Validity of PBEST Learning Model: An Innovative Learning to Improve Creative Thinking Skill and Entrepreneurial Science Thinking

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Received: August 30, 2023 Accepted: December 22, 2023 Online Published: February 13, 2024

doi:10.5430/jct.v13n1p195 URL: https://doi.org/10.5430/jct.v13n1p195

Abstract

Based on the results of previous studies, evidence was acquired indicating that the creative thinking abilities of pupils in various locations of Indonesia still require improvement. Creative and innovative thinking in science learning integrated with entrepreneurship produces entrepreneurial science thinking. Learning interventions are needed to develop competitive graduates who can face challenges and rapid changes in the 21st century. This research aims to validate the Project Based Entrepreneurial Science Thinking (PBEST) learning model. The educational development research design used is the validation studies design, which tests two criteria, namely testing content validity (which is also called relevance) and construct validity (which is also called consistency). This validation involves three experts in science education, and the validation instrument uses a validation sheet. The research and data analysis indicate that the PBEST learning model consistently produces highly relevant results that meet rigorous validity and reliability standards (with a percentage of agreement ≥ 75%). The PBEST learning model consists of four stages, namely: (1) Observe and thinking project, (2) Design project, (3) Monitoring and evaluation project, (4) Economic value. The validation of the implementation supporting learning tools confirms the validity and reliability of the semester learning plans, lecture program units, student worksheets, student books, creative thinking skill tests, and entrepreneurial science thinking tests. The PBEST learning paradigm is applicable for enhancing both creative thinking skills and entrepreneurial science thinking.

Keywords: PBEST, validity, creative thinking skills, entrepreneurial science thinking

1. Introduction

Students must have 21st century skills in order to adapt to various changes in the future. The 21st century skills encompass a range of abilities, including critical thinking, problem-solving, communication, collaboration, computing, information and communications technology, life skills, cross-cultural understanding, creativity, innovation, social responsibility, cultural awareness, universal awareness, initiative, self-management, entrepreneurship, self-direction, change-transformation leadership, and innovation (Dede, 2010; Ghamrawi et al., 2017; McLoughlin & Lee, 2008; Redecker et al., 2011; Trilling & Fadel, 2009; Wagner, 2010). Creativity is a skill needed to achieve educational goals (Lin & Ying-Wei Wu, 2016; Yang et al., 2016). Proficiency in creativity is advantageous for generating diverse outputs and surmounting intricate challenges posed by intricate social or environmental events (Hargrove, 2013). Learning must create humans who can think creatively (Fazylova & Rusol, 2016). Creativity, also referred to as creative thinking, aims to produce inventive ideas for constructing a novel product, encompassing fresh notions, novel approaches, and innovative systems (Chen et al., 2022).

Based on the Program for International Student Assessment (PISA) results, a research study tested higher and advanced thinking skills, including creative thinking. The ability of Indonesian students is ranked 74 out of 79 participating countries (OECD, 2019). Based on the assessment of student learning outcomes, especially in creative thinking skills, it still needs to be higher. This is also based on the results of research (Florida et al., 2011), which shows that creative thinking skills are low (0.037). Indonesia is positioned at the 81st rank among the 82 developing countries that were examined. Sweden ranks number one in the Creative Thinking Skills Index (0.923). Several research results show the low ability of students to think creatively in several regions in Indonesia (Anazifa & Djukri, 2017; Puspitasari et al., 2019; Retnawati et al., 2018; Schulz & Fitz Patrick, 2016; Subali et al., 2018). The deficient cognitive abilities of students in Indonesia can be attributed to various causes, including curriculum design, instructional approaches, pedagogical strategies, educational paradigms, and individual student traits (Al-Abdali & Al-Balushi, 2016). Existing learning has yet to develop creative thinking skills (Khuziakhmetov & Gorev, 2017; Wulandari et al., 2019).

Creative and innovative thinking in entrepreneurship, which refers to cognitive abilities, produces entrepreneurial thinking (Buang et al., 2009). Entrepreneurial mindset is a crucial ability required in the 21st century to confront a progressively cutthroat global environment. Entrepreneurial thinking can enhance human resources by acquiring cutting-edge knowledge, novel ideas, and robust ethics (Bacigalupo et al., 2016). Entrepreneurial thinking refers to a cognitive state characterized by the pursuit of imaginative and inventive ideas, as well as the identification of novel opportunities (Krueger, 2005).

Creativity is a form of idea in creating a product that differs from other products. Meanwhile, innovation is a form of activity that creates and develops new ideas that did not exist before. Creativity and innovation are two interrelated things, especially in business development. Creativity relates to processes that assist in sparking ideas, while innovation is the practical application of ideas that have been thought. Creative thinking is the raw material, and innovation is the commercial result of creative thinking ideas. A person's creative thinking ability can be improved and developed according to the abilities possessed by the individual (Virdianasari, 2021).

Over the past few years, numerous nations have grappled with the issue of unemployment and the dearth of employment opportunities for their populace. The issue of unemployment has compelled several nations to explore avenues for enabling their populace to engage in self-employment. In light of these conditions, entrepreneurship and entrepreneurship education are currently being incorporated into educational curricula in multiple nations (Devici & Leino, 2018). Students need to have entrepreneurial character. Science lessons can be used to develop entrepreneurial character and shape entrepreneurial science thinking (Syukri et al., 2013). By cultivating an entrepreneurial character, students can change their perspective that after graduating from college, they should be clear about finding a job but have initiatives and innovations to create jobs for themselves and others (Sulistyowati & Salwa, 2016). In Science, Technology and Mathematics (STM) education, what is currently happening has yet to reach its goal of making independent graduates. If introduced in STM education, entrepreneurship education will produce graduates with an entrepreneurial spirit to create independent businesses (Ezeudu et al., 2013).

Several research reports show learning models' effectiveness in instilling scientific thinking, entrepreneurship, and creative thinking skills. Integrating project-based learning with entrepreneurial science thinking can empower students to explore and construct novel ideas, cultivate self-reliance, foster teamwork, and foster the development of creative thinking abilities (Ahmad & Siew, 2022; Alina et al., 2019). Concurrently, multiple research studies have been undertaken to enhance the proficiency of creative thinking abilities. Multiple research findings have been conducted on the efficacy of project-based learning in enhancing creative thinking abilities (Chen et al., 2022; Sumarni & Kadarwati, 2020; Wijayati et al., 2019). Based on the results of studies on the effectiveness of project-based learning, it still only focuses on cognitive, intrapersonal and interpersonal aspects, while the career aspects are the same as recommendations for suggestions from the results of Condliffe's studies that have never been reported and followed up on (Condliffe, 2017). 21st-century skills encompass career and life skills, which involve active participation and adjustment, taking the lead and being conscious of oneself, interacting with others from different cultures, being productive and responsible, as well as demonstrating leadership and accountability. All these career and life skills aspects relate to entrepreneurial science thinking (Jamil et al., 2018). Therefore, studies and research are needed to integrate project-based learning models with an entrepreneurial science thinking approach that can improve creative thinking skills and entrepreneurial science thinking. The learning model developed is Project Based Entrepreneurial Science Thinking (PBEST); this model must meet three aspects: validity, practicality and effectiveness (Nieveen & Plomp, 2007). The objective of this research is to construct the PBEST model and verify its validity in order to assess the significance and coherence of the generated model.

2. Method

The research methodology employed is educational design research. The objective of development research is to create specific educational materials and assess the effectiveness of these materials. Several educational design research models have been developed, including Wademan's Generic Design Research Model (GDRM) (Plomp &

Nieveen, 2013). The stages of GDRM development research (Plomp & Nieveen, 2013) are (1) Problem identification, (2) Identification of tentative products and design principles, (3) Tentative products and theories, (4) Validation prototyping and assessment of preliminary products. Stages 1 and 2 begin with identifying the problem and conducting a literature review. During stage 3, the researcher created a prototype PBEST learning model together with the necessary equipment. In stage 4, the results of the prototype PBEST learning model were validated.

The PBEST instructional model and resources were validated by three professionals in scientific education. The validators were three people with details: one professor from the State Islamic University of Mataram, one doctor from the Muhammadiyah University of Mataram and one from the State University of Surabaya. Validation is conducted by utilizing the outcomes of the evaluation of content validity and construct validation. Content validation consists of several aspects: (1) the clarity of the background of the model requirements, (2) the state of the art of knowledge, (3) the clarity of theoretical and empirical support, (4) the planning and implementation of the model, (5) the management of the learning environment (Arends, 2012; Simamora et al., 2022; Sutoyo et al., 2023; Nieven & Plomp, 2013; Joyce, Well & Calhoun, 2009). Meanwhile, construct validation consists of several aspects: (1) consistency of the learning model, (2) consistency of theoretical and empirical support for the implementation of the learning syntax in the phases, (3) consistency of planning and implementation of the model, (4) Management of the learning environment, (5) Assessment and evaluation (Nieven & Plomp, 2013; Joyce, Well & Calhoun, 2009; Arends, 2012).

The data obtained from content validation (relevance) and construct validation (consistency) were evaluated using a qualitative statistical technique. This analysis was conducted to draw conclusions about the developed model and the quality of the assessment. Four scales were used to measure each component of the assessment indicators. Data analysis relies on the mean value of three validators. The assessment score is then converted into qualitative data using the 4 criterion scales in Table 1.

Table 1. Criteria for the Validity of the PBEST Learning Model

Score intervals	Criteria	Description
$3.25 < P \leq 4.00$	very valid	It can be utilized without any need for modification
$2.50 < P \leq 3.25$	valid	Can be utilized with slight modifications
$1.75 < P \leq 2.50$	quite valid	It is compatible with different versions
$1.00 < P \leq 1.75$	invalid	It is inoperable and necessitates consultation

References: Modified from Tukiran, Suyatno & Hidayati (2017); Handayani, Rahayu & Agustini (2020)

The dependability of the model validation instrument and supporting tools for the PBEST learning model is determined by calculating the interobserver agreement. This is done by statistically analyzing the percentage of agreement (R), as described by Borich (1994). Model validation instruments and PBEST learning model tools are considered reliable if they have a percentage value equal to or greater than 75% (Borich, 1994).

3. Results

Learning models can be categorized according to the desired learning outcomes, the syntax of the model, and the learning setting. Learning objectives are the final results expected based on predetermined plans. The learning model's syntax consists of sequential phases or steps that are followed during the learning process. The learning environment is the context in which learning must be carried out, including improving student motivation and conditioning (Arends, 2012). There are five main components in a good learning model, namely: (1) syntax, (2) social systems, (3) reaction principles, (4) support systems, and (5) instructional impacts and accompanying impacts (Joyce et al., 2009).

The PBEST hypothetical model used to increase creativity and entrepreneurial science thinking consists of 4 phases, namely: (1) Observe and think project, (2) Design project, (3) Monitoring and evaluation project, and (4) Economic value. An overview of the PBEST model syntax is in Figure 1.

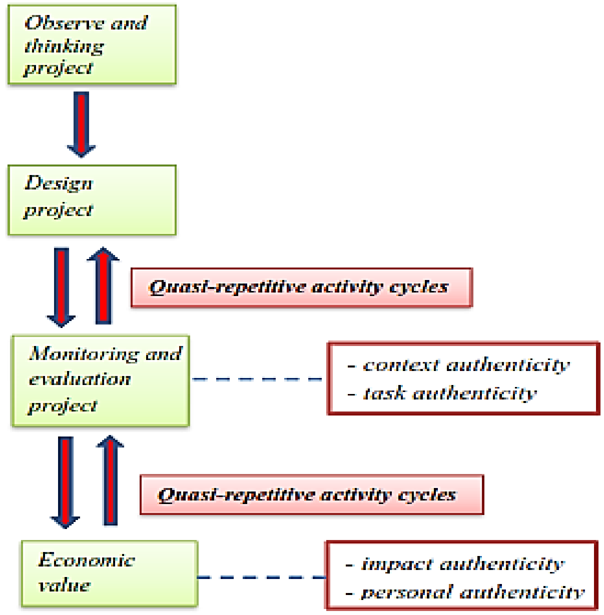

Figure 1. PBEST Model Syntax

The syntax of the PBEST model is described in learning activities at each phase, which are equipped with learning achievement indicators that will be developed at each stage of the model. Learning activities are arranged based on suitability to the goals achieved in each phase. Learning activities in each phase are equipped with learning achievement indicators for creative thinking skills and entrepreneurial science thinking, which will be developed at each stage of the PBEST model in Table 2.

Table 2. Relations of Syntax, Learning Activity Indicators of Learning Outcomes

Syntax	Learning Activities	Learning achievement indicators	
		Creative thinking skills	Entrepreneurial science thinking
Phase 1, Observe and thinking project	• Make observations of products and phenomena • Thinking of product ideas	Fluency Originality Fleksibility Elaboration	Observation New Idea
Phase 2, Design project	• Designing projects • Making project products in groups	Fluency Originality Fleksibility Elaboration	Inovation
Phase 3, Monitoring and evaluation project	• Monitoring the progress of project products • Doing self-reflection • Perform context and task authentication • Perform product revisions	Fluency Originality Fleksibility Elaboration	Creativity
Phase 4, Economic value	• Publish products • Perform impact and personal authentication • Perform product revisions • Presenting the final product	Fluency Originality Elaboration	Creativity Value

The validity of the learning model resulting from development research must meet the aspects of relevance and consistency. Testing the model's validity includes testing the content and construct validity of the prototype of the learning model being developed. The content validity of the learning model assesses the need for model intervention, and the model has been designed based on the latest scientific developments. In contrast, construct validity assesses how the intervention model has been designed constructively and logically (Plomp & Nieveen, 2013). The validators of the learning model are three science education experts. The validator evaluates the model that has been developed using a model validation instrument with several assessment aspects. The results of content validation and construct validation of the PBEST model and test reliability are in Table 3.

Table 3. Results of Content Validation, Construct Validation and Reliability

No	Component	Average	Validity category	Reliability value	Reliability category
A. Content validity of PBEST model					
1	Clarity of the background of the model requirements	3.67	very valid	100	reliable
2	State of the art of knowledge	3.83	very valid	93.33	reliable
3	Clarity of theoretical and empirical support	3.89	very valid	96.77	reliable
4	Planning and implementation of models	3.83	very valid	98.42	reliable
5	Management of the learning environment	3.83	very valid	93.33	reliable
B. Construct Validity of PBETS model					
1	Learning model consistency	3.89	very valid	9569	reliable
2	Consistency of theoretical and empirical support for the implementation of the syntax	3.91	very valid	96.77	reliable
3	Planning consistency and model implementation	3.83	very valid	96.77	reliable
4	Consistency in the management of the learning environment	4.00	very valid	100	reliable
5	Assessment and evaluation	3.83	very valid	93.33	reliable
	Average	3,85	very valid	96,44	reliabel

Learning tools are also developed to support the implementation of the PBEST model, which is oriented towards developing creative thinking skills and entrepreneurial science thinking. The construct and content validity of the PBEST model learning tools measure the consistency and logic of the learning model support tools that have been developed. The tools tested for validity include semester learning plans, lecture program units, student activity sheets, student textbooks, a creative thinking skills test, and an entrepreneurial science thinking test. Three validators assessed the validity of the learning tools supporting the PBEST model developed by the researcher using the validity instrument sheet provided. The validation findings of the PBEST model learning tools are presented in Table 4.

Table 4. The Results of the PBEST Model Learning Tools Validation

No	Component	Average	Validity category	Reliability value	Reliability category
1	Semester Learning Plan	3.89	very valid	98.64	reliable
2	Lecture Program Unit	3.81	very valid	98.61	reliable
3	Student worksheets	3.91	very valid	99.14	reliable
4	Student book	3.70	very valid	95.89	reliable
5	Creative thinking skills test	3.73	very valid	93.79	reliable
6	Entrepreneurial science thinking test	3.72	very valid	91.60	reliable

4. Discussion

The validation results of the PBEST model, conducted by three validators specialized in scientific education, indicate that both the content validity and construct validity of the PBEST model fall inside the highly valid and reliable category. The PBEST learning model that has been developed has syntax, social systems, reaction principles, support systems, instructional impacts and accompaniment impacts (Joyce et al., 2009; Utomo, 2020). The learning model that has been developed has four syntaxes: (1) Observe and think project, (2) Design project, (3) Monitoring and evaluation project, and (4) Economic value. The social system and reaction principle can be seen from the activities of lecturers and students in the lesson plan. The support system uses tools and materials in the lesson plan. The influence of teaching and support can be observed using learning indicators that aim to cultivate skills in creative thinking and entrepreneurial science thinking. The PBEST model has logical and rational design according to the model consistency criteria. This is supported by the validity test findings of all components, which exhibit high quality and align with the standard learning characteristics. This model encompasses all the attributes that demonstrate logic and rationality as empirical proof and a coherent theoretical foundation for designing and executing it, encompassing instructional behavior/activities, learning environment, assessment, and evaluation (Arends, 2012).

After a focus group discussion activity, three experts tested the validity of the PBEST model book's content validity and construct validity of the PBEST model book after a focus group discussion activity was carried out. The validity of the PBEST model measures three aspects of assessment: (1) the need for PBEST model development; (2) PBEST model design based on the novelty of scientific knowledge; and (3) a description of the PBEST model (Plomp & Nieveen, 2013). Based on the results of data analysis, the results obtained from assessing the content validity of the PBEST model, as presented in Table 3, show that the average model validity score is 3.85 with very valid criteria with reliability of 94.44% (Reliable, PA ≥ 75%). The PBEST model meets the requirements for the relevance of model development, namely the need for model development, model design based on the novelty of scientific knowledge, and the existence of an explicit model description so that it can be implemented in learning.

Creative thinking skills are part of 21st century skills (Gore, 2013; Voogt & Roblin, 2012), while entrepreneurial science thinking is related to entrepreneurship and self-direction skills, life skills and careers which are part of 21st century skills (Ghamrawi et al., 2017; Trilling & Fadel, 2009). The PBEST learning model can train some of the 21st century skills needed so that students can adjust to the fast-changing world (Brown et al., 2008; Moyer, 2016; Rotherham & Willingham., 2009; Varis, 2007). The PBEST model was developed based on theoretical studies and empirical studies, relevant learning theories which became references in the development of the model, namely Piaget's learning theory, Vygotsky's Sociocultural, Bandura's Sociocognitive and Constructivism theory (Leong & Bodrova, 2012; Miller, 2011; Moreno, 2010; Schunk et al., 2014; Woolfok, 2016). The PBEST model is derived from the integration of the project-based learning (PjBL) model with entrepreneurial science thinking (EST), and is used for empirical studies that build upon the findings of earlier research. Several types of PjBL models have been developed depending on competency development objectives.

One of the PjBL models that has been developed according to Larmer, Mergendoller, & Boss (2015), there are seven main elements in designing learning with PjBL: (1) challenging problem or question), (2) sustained inquiry, (3) authenticity, (4) student voice and choice, (5) reflection, (6) criticism and revision, and (7) a public product. A critical element in PjBL activities is the presence of Quasi Repetitive Activity Cycles (Parker et al., 2013). Through this activity cycle, students will be given the opportunity to revise the ideas generated to stimulate creative thinking to have a deep understanding. Quasi Repetitive Activity Cycles provide opportunities for students to provide feedback, reflection and revision of ideas or improvement strategies in the future (Bransford et al., 2006). Meanwhile, the concept of entrepreneurial science thinking is developed with five elements: (1) Observe, (2) new ideas, (3) innovation, (4) creativity, and (5) society (Syukri et al., 2013). Table 3 shows the results of the PBEST model validation, which indicate that the generated model is valid and reliable. Some suggestions from experts for the improvement and development of the PBEST model: discussion of theoretical and empirical studies needs to be explained in detail and given an in-depth analysis by completing references, exploring the weaknesses of previous models so that it becomes a concern in model development. By making improvements according to input from experts, a PBEST approach is developed to enhance both creative thinking skills and entrepreneurial science thinking.

To support the implementation of the PBEST model, researchers have also developed learning tools and have validated the tools developed. Based on the validation of the learning tools presented in Table 4, the semester learning plans, lecture program units, student worksheets, student books, creative thinking skill tests, and entrepreneurial science thinking tests are valid and reliable. Advice from experts in developing semester lesson plans: learning steps are more detailed, and entrepreneurial science thinking learning objectives are more meaningful. For lecture program units, experts provide input regarding the adjustment of graduate learning outcomes with course learning outcomes and indicators. For student worksheets, experts provide input that the characteristics of the PBEST model must be visible in the student worksheet. According to experts, student books must pay attention to the material, display the contents must be exciting and can increase students' interest in reading. The tests for creative thinking skills and entrepreneurial science thinking that have been compiled need to be added to the assessment score for each question; for innovative indicators, you have to make questions that can generate different thoughts from what already exists. Researchers have refined the learning tools developed by incorporating feedback from professionals. Effective learning tools can facilitate the use of a pedagogical framework. (Berndtsson et al., 2020; Mavilidi et al., 2021; Oliveira et al., 2019; Reusser, 2012). The updated educational resources can be utilized to facilitate the application of the PBEST framework in order to enhance students' creative thinking skills and entrepreneurial science thinking.

5. Conclusion

Based on the research and data analysis results, it can be concluded that the PBEST learning model results in excellent relevance and consistency with very valid and reliable criteria (percentage of agreement ≥ 75%). The PBEST learning model consists of four stages, namely: (1) Observe and thinking project, (2) Design project, (3) Monitoring and evaluation project, (4) Economic value. Based on the results of the validation of the implementation supporting learning tools, the semester learning plans, lecture program units, student worksheets, student books, creative thinking skill tests, and entrepreneurial science thinking tests are valid and reliable. The PBEST learning model can be used to improve creative thinking skills and entrepreneurial science thinking. Additional investigation is needed to ascertain the efficacy and feasibility of the PBEST model in enhancing creative thinking skills and entrepreneurial science thinking.

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Acknowledgments

We thank Indonesia's Ministry of Education, Culture, Research, and Technology for providing financial support through the doctoral dissertation research grant 2023.

Authors contributions

Prof. Dr. Suyatno Sutoyo was responsible for study design and revising as well as drafting the manuscript. Prof: Dr. Achmad Lutfi was responsible for data collection and drafting the manuscript. Mr. Nanang Rahman was responsible for data collection and revised the manuscript.

Funding

This work was supported by Indonesia's Ministry of Education, Culture, Research, and Technology (Project number: 948/UN38/HK/PP/2023).

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Sciedu Press.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.