et al., 2025), there is a necessity to relate the mathematics learning to the idea of a situated cognition where students comprehend mathematical ideas within the context of their use and applications in reality. Also, when the teaching of the content presents it in a dry and lifeless context separated from reality and the real use of ideas, the students' intrinsic motivation will collapse, and the creativity will never develop and flourish if it's unrelated and unpassionate about what it's being presented with.

On the basis of the synthesis of the problems identified in the preliminary study (Table 3), there is an urgent need to transform the learning approach from procedural-mechanistic instruction to a contextual project-based learning environment. The low level of fluency identified among students is directly addressed through the Inquiry phase of the CoPjBL syntax, where students are required to explore real-world data, generate multiple assumptions, and propose various solution pathways rather than follow a single predefined procedure. This phase provides structured opportunities for divergent thinking and idea generation (Wallach & Torrance, 1968).

The lack of flexibility, reflected in students' reliance on a single solution method, is targeted through the Learning Community phase. In this phase, collaborative discussions and peer exchanges expose students to alternative strategies, encouraging them to shift perspectives and reconsider their initial approaches, as supported by the knowledge-building framework proposed by Bereiter and Scardamalia (Bereiter & Scardamalia, 2014).

Meanwhile, the low level of originality identified in Table 3 is addressed through the Modeling and Reflection phases. The Modeling phase requires students to transform mathematical solutions into self-designed products or representations, fostering novel and personal expressions of ideas (Savin-baden & Major, 2004; Tan, 2003). The subsequent Reflection phase further strengthens originality by prompting students to evaluate the uniqueness, effectiveness, and limitations of their solutions, thereby encouraging refinement and innovation beyond standard procedural responses. Collectively, these syntactic features confirm that the development of the CoPjBL model is not merely a theoretical response but a targeted pedagogical intervention aligned with the specific creativity challenges identified in this study.

In conclusion, the challenges faced by creativity in System of Linear Equations in Three Variables learning at Pangudi Luhur St. Yosef Surakarta High School are indeed at the system level, involving student cognitive, pedagogic, and item levels. In this discussion, it is recommended that the development of the CoPjBL approach itself must be designed specifically to address the challenges identified in Table 1. The stages involved in the CoPjBL approach need to allow the students to tinker and experiment (fluency), identify real-world problems from different perspectives (flexibility), and produce innovative solution products (originality). In this manner, by transforming the paradigm from "learning about mathematics" to "learning to use mathematics to solve project problems," it is hoped that the creativity potential of the students could be maximized. Indeed, this fits the vision of 21st-century learning as envisioned by (Trilling & Fadel, 2009), wherein schools are envisioned as "incubators of innovation and creativity."

**The CoPjBL Model as a Pedagogical Solution**

A fundamental contribution of this study lies in the structural reconstruction of contextual project-based learning into a coherent instructional design model, referred to as the Contextual Project-Based Learning (CoPjBL) model. Unlike existing contextual PjBL approaches that generally treat Contextual Teaching and Learning (CTL) principles as supplementary strategies, the CoPjBL model elevates the seven CTL components: Constructivism, Inquiry, Questioning, Learning Community, Modeling, Reflection, and Authentic Assessment, into explicit and sequential learning syntax. This transformation shifts CTL from a philosophical orientation into an operational framework that directly guides instructional flow.

The novelty of the CoPjBL model is further reflected in its syntactic structure and sequencing. In contrast to standard PjBL models that often begin with project assignment or problem definition, CoPjBL intentionally positions the Constructivism phase at the initial stage to establish students' cognitive readiness and contextual understanding before engaging in inquiry and project development. This sequence is designed to address the abstract nature of the System of Linear Equations in Three Variables by ensuring that students construct meaningful mental schemata prior to formal problem solving (Johnson, 2002).

Moreover, each phase in the CoPjBL syntax is deliberately aligned with specific creativity indicators, creating a systematic link between learning activities and the development of fluency, flexibility, and originality. This explicit alignment distinguishes CoPjBL from conventional PjBL models, which are often product-oriented and do not clearly articulate how instructional phases support particular dimensions of creativity (Savin-baden & Major, 2004; Tan, 2003). By structuring contextual and project-based elements into a sequenced pedagogical ecosystem, CoPjBL functions not merely as a combination of approaches but as a design-based instructional model aimed at fostering creative mathematical thinking.

The final results of the CoPjBL syntax design are outlined operationally in Table 4, which details the sequential learning phases, corresponding student activities, and the targeted creativity indicators addressed in each phase. Specifically, the syntax begins with Constructivism to build contextual understanding, followed by Inquiry and Questioning phases that engage students in data exploration and idea generation to promote fluency. The Learning Community phase facilitates collaborative discussion and strategy comparison to develop flexibility, while the Modeling phase requires students to create self-designed representations of solutions to foster originality. The final Reflection and Authentic Assessment phases support students in evaluating and refining their ideas, ensuring alignment between learning activities and creativity development. This explicit mapping between syntactic phases, student activities, and creativity indicators ensures that the logical structure of the CoPjBL model can be clearly understood even without immediate reference to the table.

**Table 4.**
*Syntax Model CoPjBL Construction Results and Their Relevance to Creativity*

| Phase | CoPjBL Model Syntax | Learning Activities | Creativity Target Indicators |
|---|---|---|---|
| 1 | Constructivism | Explore real shopping/transaction experiences to develop the concepts of variables $x, y,$ and $z$ | Sensitivity: Build sensitivity to mathematical problems. |
| 2 | Inquiry | Conduct field investigations (e.g., price surveys) to find coefficient data. | Fluency: Streamline the flow of data and idea collection. |

| | | | |
|---|---|---|---|
| 3 | Questioning | Ask critical questions about solution methods (elimination vs. substitution). | Elaboration: Deepening analysis and solution details. |
| 4 | Learning Community | Group discussions to exchange strategies and validate ideas among friends. | Flexibility: Adopting diverse perspectives on solutions. |
| 5 | Modeling | Create a final mathematical model and demonstrate real solution products. | Originality: Creating unique models/products. |
| 6 | Reflection | Analyze the effectiveness of the chosen strategy and the constraints encountered. | Evaluation: Assessing one's own ideas and those of others. |
| 7 | Authentic Assessment | Assess the performance of the inquiry process and the quality of the final project product. | (Measuring creativity holistically) |

The application of the Constructivism and Inquiry phases as the initial foundation of the model has been proven theoretically capable of breaking the deadlock of System of Linear Equations in Three Variables material abstraction. In the Constructivism phase, students are invited to reconstruct their perception that mathematics is a tool for life, not just symbol manipulation, which according to (Redish, 1994) is a vital first step in science and mathematics learning. Furthermore, the Inquiry phase forces students to actively seek primary data in the field, rather than simply accepting ready-made data from practice questions. (Serin, 2019) support this design finding with the argument that real data-based inquiry activities help students visualize complex problem structures. Without this in-depth inquiry phase, students' creativity will be dulled due to the lack of raw material that can be processed into new ideas.

“Questioning, Learning Community, and Modeling” is structured in such a way that it shatters the intellectual isolation that students face in a regular math class. Indeed, the Learning Community phase serves as a proper dialectical environment where students' novice thoughts are acknowledged, arguable, and enlarged collectively, a process that, as claimed by (Pengembangan, 2023), considerably causes Collaborative Critical Thinking. Ultimately, the Modeling phase requires students not only to tackle equations but to represent their answers as unique creations/models or products. As indicated by (Liu et al., 2025), the ability to model through tools/technology stands as the strongest predictor of conceptual comprehension. Therefore, this syntax confirms that the creativity generated comes not from guesswork but a mature process of deliberation.

The validation process for the Contextual Project-Based Learning (CoPjBL) model was conducted comprehensively, involving six validators divided into three groups of expertise to ensure the accuracy of the assessment from various perspectives. The first group consisted of two Instructional Design Experts (Validators 1 & 2) who focused on assessing the structure, syntax, and rationality of the model. The second group consisted of two Mathematics Content Experts

(Validators 3 & 4) who validated the depth System of Linear Equations in Three Variables content and the accuracy of mathematical principles in the project. The third group involved two Education Practitioners or Senior Mathematics Teachers (Validators 5 & 6) to assess the practicality and applicability of the model in real classrooms. The use of multiple raters aims to minimize subjective bias and meet the standards of data triangulation in development research (Kartikasari et al., 2016). Quantitative data was obtained through validation sheets with a Likert scale, which was then converted into Aiken's V (Aiken, 1985) agreement index to determine the validity level of each aspect.

To measure the content validity coefficient of expert assessments, this study used Aiken's V formula. This index was chosen because it is capable of measuring the level of agreement among a group of raters (validators) on specific items of the instrument.

$$V = \frac{\sum s}{n(c-1)}$$

Explanation:
$V =$ Rater agreement index (Aiken Index)
$s = r - l_0$ = Score given by each rater minus the lowest score
$r =$ Score given by the rater/validator (e.g., 1 to 5)
$l_0 =$ Lowest assessment score (e.g., 1)
$n =$ Number of raters/validators (in this study, $n = 6$
$c =$ Number of assessment scale categories selected by raters (e.g., 5 for a 1-5 Likert scale)

The resulting $V$ index value will range from 0 to 1. The closer it is to 1, the higher the level of validity and agreement among validators on the item being assessed. After the $V$ index value is obtained, the result is interpreted to determine the feasibility or validity of the developed CoPjBL model. The following is a score conversion table used as a reference for decision making:

**Table 5.**
*Interpretation Criteria for Aiken's V*

| **Value Interval ($V$)** | **Category Validity** | **Description** |
|---|---|---|
| $0{,}80 < V \leq 1{,}00$ | Highly Valid | The instrument/model can be used without revision or with minor revisions. |
| $0{,}40 < V \leq 0{,}80$ | Sufficiently Valid | The instrument/model can be used with moderate revisions/improvements to certain parts. |
| $V \leq 0{,}40$ | Less Valid | The instrument/model is not suitable for use and requires total revision or replacement of indicators. |

The assessment results from two Instructional Design Experts focused on the feasibility of constructing a model that integrates the seven pillars of Contextual Teaching and Learning

(CTL) into the learning syntax. Table 6 shows that there is a high consistency of assessment between Validator 1 and Validator 2, especially in the “Learning Syntax” aspect. Validator 1 gave an average score of 4.8 (on a scale of 5) and Validator 2 gave a perfect score of 5.0 on the aspect of sequencing the phases from Constructivism to Authentic Assessment. This resulted in an Aiken's V Index of 0.97 on the syntax aspect, indicating that the learning flow was considered very logical and systematic. (Richey et al., 2010) emphasized that high validity in the syntax aspect is a key indicator that a learning design model has a solid framework for achieving instructional objectives. This assessment confirms that the integration of CTL pillars in CoPjBL is not merely an add-on, but an integrated structure. Based on the interpretation criteria presented in Table 5, all Aiken’s V values obtained in Table 6 fall within the “Highly Valid” category $(V > 0.80)$.

**Table 6.**
*Data from Instructional Design Expert Validation (V1 & 2)*

| No. | Assessment Aspect | Average Score of V1 | Average Score of V2 | Aiken’s V Index | Category |
|---|---|---|---|---|---|
| 1 | Theoretical & Philosophical Rationale | 4,7 | 4,8 | 0,94 | Highly Valid |
| 2 | Learning Syntax (7 Pillars) | 4.8 | 5,0 | 0,97 | Highly Valid |
| 3 | Social System & Reaction Principles | 4,6 | 4,7 | 0,92 | Highly Valid |
| 4 | Support System (Guidebook) | 4,5 | 4,6 | 0,90 | Highly Valid |
| | Average Total | 4,65 | 4,78 | 0,93 | Highly Valid |

The second group of validators, namely Mathematics Subject Matter Experts, highlighted the suitability System of Linear Equations in Three Variables content with the project activities designed in the model. Based on the data in Table 7, the “Content Quality” aspect received an excellent rating, with Validator 3 and Validator 4 agreeing to give a high score with a V index of 0.95. Both experts agreed that the Inquiry and Modeling phases in the CoPjBL syntax successfully accommodated the abstract characteristics System of Linear Equations in Three Variables material to make it more concrete. However, there was a slight difference in opinion on the “Question/Problem Construction” aspect, where Validator 3 (score 4.4) tended to be more critical than Validator 4 (score 4.7) regarding the level of difficulty of the questions in the Questioning phase. This input became the basis for important revisions to ensure that trigger questions were not too difficult for students with low abilities. Overall, the high validity of the material ensured that the pedagogical innovation of the model did not sacrifice the mathematical substance that students must master (Serin, 2019).

**Table 7.**
*Data from Mathematics Subject Matter Experts (V 3 & 4)*

| No. | Assessment Aspect | Average Score of V3 | Average Score of V4 | Aiken's V Index | Category |
|---|---|---|---|---|---|
| 1 | Quality of Content | 4,8 | 4,9 | 0,95 | Highly Valid |
| 2 | Relevance to Real Life Context | 4.7 | 4,8 | 0,94 | Highly Valid |
| 3 | Construction of Questions/Project Problems | 4,4 | 4,7 | 0,90 | Highly Valid |
| 4 | Language & Mathematical Symbols | 4,6 | 4,6 | 0,91 | Highly Valid |
| | Average Total | 4,62 | 4,75 | 0,92 | Highly Valid |

The third group of validators provided a field perspective on the feasibility of the model if it were to be implemented within the limited duration of a lesson. The data in Table 3 shows that the "Practicality of Use" aspect received the lowest Aiken's V index compared to other aspects, namely 0.86, although it was still in the highly valid category. Validator 5 gave a score of 4.2 on the aspect of time allocation, highlighting the challenge of completing the Modeling and Reflection phases in one face-to-face meeting. In contrast, the aspect of "Authentic Assessment Instruments" was rated very positively by Validator 6 (score of 4.8), who appreciated the process assessment rubric, which is rarely found in conventional tools. These practitioner validation findings are crucial because, according to (McKenney & Reeves, 2014), an educational product must not only be scientifically (academically) valid but also practical and usable for end users.

**Table 8.**
*Data from Education Practitioners (V 5 & 6)*

| No. | Assessment Aspect | Average Score of V5 | Average Score of V6 | Aiken's V Index | Category |
|---|---|---|---|---|---|
| 1 | Practicality of Model Use | 4,2 | 4,5 | 0,86 | Highly Valid |
| 2 | Suitability to Student Characteristics | 4,5 | 4,6 | 0,90 | Highly Valid |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Clarity of Instructions (Student Worksheets & Teachers) | 4,6 | 4,7 | 0,92 | Highly Valid |
| 4 | Authentic Assessment Instruments | 4,6 | 4,8 | 0,93 | Highly Valid |
| | Average Total | 4,48 | 4,65 | 0,90 | Highly Valid |

In all, the combination of these three validation methods creates a set of extensive yet convincing validation evidence for the CoPjBL model. Altogether, the average value for Aiken's V Index of the six validators is 0.92, which states that this model is "Highly Valid" without any conditions. This model's design validation, with a validation index of 0.93, confirms the conceptual grounds on which the model was based. The one for content validation, with 0.92, confirms the accuracy of its contents, while that of 0.90 for practitioners' validation confirms the practicality of the model. That these validation indexes are consistently above 0.80 for all six validators confirms that all of these measures have a high degree of inter-rater reliability, meaning that all these experts' perceptions of model quality were viewed consistently. These all debunk the impression that, due to its complexity in requiring 7 CTL syntaxes, this model would be difficult to accept or apply. On the contrary, this set of evidence on validation shows that it is actually this complexity that helps users clearly grasp the flow of the model's process of learning.

The high validity in the syntactic aspect (V=0.97) of Design Experts has significant theoretical implications for the development of student creativity. Experts agree that the Constructivism and Questioning phases are critical components that distinguish CoPjBL from the conventional PjBL model. In the validation discussion, Validator 1 emphasized that without an explicit Questioning phase, students tend to perceive project assignments as mere administrative burdens rather than intellectual challenges. With this validation, the CoPjBL model has been proven to be constructively capable of providing the scaffolding students need to achieve fluency and elaboration indicators. (Kartikasari et al., 2016) support this finding by stating that the construct validity of the model is the best predictor of the model's effectiveness in improving higher-order thinking skills.

It becomes highly interesting to observe that the difference in the results of the Subject Matter Experts (SMEs) (0.92) and Practitioners (0.90) on validation reveals that although Subject Matter Experts are very satisfied with the level of content provided, pragmatic comments made by Practitioners on time management testify that the comments made on time management are true and are reflected in the V5 score. It is only this slight deviation that fulfills the gap between idealisms of the academy and the realisms of the classroom. The improvements that emerged when taking notice of the comments made by the practitioners, such as the simplification of the rubric during the Authentic Assessment phase of the CoPjBL, even further heighten the value of the overall CoPjBL modeling. As stated by (Pengembangan, 2023), “Having valid but unusable measures will cause the measures to fail when they are shared with others”. The results of the validation proved that there was equilibrium gained between the rigidity and flexibility of requirements of the Systems of Linear Equations in Three Variables content standards.

Based on the detailed quantitative data presented by the six validators above, it can be concluded that the CoPjBL model meets the criteria for content and construct validity with a rating of very satisfactory. The main strength of this model lies in its systematic syntax and contextually relevant material, as confirmed by Validators 1, 2, 3, and 4. Meanwhile, the notes from Validators 5 and 6 have been accommodated to ensure practical implementation. With a combined Aiken's V Index of 0.92, this model is declared theoretically feasible and ready for empirical testing in the field. This multi-level validation process provides scientific accountability assurance that CoPjBL is not merely a trial and error product, but a measurable educational intervention to develop student creativity.

## 4. Conclusion

On the basis of the findings of the research and development conducted, it has been concluded that the low creativity level profile of students Systems of Linear Equations in Three Variables in the Contextual Project-Based Learning (Co-PjBL) material influenced by the dominant position of the Mechanistic Learning approach could be overcome by the development of the Contextual Project-Based Learning (CoPjBL) model. This new model, which uniquely combined the seven key pillars of the Contextual Approach to the Learning syntax in a very innovative manner, has already been found to be of very high Content and Construct validity with an average value of Aiken's V of 0.92 on an overall assessment by six Validator experts. These results, accordingly, validate the truth of the hypothesis that the developed CoPjBL model not only satisfies the standards of theoretical feasibility and operational practicality but also provides a systematic and pedagogical solution to augment the metamorphosis of the students from passive information Receivers to Adaptive Solution Makers. Hence, the model has been found to be highly Feasible and suitable for application to improve the creative thinking abilities of the students at Pangudi Luhur St. Yosef High School in Surakarta.

## 5. References

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177/0013164485451012

Asriadi, M., & Istiyono, E. (2020). Exploration of Creative Thinking Skills of Students in Physics Learning. *Journal of Educational Science and Technology (EST)*, *6*(2), 151–158. https://doi.org/10.26858/est.v6i2.12737

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Bereiter, C., & Scardamalia, M. (2014). *Bereiter, C. & Scardamalia, M. (2014). Knowledge building and knowledge creation: One concept, two hills to climb. In S. C. Tan, H. J.*

*So, J. Yeo (Eds.)*. 35–52.
Cates, W. M. (2011). Richey, Klein & Tracy: The instructional design knowledge base: theory, research, and practice. *Educational Technology Research and Development*, *59*(5), 737–739. https://doi.org/10.1007/s11423-011-9213-6
Dumont, R., & Willis, J. O. (2008). Torrance Tests of Creative Thinking. *Encyclopedia of Special Education*, 2022–2023. https://doi.org/10.1002/9780470373699.speced2110
Fazriatun, F., Susilawati, S., Taufik, M., & Sutrio, S. (2023). Validitas Perangkat Pembelajaran Model Discovery Learning Berbantuan Video untuk Meningkatkan Pemahaman Konsep Momentum dan Impuls. *Jurnal Ilmiah Profesi Pendidikan*, *8*(1), 376–383. https://doi.org/10.29303/jipp.v8i1.1197
Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational Research: An Introduction*. Allyn and Bacon. https://books.google.co.id/books?id=_rRhQgAACAAJ
Hunaidah, M., Susantini, E., & Wasis, W. (2018). Validitas model pembelajaran CinQASE untuk meningkatkan keterampilan individual critical thinking (INCT) dan collaborative critical thinking (CCT). *Seminar Nasional Fisika*, 1–4.
Johnson, E. B. (2002). *Contextual Teaching and Learning: What It Is and Why It's Here to Stay*. SAGE Publications. https://books.google.co.id/books?id=2HRoigMMdqMC
K, R. N., & Suharto, Y. (1985). *Strategi belajar mengajar*. PT. Bina Aksara, Jakarta. https://books.google.co.id/books?id=UjtinQAACAAJ
Kartikasari, I., Rusdi, M., & Asyhar, R. (2016). Konstruksi dan Validasi Model Desain Pembelajaran Berbasis Masalah untuk Mengembangkan Kreativitas Siswa. *Edu-Sains: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *5*(1). https://doi.org/10.22437/jmpmipa.v5i1.2855
Liu, Z., Xing, W., Ngo, B., Jiao, X., Jiang, S., & Li, C. (2025). Engagement patterns of middle school students with AI teachable agents in mathematics learning. *Scientific Reports*, *15*(1), 1–13. https://doi.org/10.1038/s41598-025-24841-8
Maskur, R., Sumarno, Rahmawati, Y., Pradana, K., Syazali, M., Septian, A., & Palupi, E. K. (2020). The effectiveness of problem based learning and aptitude treatment interaction in improving mathematical creative thinking skills on curriculum 2013. *European Journal of Educational Research*, *9*(1), 375–383. https://doi.org/10.12973/eu-jer.9.1.375
McKenney, S., & Reeves, T. C. (2014). Educational design research. *Handbook of Research on Educational Communications and Technology: Fourth Edition*, 131–140. https://doi.org/10.1007/978-1-4614-3185-5_11
Metaputri, N. K., & Garminah, N. N. (2016). Pengaruh Model Pembelajaran Inkuiri Terbimbing Dan Minat Belajar Terhadap Keterampilan Proses Sains Pada Siswa Kelas Iv Sd. *Jurnal Pendidikan Dan Pengajaran*, *49*(2), 89. https://doi.org/10.23887/jppundiksha.v49i2.9013
Omoniyi, A. A., Jita, L. C., & Jita, T. (2025). Teachers' Experiences with Flipped Classrooms in Senior Secondary Mathematics Instruction. *Computers*, *14*(5), 1–29. https://doi.org/10.3390/computers14050180

Pendidikan, J., Dan, M., Mathematical, I. S., Skills, R., Systems, I. N., Equations, L., Two, I. N., & Stem, T. G. (2025). *THROUGH GEOGEBRA-BASED STEM*. *16*(1), 67–81.

Pengembangan, R. (2023). *Vol 3 No . 2 Tahun 2023 Hal 133 – 151 Lembar Validasi : Instrumen yang Digunakan Untuk Menilai Produk yang Dikembangkan Pada Penelitian Pengembangan Bidang Pendidikan*. *3*(2), 133–151.

Pivec, M., & Panko, M. (2011). Instructional Design. *Social Information Technology*. https://doi.org/10.4018/9781599047744.ch024

Prof. Dr. H. Punaji Setyosari, M. E. (2016). *Metode Penelitian Pendidikan \& Pengembangan*. Prenada Media.

Redish, E. F. (1994). Implications of cognitive studies for teaching physics. *American Journal of Physics*, *62*(9), 796–803. https://doi.org/10.1119/1.17461

Richey, R. C., Klein, J. D., & Tracey, M. W. (2010). *The Instructional Design Knowledge Base: Theory, Research, and Practice*. Taylor \& Francis. https://books.google.co.id/books?id=WaLHBQAAQBAJ

Rotherham, A. J., & Willingham, D. (2010). *21st Century Skills : The Challenges Ahead What Will It Take ? 67*(1), 1–5.

Sari, P. I., Gunawan, G., & Harjono, A. (2017). Penggunaan Discovery Learning Berbantuan Laboratorium Virtual pada Penguasaan Konsep Fisika Siswa. *Jurnal Pendidikan Fisika Dan Teknologi*, *2*(4), 176–182. https://doi.org/10.29303/jpft.v2i4.310

Sari, P. I., & Harjono, A. (2016). *Penggunaan Discovery Learning Berbantuan Laboratorium Virtual pada Penguasaan Konsep Fisika Siswa Abstract-- Discovery learning is a way of teaching that gives students the knowledge to construct a concept discovered through an experiment . The implementa*. *II*(4), 176–182.

Savin-baden, M., & Major, C. H. (2004). *Problem-based Foundation s of Foundations Problem-based Learning*.

Schratz, M. (2020). Voices in educational research: An introduction. In *Qualitative Voices in Educational Research* (pp. 1–6). https://doi.org/10.4324/9781003008064-1

Serin, H. (2019). Project Based Learning in Mathematics Context. *International Journal of Social Sciences & Educational Studies*, *5*(3), 232–236. https://doi.org/10.23918/ijsses.v5i3p232

Simms, V. (2016). Mathematical mindsets: unleashing students' potential through creative math, inspiring messages and innovative teaching. *Research in Mathematics Education*, *18*(3), 317–320. https://doi.org/10.1080/14794802.2016.1237374

Tan, O. (2003). *Berbasis Masalah Sedang belajar Inovasi*.

Thomas, J. . (2000). A review of research on project-based learning. The Autodesk Foundation. *Interdisciplinary Journal of Problem-Based Learning*, *22*(1), 1–18.

Totten, S., Sills, T., Ross, P., & Digby, A. (1991). *Cooperative Learning: A Guide to Research*. Garland.

Trilling, B., & Fadel, C. (2009). 21st Century Skills Learning. *Journal of Sustainable Development Education and Research*, *2*(1), 243.

Wallach, M. A., & Torrance, E. P. (1968). Torrance Tests of Creative Thinking: Norms -- Technical

Manual. *American Educational Research Journal*, *5*(2), 272. https://doi.org/10.2307/1161826

Xing, W., Song, Y., Li, C., Liu, Z., Zhu, W., & Oh, H. (2025). Development of a generative AI-powered teachable agent for middle school mathematics learning: A design-based research study. *British Journal of Educational Technology*. https://api.semanticscholar.org/CorpusID:277907755

Yuliyanto, A., Syaodih, E., Dharmawan, A., Pertiwi, C. K., Muqodas, I., Saputra, D. R., Education, P., Program, S., Pendidikan, U., Teacher, E., Study, E., Indonesia, U. P., Indonesia, U. P., & Timur, J. (2021). *Mathematics creative thinking skills instrument to solve cube and rectangular prism volume problems for elementary school students*. *9*(1), 59–84.