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UTILIZATION OF INTERNET-BASED TEST (IBT) REGARDING ITEM RESPONSE THEORY (IRT)-BASED ECONOMIC LEARNING FOR THOUGHT PROCESSES IN THE BRAIN

AI NUR SOLIHAT[1,2], DADANG DAHLAN[1,*],
K. KUSNENDI[1], BUDI SUSETYO[1]

[1]Universitas Pendidikan Indonesia, Bandung, Indonesia,
[2]Universitas Siliwangi, Tasikmalaya, Indonesia
*Corresponding Author: dadangdahlan@upi.edu

Abstract

This study aims to describe the process of developing an Internet Test (IBT) based on item response theory (IRT) to measure students' creative thinking skills in economic learning associated with the thinking process. The method used in this research is design-based research (DBR), which has stages of analysis, design, development, and evaluation. The research result is based on an IBT. Media experts have tested this IBT, and it can be used to measure creative thinking skills in economic learning. The IBT has been proven to improve creative thinking skills. This IBT provides interactive features that engage users in various tasks and challenges, stimulating cognitive flexibility and innovation. As a recommendation for future researchers, her development is related to this IBT thus it can be used to measure other higher-order thinking skills in economic learning and other subjects.

Keywords: Creative thinking, Economic learning, Internet-based test (IBT), Item response theory (IRT).

1. Introduction

Thinking processes are essential for solving complex problems and fostering innovative solutions, involving the brain's ability to process information, form connections, and drawing conclusions [1]. Systems thinking skills are crucial for navigating the complexities of the 21st century [2, 3]. These skills allow students to organize their thoughts meaningfully by identifying connections between seemingly unrelated problems, thus understanding them as interrelated issues [4, 5]. This capability helps students grasp the multilevel structure of various concepts and the relationships among them [6, 7], enhancing their overall comprehension and problem-solving abilities [8, 9]. Two primary thinking techniques, convergent and divergent thinking, play a crucial role: convergent thinking creatively combines knowledge, while divergent thinking generates multiple possibilities [10]. Using both techniques sequentially enhances creativity more effectively than divergent thinking alone [11]. These processes are integral to information processing and decision-making [12].

Advancements in technology, such as personal computers and the Internet, significantly influence the thinking process by altering cognitive behaviours and information processing patterns [13]. Internet enhances students' information competence in the learning process [14]. In educational settings, technology facilitates the development of thinking skills by providing personalized and adaptive learning experiences [15]. Integrating technology into education serves as a crucial tool for enhancing students' cognitive abilities [16, 17]. Furthermore, technology impacts educational assessment methods, allowing for more authentic and detailed evaluations of students' problem-solving strategies and cognitive abilities [18]. To support this issue, one of the strategies for applying technology is using the internet. Internet-based assessments are efficient, valid, and eliminate biases, providing insights into creative thinking [19].

The Torrance Test of Creative Thinking (TTCT) is a widely researched instrument for measuring creativity, validated across various cultures and demonstrating significant correlations between creative achievements and TTCT scores [20, 21]. However, assessing creative thinking is complex, involving judgments from expert communities or the general public [22-24]. Although the TTCT shows significant relationships between creative indicators and achievements, distinguishing creativity from traits like intelligence and expertise remains challenging [20]. Guilford's multifactor structure of intelligence aimed to identify components of creative thinking, yet these tests lack validation against external measures of creative productivity [25]. This complexity underscores the need for robust, multifaceted approaches to accurately measure and understand creativity.

The author examines the creation of an Internet-based test (IBT) aimed at improving accuracy and consistency in evaluating creative thinking in the context of learning economics. This new approach offers substantial improvements in educational evaluation through increased accessibility and efficiency, by overcoming the logistical limitations of conventional paper-based examinations. Internet-based assessments can use adaptive technology to adjust the difficulty of questions based on each student's performance, resulting in more precise and individualized assessments. In addition, these exams collect extensive data on the

speed at which students respond and how they interact, providing a deeper understanding of students' cognitive processes.

The novelty of developing an IBT using item response theory (IRT) for measuring students' creative thinking skills lies in its enhanced precision, adaptivity, and comprehensive data collection. IRT allows for more accurate assessments by modelling the probability of a correct response based on both individual ability and item characteristics, addressing variations in test item difficulty and individual differences [26]. Integrating IRT with IBT enables real-time adjustment of question difficulty, ensuring personalized and accurate evaluations [27]. These tests also capture detailed process data, providing deeper insights into cognitive processes [15]. Advanced algorithms enhance validity and reliability, reducing human error and bias, and ensuring fair assessments across diverse populations [28]. Seamless integration with educational technologies supports continuous formative assessments, facilitating ongoing feedback and adaptive teaching strategies [29].

Additionally, the digital platform enables innovative assessment models that go beyond multiple-choice questions, such as creative tasks that reflect real-world challenges. This approach not only improves the accuracy and fairness of assessments but also provides valuable insights to inform instructional practices and support the development of student's creative potential.

2. Literature review on Process of thinking

The human brain is a complex organ with distinct regions that mediate specific cognitive functions, notably through its hemispheres, which are crucial in various aspects of cognition [30]. The left hemisphere typically processes language, words, numbers, and equations [31], while the right hemisphere is linked to creativity, imagination, music, and colour processing [32]. Other critical structures include the cerebral cortex and frontal lobes, which play significant roles in decision-making, motor control, and emotional regulation [33].

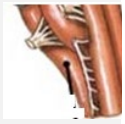
Additionally, the cerebellum coordinates voluntary movements, balance, and posture, aiding in the perfection of motor skills [34]. The brainstem, located at the base of the brain, controls vital functions such as breathing, heart rate, and blood pressure, and serves as a pathway for nerve signals between the brain and the rest of the body [35]. These components together underscore the brain's intricate structure and multifaceted roles in maintaining cognitive and physiological processes. Details for the parts of the brain stem and their functions can be seen in Table 1.

The information conveying process involves the diencephalon, mesencephalon, pons, and medulla oblongata, all connected by the central nervous system [36]. This network coordinates sensory input and motor output, allowing signals to travel between brain parts for processing sensory information and motor responses [37]. This ensures smooth communication and coordination of cognitive functions. The visual representation of this information delivery process is shown in Fig. 1.

Figure 1 explains sensory receptors detect environmental stimuli, such as touch, sound, or light, and convert them into electrical signals that travel along sensory neurons to the central nervous system for processing [38]. In the central

nervous system, sensory information is integrated and processed in various brain regions to generate an appropriate response [39]. This processing involves interpreting the stimuli and determining the necessary motor output [38]. Once processed, motor neurons in the central nervous system receive signals that carry instructions to effector organs like muscles or glands [39]. These signals travel from the brain to the effector organs, prompting them to execute the appropriate response [38, 40]

Table 1. Parts of the human brainstem.

Parts of the human brainstem	Function	Figure
Diencephalon **Thalamus** **Hypothalamus**	Relay and Processing centres for sensory information Centers controlling emotions, autonomic functions, and hormone production	
Mesencephalon	Processing of visual and auditory data Generation of reflexive somatic motor responses Maintenance of consciousness	
Pons	Relays sensory information to cerebellum and thalamus Subconscious somatic and visceral motor centres	
Medula oblongata	Relays sensory information the thalamus and to other portions of the brain stem Autonomic centres for regulation of visceral function (cardiovascular, respiratory, and digestive system activities)	

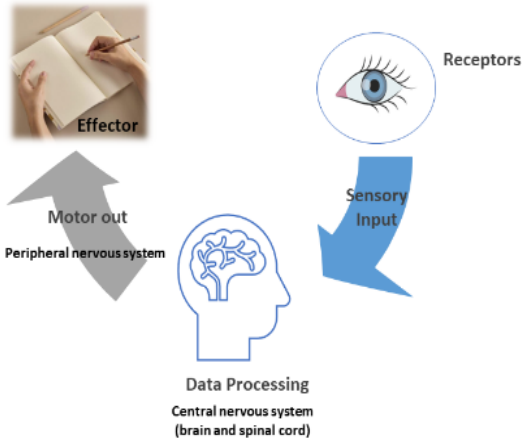


Fig. 1. Flow of thinking process.

3. Method

This study developed the IBT using design-based research (DBR). DBR is a research methodology focusing on studying learning in a particular context by systematically designing and analysing instructional strategies and resources. DBR aims to generate and expand knowledge about the development of learning environments that effectively facilitate targeted educational goals. The DBR stages in developing this IBT begin with analysis, design, development, and evaluation. To develop this IBT, media experts conducted a validity test. After being declared valid, this IBT was tested on a limited basis for 32 students.

4. Results and Discussion

4.1. Creative thinking instrument test

The development of a creative thinking instrument for economic learning was informed by needs analysis through questionnaires and interviews with economics teachers, revealing that 58.3% had never created such tests due to time and administrative constraints, though 70.8% recognized their importance. Key economic topics for creative thinking assessments were identified, resulting in 60 multiple-choice items based on Torrance's creative thinking dimensions and Bloom's Revised Taxonomy, validated by nine experts and achieving a reliability value of 0.96 from a test with 32 students. To ensure quality, Item Response Theory (IRT) was used with three logistic parameters - differentiability, difficulty, and guessing - validating 57 items. Implementing the instrument as an IBT aligns with findings by Nakayama et al. [28] that IRT-based internet tests enhance assessment effectiveness and offer reliable ability estimates tailored to student capabilities.

4.2. Use of internet-based test (IBT)

The Interactive-Based Test (IBT) was developed to measure cognitive abilities, including creative thinking skills in economic learning, tailored for students using Internet technology. The IBT design includes a user-friendly online platform with features like course menus, instructor profiles, and test initiation. Students start the test by selecting economics from the "All Courses" menu, logging in with provided credentials, and accessing essential information about competencies, subject matter, and creative thinking dimensions through the overview menu.

The test system allows students to answer questions sequentially or non-sequentially, with completed questions indicated by a change in appearance. Upon completion, students receive their test scores immediately. This structured and accessible approach ensures efficient navigation and thorough assessment of students' creative thinking skills in economics. The flow of using the IBT is shown Fig. 2.

The implementation given to students proved that this IBT is very easy to use and can measure students' creative thinking skills in learning economics. This IBT has been used by a total of 906 high school students in class X. Based on the test results in this study, out of 906 students participating in the test, they are grouped into three categories: high, medium, and low ability. The student ability categories can be seen in Table 2.

Fig. 2. The flow of using internet-based test (IBT) in measuring creative thinking in economics learning.

Table 2. Distribution of student ability categorisation.

No.	Score	F	Relative freq. (%)	Cumulative Freq	Categories
1	X < 20	189	20,86	-	Low
2	20 ≤ X < 39	483	53,31	74,17	Medium
3	39 ≤ X	234	25,83	100	High
	Total	906	100	100	

An analysis of student ability using the minimum completeness criteria (KKM) and the criteria reference assessment (PAK) [40]. Set the cut-off score for creative thinking ability in economic learning at 46. Of the 906 students tested, only 164 (18.10%) passed, highlighting a need to reassess learning approaches and evaluations. The developed IBT has proven effective in enhancing creative thinking skills by offering interactive features that engage students in tasks and challenges, thereby stimulating cognitive flexibility and innovation. Internet technology alters cognitive behaviour through information processing [41], and tests foster creativity and originality by encouraging problem-solving and idea generation [42]. The low pass rate of 18.10% indicates a critical need for evaluating and improving the learning process to better develop students' creative thinking abilities.

5. Conclusions

The thinking process, crucial for solving complex problems and fostering innovative solutions, involves the brain processing information, making connections, and drawing conclusions. There are two essential thinking techniques: convergent and divergent thinking, both critical for developing creative thinking skills. A valid and reliable creative thinking instrument based on the IRT 3-parameter logistics analysis model was developed for economics teachers to measure students' creative thinking skills through IBT. This IBT accurately assesses creative thinking according to student abilities, providing reliable estimations of their skills. Evidence from a creative thinking test on 906 students showed that 164 students, or 18.10%, passed. Despite its effectiveness, the IBT currently only measures creative thinking. Future development could enhance the IBT by incorporating features to assess other higher-order thinking skills, such as

analytical and critical thinking, expanding its applicability beyond economics to other subjects.

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