

Research article

Designing Teaching Materials Using ACAR to Inspire Critical and Creative Thinking

Dwiyono Hari Utomo

Department of Geography Faculty of Social Science, State University of Malang, Malang City East Java, Indonesia

Abstract.

Teaching materials not only contain text and pictures but have a learning material organization that can build higher-order thinking skills. Teaching materials contain the organizational structure of the sequence of student activities. This research aimed to design 'climatology' teaching materials that can hone critical and creative thinking skills. Teaching material products were designed to include the preparation of material with a compilation format based on ACAR (activation, confirmation, activities, and resume), which comes from brain-based learning theory. The teaching materials were validated, tested, and implemented in field learning. The results of the evaluation showed that students were able to use the materials to master the concepts used to solve problems. This showed that the ACAR learning model design effectively helped to hone students' critical and creative thinking skills.

Keywords: ACAR, creative thinking, teaching materialCorresponding Author: Dwiyono
Hari Utomo; email:
dwiyono.hari.fis@um.ac.id

Published: 12 October 2022

Publishing services provided by
Knowledge E

© Dwiyono Hari Utomo. This article is distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use and redistribution provided that the original author and source are credited.

Selection and Peer-review under the responsibility of the ICGE 2021 Conference Committee.

1. Introduction

The teaching material acts as a precondition before learning in class. Students have read and studied teaching material before entering class, so students already have preliminary knowledge. Based on the initial knowledge of students, they construct knowledge through the process of assimilation [1] and mutual assimilation [2]. Teaching material invites students to dialogue in their brains and to construct their knowledge as constructivism Piaget [3]. Student dialogue independently involves the work of the brain to be able to answer itself with the support of various sources of information including open source.

The teaching materials include content, format, and layout. The content is adjusted for specific subjects; the format contains a structured order of presentation, and layouts contain an organized mode of presentation of text and image layouts. Illustrated teaching materials can strengthen the self-centered internal dialogue between text and images. Images can animate analogous ideas. Images can provide direct experiences.

OPEN ACCESS

They prove images as a visual elaboration to be very effective [4] and can visualize verbal information written with holistic symbols and visual patterns [5]. Images in teaching materials can be recalled [6]. Format concerns the design of structured learning based on the way the brain learns [7]. They design the format of teaching materials and layouts based on brain-based learning theory which procedurally activates the workings of the brain. Learning starts from the activation of the brain to activate neurons, then is ready to carry out thought processes, such as critical thinking, and creativity. Teaching materials in the form of textbooks have implications for the activation of the brain in the form of readings or images so that the eye is the main sensory.

The writing of existing teaching materials has not been patterned in the format of its preparation. Teaching material is dominated by informative texts, without encouraging students to think. Teaching materials do not yet present examples of phenomena that occur in nature and society. Teaching materials without reinforcing the concept and cannot measure the progress of learning. Students want teaching materials that are suitable for their world, in the era of digital communication. Progress in the 21st century suggests several attributes that must be mastered by students such as curiosity and creativity, rational thinking and problem-solving tactics, leadership and influence skills, effective interaction and conversation skills, examining and manipulating information skills [8][9]. Students in their digital age have developed a 'cultural brain', a brain formed by their constant exposure to digital bombardment which is their daily experience [10].

Model ACAR (Activation, Confirmation, Activities, and Resume) developed in the writing of teaching materials based on brain-based learning. We can see the ACAR model in the presentation formats that are patterned on each topic. Activation as an initial step to open students' minds through their current existence, can be through a conversation mode or a story presentation related to the topic. Confirmation provides opportunities for students to take an active role in determining learning objectives on related topics. The goals that have been submitted so that it becomes a commitment to achieve them together. Activities contain a series of activities starting from reading concepts that contain reasoning that must be linked to the memory so that the brain is always working and learning. The resume provides a brief review of what students have learned and so that students gain reinforcement on the concepts they have learned.

The design of teaching materials about the climatology can provide literacy in the mindset of students about the concept and its implementation in social life. Students are enriched cognitively through various sources on climate change, global warming, extreme weather, and their effects on life. The ACAR model invites students to argue about solving cases and provide ideas for solving them. In the end, students can be

inspired to think critically and creatively about how to adapt to climate change. Student inspiration can be stored permanently in its long- term memory so that it can be used in other cases

1.1. ACAR Model

Learning design is defined as a systematic procedure developed for substantial learning improvement [11] and for creating effective learning [12]. The design of teaching materials follows a systematic procedure as in the development of learning designs. The ACAR model as a teaching material design is inspired by the seven steps of learning Sousa [5] and Smith referred to by Salmiza [13]. ACAR as an abbreviation of Activation, Confirmation, Activities, and Resume. Activation in the model ACAR is intended to stimulate the memory processor system (prior knowledge). Activation in writing teaching materials on topic 'climate impact on life' takes place at the beginning of the topic opening in the form of a presentation of the conversation of several people related to the topic to be written [3]. This form of conversation as a cognitive footing for the activation of neurons does their job of activating other neurons in brain elements. The function of neurons as the recipient and sender of information. Neurons send information through electrical signals, which move from cell to cell through synapses, triggering the release of neurotransmitters. There are about 100 billion neurons in the brain, each with massive connections to other neurons [14]. Presentation of the appropriate context before the story can increase understanding and recall of ideas [4]. Sousa [5] opens with a topic sentence statement or expert opinion related to the topic that was studied. Activation helps students make connections or as a cognitive foothold between their own knowledge and experiences and new information learned. This connection can motivate students to continue learning the content of teaching materials [15].

Confirmation in the model A-CAR is modifying the second step of Salmiza [13], namely 'clarify the outcomes and paint the big picture', but confirmation intended to convey the purpose is different. The difference in the confirmation, the purpose of writing in the teaching materials, while clarifying the outcomes and painting the big picture presented in class. At confirmation, students can add themselves to teaching materials, then become a joint commitment. Confirmation of the goal needs to be written and become a joint commitment, because the goal is an important aspect of learning [7], and as the second element in the format of the preparation of teaching materials. In his book entitled 'Instructional Technology & Media for Learning'[16], put shortly

learning objectives for each chapter before a description of the material or prior learning activity. Placement of learning goals before learning activities provides direction for concentration, attention flow [4], and improving performance [7]. Interest can also be a challenge that must be faced because learning is enhanced by challenge and inhibited by threat [17].

Activities contain learning activities as a third step in the format of writing teaching materials that contain the learning process of the content of learning materials. Activities start from reading text, reading graphics, reading tables, interpreting pictures, doing internet links, doing assignments, answering questions, making questions, and taking notes. Learning activities are directed at finding main ideas, using reading strategies that they believe can achieve goal [3], and triggering brain work to be able to think critically and creatively. Learning activities to build brain work dynamically supported by the application of concepts to get the benefits of the concept. Schunk [3] places the application of concepts at each end of learning activities. Sousa [5] places practitioner space as a concept application at the end of each learning activity. Caine & Caine [17] provides the principle that the 'humans understand and remember best when facts and skills are embedded in natural, spatial memory'.

The resume becomes the fourth step and the final step of the A-CAR model referring to the sixth step of Salmiza [13], namely: review for students' retention but the seventh step previewing the next topic is not referenced because the next topic risks confusing students. Textbooks are written by Schunk [3], Reed [4] Sousa [5] and Smaldino [16], each place a resume at the end of learning activities or the end of concept application. Resumes provide the effect of reinforcing concepts, retention, and facilitating memory recall.

1.2. Critical and Creative Thinking

The ability to think critically shows someone's maturity, they are tough and don't give up easily, so they can solve their life's problems. Critical thinking shows one's readiness to respond and reflect on problems. Students think critically when they reflect on what they have achieved and when they evaluate these achievements against the appropriate criteria [18]. The National Council for Excellence in Critical Thinking (NCECT) states that critical thinking is defined as an active and skilled process of conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from observations, experiences, reflections, reasoning, or communication, as a guide for beliefs and actions [19]. Critical thinking is the process of applying reasoned thinking

[20], precise and systematic [21]. More clearly the opinion of Liebler [22] takes Richard Paul's opinion that critical thinking is thinking about thinking, while thinking to make thinking better. So the ability to think critically is an activity of the brain to respond, converge based on knowledge and experience in real time.

The ability to think creatively occurs when students are fully involved in learning, they are confident to make speculations and statements and feel empowered to articulate their learning to others around them [18]. The image of creative thinking is not like an umbrella before it rains, but a form of response that challenges his mind because there is no umbrella when it rains. They apply solutions, when there are no solutions, to creative thinking [23]. Creative thinking leads to new insights, new approaches, fresh perspectives, and new ways to understand things [24]. The main thoughts are not on the umbrella but on how to avoid getting rained on. The choice of solution item has occurred in his mind, and the closer the personal relationship is to the creative thought item, the more likely the student will produce more creative ideas [25]. Creative thinking can be disrupted when thinking about getting wet due to the rain and its benefits when he gets to his destination. Then the goal must be an attraction, is it fun, or is there something that attracts attention. So, creative thinking does not occur if motivation does not support it [26]. Creative thinking not only produces ideas, but also makes judgments about those ideas [27] and is 'thinking outside the box'[28].

Critical and creative thinking are interdependencies. Bloom incorporates creation in the highest cognitive level, producing unfamiliar patterns or structures by divergent thinking [5]. Creativity implies that solutions are not only true but also unique, useful [29] effective in various situations. Creativity requires cognitive abilities, such as effective control of working memory, ongoing attention, cognitive flexibility, and conformity assessment derived from the prefrontal cortex [4]. Creativity, as a cognitive activity that generates new insights into the problem and not limited to the results of pragmatic [6].

2. Method

A-CAR as a model of the organization of teaching materials designed using development research. Development research is procedurally oriented to the needs of students through initial analysis to determine the design. Design in the form of written procedures based on logical and scientific reasons about how learning can improve students' thinking abilities. Designs that have been validated later developed to the exact shape in the form of teaching materials constructive in which includes how to learn through a systematic procedure. Each topic is preceded by questions as brain activation, as

well as when studying certain topics in it also invites students to think critically, and creatively. At the end of the topic, there is a resume to reinforce the concept.

The trials carried out on students to obtain feedback and compliance of design with the way they think. The design of teaching materials that have been validated and revised to become a design of teaching materials that are feasible and implemented to obtain student responses to the design of teaching materials. The research model development is de science of models Borg & Gall for optimization of intervention (Figure 1). The development research steps include preliminary research, need analysis, literature review, analysis of existing teaching material, teaching material design, tryout, expert judgment, revisions, final product, implementation, dissemination, and publishing. The ability to think critically and creatively is known from feedback through the classical question-and-answer method which is then discussed. Questions as identified by Ged Gast are intended to encourage creative, imaginative, or innovative thinking to foster speculation, ideas, and challenge to a higher order of thought using examples and building student responses [20]. The question uses why, how, where, and which.

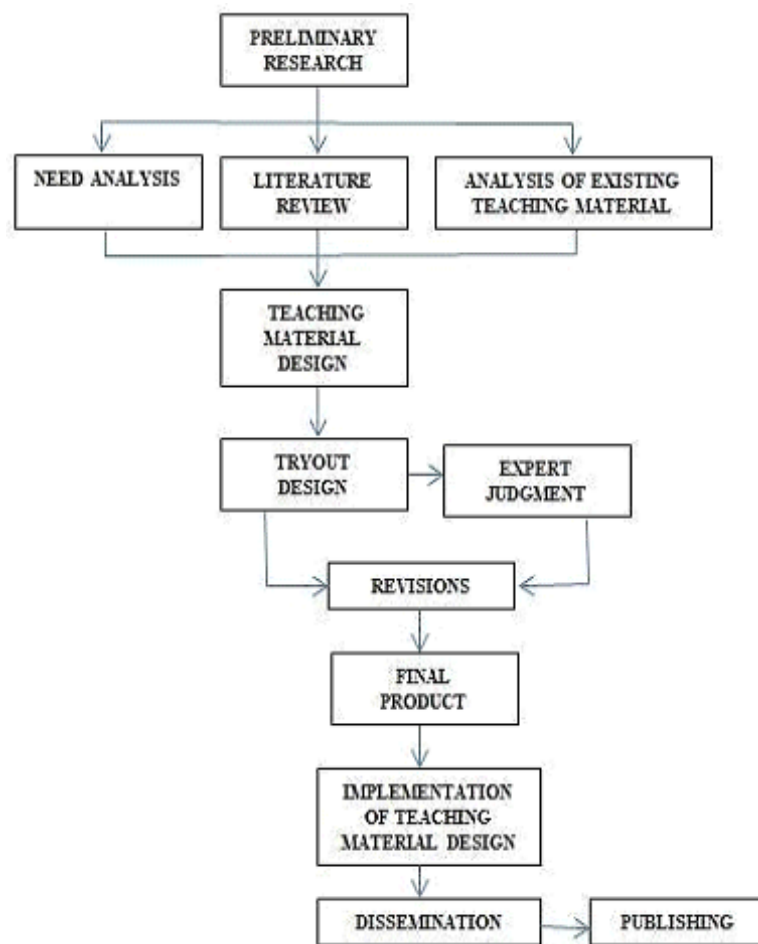


Figure 1: Development research procedures.

3. Result and Discussion

3.1. Result

The design of teaching materials has been validated and deserves further implementation. The manifestation of teaching material design is structured as follows:

1. *Activation*, as a cognitive foundation, puts it at the beginning to open the student's brain to synchronize between the contents of the reading with the experience that has been stored in his memory. Example of activation:

Humans live in a varied and varied environment as well as human responses to that environment. Tropical regions such as Indonesia, which has low- temperature fluctuations, do not affect fashion. But in the sub-tropical and temperate latitudes, fashion must be adjusted to the temperature of the season, because winters are very cold, and summers are very hot. Fashion for summer is impossible for winter or vice versa. However, Indonesia is affected by seasonal rhythms, so during the rainy season wear a raincoat, and during the dry season wear a jacket. Vegetation life is affected by rainfall and temperature, such as in areas that have 4 seasons, vegetation thrives and develops in spring or spring, while in autumn the leaves fall, then winter vegetation experiences a period of rest such as dormancy. In tropical areas such as Indonesia, vegetation can thrive and be green all the time, but some wither in the dry season as a decisive season feature. The toughness of the weather can occur in extremes, such as too cold temperatures, too hot temperatures, and the occurrence of storms, this has become a hydrometeorological disaster. The climate has changed globally, does it affect the territory of Indonesia?

1. *Confirmation*, contains learning objectives that require student commitment to do so and can be written on the sheet provided.

Like a kite that is restrained, it has a clear direction, can be controlled, and can be fun. The direction of the kite corresponds to the direction of the wind, and the direction of the wind is clear to North, South, West, or East. Kites can swoop, turn, and soar. Various colors adorn the kite, attractive, dazzling, and can be a fun activity. Have you ever played a kite? What are the main requirements to be able to fly a kite? If you have played kites with some friends, where have you played kites? Do you see that the kite is going in one direction? As you learned about the wind, then you have a clear goal, namely:

1. (a) Find the cause of global winds

- (b) Finding [the cause of the hurricane
- (c) Find the cause of the storm
- (d) Finding facts about the impact of storms on human life
- (e) Find ways to mitigate meteorological disasters in Indonesia

If there are other goals, please write them here:

3. *Activities*, containing the concept of the climate impact on life which is divided into influence on health, agricultural cultivation, the comfort of life, acclimatization, climate change, extreme weather, acid rain, greenhouse effect, global warming, and tasks. An example of brain activity can be seen in the following example statement:

Each storm moves with its trajectory. However, in general, storms that form north of the equator move west or northwest, and storms that form south of the equator move west or southwest. This is related to many factors including the direction of the Earth's rotation and the Coriolis force it creates. Tropical storms move directly proportional to the magnitude of the Coriolis force of the earth, apply the mathematical function Sinus ($\Phi = \text{latitude}$). Because Indonesia is located in the equatorial region with low latitude, the sine price obtained is close to zero. This makes it impossible for any tropical storm to cross Indonesian territory. Based on climatological data, the growing area of tropical storms is above 10° South Latitude from December to April and above 10° South Latitude from September to November.

The statement exposes students to assimilate or accommodate the concepts that already exist in their memory. This assimilation process can proceed to the next reading, if not then the accommodation process by means of students looking for the previous reading or giving a question mark and can ask during lectures.

Indonesia is not like countries that are often on the trajectory of storms such as America, Japan, Australia, the Philippines, or other countries. Indonesia will only be affected indirectly in the form of strong winds, high waves, and rain in areas close to where the storm is growing. During the dry season, Tropical Storms grow around the waters north of Papua New Guinea and move towards the Philippines and Korea/Japan. Storms of this type include Tropical Storm Cimarron (6 October – 6 November 2006), Tropical Storm Durian (26 November – 6 December 2006), and Tropical Storm Utor (6 – 14 December 2006). Usually, the affected areas are around North Sulawesi and Papua New Guinea. During the rainy season, tropical storms grow around the waters of the Timor Sea or the Gulf of Carpentaria and move towards the West or Southwest. Storms of this type include Tropical Storm Nelson (6 – 7 February 2007), Tropical Storm George (3 – 9 March 2007), and Hurricane Jacob (7 – 12 March 2007). This storm affects

weather conditions in the areas of East Nusa Tenggara, West Nusa Tenggara, Java, Bali and South Sumatra.

In this statement expect students to open their memory or mind map and have a dialogue with the concepts that exist in the memory. The concept in student memory should be about the rainy season occurring in the month and the position of the sun in the northern or southern hemisphere so that the ITCZ pathway can be known. If this has been found then there is no difficulty for students to read the sequel. Another activity is to observe several pictures and students are assigned to create stories related to the pictures. The story can be written in the space that is available. We intend this to explore students' knowledge of synthesis.

The activity of looking at the picture to create a short narrative that is related to the image and interrelated. This is intended so that students can be motivated to imagine and set forth in logical stories. Images as natural phenomena that occur in the environment are sourced from environments that have been known by students. Other tasks students must do to answer questions that can be discussed with other students and reported results. Reading resources can access the website link provided.

4. *Resume* is the final step in closing the topic of teaching materials derived from previous readings that have been studied by students. Example resume as follows.

Climate occupies a region for many years. Humans and other living things have adapted over the years. Adaptation as a form of adjustment to the climate. Genetic climates have led human life to a fertile area with green vegetation. In places overgrown with vegetation, where there is also a water source, this is an indicator of a wet climate. Humans have controlled the climate. However, nowadays humans have controlled the climate or man-made climate so that the climate changes. The earth is getting hotter due to human activities. More and more greenhouse gases fill the atmosphere, causing higher temperatures to cover the whole world (global warming). Humans are adapting again to the new climate, but humans who are not able to adapt become a disaster. Extreme weather sinks fishing boats, floods hit villages, people starve. Long, dry summers make farmland dry, plants die, animals die, and humans die too. Efforts to control the dangers of extreme weather have been called for and even enacted worldwide, namely to reduce greenhouse gas emissions, and carry out reforestation of one man one tree.

This resume contains moral messages about the consequences of human activity that cause climate change and so that students can have empathy for the people affected by climate. In addition, students are expected to be able to explore their knowledge and find ideas to reduce the effects of climate change.

3.2. Discussion

Design of teaching materials based on brain-based learning can improve curiosity, and curiosity is important for a scientist [30], a trigger curiosity to activate the learning system in the brain [31]. Curiosity is an intrinsic desire to know, see, or experience that motivates search behavior [32]. Information seeking through reading the conditions of students learning without pressure, they have dialogue, and internet access puts students in a state of general relaxation to improve innate [33] and assist the process of assimilation [34]. Students have patterned the habit of learning critical and creative thinking through constructive teaching materials and have been synchronized with the way of the brain learns. This shows that the ability to think critically and creatively can be awakened.

The ability to think critically and creatively can be aroused because teaching materials containing writing and pictures have consequences for reading activities. Reading is not pronounced but processed in the brain through eye sensors. The clarity of letters, the clarity of words or pictures, the correctness of language, the clutter of sentences, and the accuracy of context have an effect on the clarity of information. Sentences or words and terms are recognized. The introduction of words or terms that have been understood, forms a new mental representation through information transformation [6] and manipulates internal symbols that are full of meaning[7]. Emile Javal found the phenomenon that in the process of reading the human eye does not observe letter by letter sequentially but moves in small jumps (sacred motion) accompanied by instantaneous fixation at certain points. At this time assimilation occurs with his knowledge and experience, dialogue, discussion, and pattern synchronization occur [6].

Learning and memory are driven by context [35], the context is the topic of teaching materials. The teaching materials topic of writing and drawing that involve the sensor senses (especially the eyes). Reading depends on the ability to recognize the visual symbols of the alphabet in the right order. The eyes make small movements flicking from one letter to the next. The letters are identified during each eye fixation, but the order is given by the pointing eye when each letter is visible. Visual control of the eye's movement system is dominated by a large network of neurons known as the magnocellular system. This tissue can be traced directly from the retina, through pathways to the cerebral cortex and cerebellum, to the motor neurons of the eye muscles. The magnocellular system plays an important role in helping to turn the eyes on each letter in turn, and hence determine its order [36].

The teaching materials lead to the formation of critical and creative thinking, involving the brain-based learning theory [3], cognitive theory and its application [4], cognitive psychology [6], and brain-based learning [7] [17]. The indication lies in responsive action in the form of questions [37]. In this regard, the content of teaching materials involves more students in thinking about concepts. Students can find their own clarity of the concept of using his mind, a link to the internet for the development of knowledge and reasoning. Students use their reasoning to analyze, synthesize, analogize, think critically, and creatively, as well as metaphysical or meta-cognitive abilities [6] to explore logic.

The teaching materials cannot be separated from the influence of communication technology, such as laptops, hand phones, and wifi into a tool to complete information. In this regard, teaching materials be relevant, to accommodate the needs of students self, pay attention to the student world as a customized and work-oriented environment. Students are free to browsing and it has become their passion to explore information without limits.

The attractiveness of the teaching materials lies in setting the layout display teaching materials in the form of pictures, graphs, and maps as supporting texts. Appearance can give the impression of a supportive view and as an attractive framework [7]. Support for textual content has principles of relevance and unity, can strengthen long-term memory [3][4][5][7]. Content bears a special name that is topical and distinguishes it from other content even on the same teaching material but remains consistent in the continuity between topics. The characteristics of this content can provide direction for competencies that can be realized in students. In other words, the identification of specific content needs provides an indication of the competency that can be realized by students. This content specification cannot be separated from the curriculum which has become a procedural system.

The capacity for creative thinking of students is not always influenced by academic ability. Low academic ability is not necessarily low creative potential, and high academic ability does not necessarily indicate high creativity [38]. This can occur because the development of creative thinking is not only through learning but also through a culture that is 'wrapped up' in the ability to think creatively. Culture as a source of experience to act creatively. Creative action is shown by the interaction of individuals (personality, intelligence, knowledge, and experience) with contextual factors (education, social environment, family, economic, and physical conditions) [39].

The ability to think critically and creatively students is an important educational goal [40] contained in the curriculum, which is to produce high quality and highly competitive graduates. The ability to think critically and creatively remains permanently stored in

long-term memory. Students can easily summon and utilize critical and creative thinking skills in unfamiliar situations, because the brain learns new patterns but while learning in its own pattern [33].

4. Conclusion

The design of teaching materials with the ACAR model has been able to sharpen the brains of students and inspire them to think critically and creatively because on teaching materials students are actively invited to think. Critical and creative thinking as a logical consequence of brain-based learning that involves all thinking skills to respond carefully and argumentatively to the context. The structured pattern in the format of teaching materials makes it easy for students to accept assignments with no psychological pressure, but there is a challenge to learn. The teaching materials are narrated as if students have a role in them so students are interested and enthusiastic to learn. Critical and creative thinking has become a mandatory menu that is manifested in asking, answering, or presenting ideas. Students who already have the critical and creative thinking skills that have been honed can be utilized in other situations.

5. Acknowledgments

Thank you to Faculty of Social Science, Universitas Negeri Malang, Indonesia who provided support and inspiration for writing this article. All lecturers who participated gave moral support to reach dreams.

References

- [1] Ensar F. How children construct literacy: Piagetian perspective. *International Journal of Secondary Education*. 2014;2(2):34–39. <https://doi.org/10.11648/j.ijssedu.20140202.12>.
- [2] Devries R. Vygotsky, Piaget, and education: A reciprocal assimilation of theories and educational practices. *New Ideas in Psychology*. 2000; 18:187–213.
- [3] Schunk, D. H. *Learning Theories, an Educational Perspective* (6th ed.). Boston, MA: Pearson Education Inc;2012.
- [4] Reed SK. *Cognition theory and applications*. 7th ed. Singapore: Cengage Learning Asia Pte Ltd; 2007.
- [5] Sousa DA. *How the brain learns*. 4th ed. Thousand Oaks, California: SAGE; 2011.

- [6] Solso RL, Maclin OH, Kimberly MM. Cognitive psychology. 8th ed. Boston, MA: Pearson Education Inc.; 2008.
- [7] Jensen E. Brain-based learning. Thousand Oaks, California: SAGE; 2008.
- [8] Ansari, U., & Malik, S. K. Image of an effective teacher in 21st century classroom. *Journal of Educational and Instructional Studies in the World*. 2013;3(4):61–68.
- [9] Pacific Policy Research Center. 21st century skills for students and teachers. Research & Evaluation. Honolulu: Kamahameha Schools, Research & Evaluation Division; 2010.
- [10] Wentworth H. Education for the 21st century: Here, now and into the future. 21st century fluency series. Porto Alegre: Pontifical Catholic University of Rio Grande do Sul. 2016. Available from: <https://ebooks.pucrs.br/edipucrs/relatoriosocial/2016>.
- [11] Seel NM, Lehmann T, Blumschein P, Podolskiy OA. Instructional design for learning, theoretical foundations. Rotterdam: Sense Publishers; 2017.
- [12] Abbie H, Timothy D. The essentials of instructional design. 3rd ed. New York: Routledge; 2016.
- [13] Salmiza S. The effectiveness of brain-based teaching approach in dealing with the problems of students' conceptual understanding and learning motivation towards physics. *Asia Pacific Journal of Educators and Education*. 2012;26(1):19–29.
- [14] Goswami U. Neuroscience and education. *Educational Philosophy and Theory*. *British of Educational Psychology*. 2004;74(1)1–10. <https://doi.org/10.1080/00131857.2013.866532>.
- [15] Marina L, Acosta E, Ferri MM. Reading strategies to develop higher thinking skills for reading comprehension. *Profile Issues in Teachers' Professional Development*. 2010;12(1):107–123.
- [16] Smaldino SE, Lowther DL, Russel JD. Instructional technology & media for learning. 9th ed. Noida: Pearson Prentice Hall; 2008.
- [17] Caine RN, Caine G. Understanding a brain-based approach to learning and teaching. *Educational Leadership*. 1990;48(2):66–70.
- [18] Padget S. Creativity and critical thinking for teachers in training. London: Routledge; 2012. <https://doi.org/0415692822>.
- [19] Changwong K. Critical thinking skill development: Analysis of a new learning management model for Thai high schools. *Journal of International Studies*. 2018;11:37–48. <https://doi.org/10.14254/2071-8330.2018/11-2/3>.
- [20] Gast G. Effective questioning and classroom talk. United Kingdom: NSEAD. 2016. Available from: http://www.nsead.org/downloads/Effective_Questioning&Talk.pdf

- [21] Lau JYF. An introduction to critical thinking and creativity, think more, think better. Hoboken, New Jersey: Wiley; 2011.
- [22] Liebler N. What is critical thinking? *Inquiry: Critical Thinking Across the Disciplines*. 1988;1(1):5–5. <https://doi.org/10.5840/inquiryctnews19881179>
- [23] Pucchio, GJ., Mance M., Suttalse, LB., Reali , PD. Creative thinking and creative problem solving in the 21st century. New York: International Center for Studies in Creativity; 2014.
- [24] Khuana K, Khuana T, Santiboon T. An instructional design model with the cultivating research-based learning strategies for fostering teacher students' creative thinking abilities. *Academic Journals (Educational Research and Reviews)*. 2017;12(15):712–724. <https://doi.org/10.5897/ERR2017.3239>.
- [25] Hong E, Peng Y, O'Neil HF, Wu J. Domain-general and domain-specific creative-thinking tests: Effects of gender and item content on test performance. *Journal of Creative Behavior*. 2013;47(2):89–105. <https://doi.org/10.1002/jocb.26>.
- [26] Baum LM, Newbill PL. Instructional design as critical and creative thinking: A journey through a Jamestown-era Native American village. *TechTrends*. 2010;54(5):27–37. <https://doi.org/10.1007/s11528-010-0434-z>.
- [27] Drapeau P. Sparking student creativity, practical ways to promote innovative thinking and problem solving. Alexandria, Virginia, USA: Association of Supervision and Curriculum Development.2014.
- [28] Glăveanu VP. Distributed creativity thinking outside the box of the creative individual. New York: Springer; 2014. <https://doi.org/10.1007/978-3-319-05434-6>.
- [29] Allen CD. Creative thinking for individuals and teams: An essay on creative thinking for military professionals. Carlisle: United State Army War College; 2012.
- [30] Sarukkai S. Science and the ethics of curiosity. *Current Science*. 2009;97(6):756–767.
- [31] Kidd C, Hayden BY. Perspective: The psychology and neuroscience of curiosity. *Neuron*. 2015;88(3):449–460. <https://doi.org/10.1016/j.neuron.2015.09.010>.
- [32] Litman JA. Psychology of motivation. NewYork: Nova Science Publishers, Inc.; 2007. Curiosity as a feeling of interest and feeling of deprivation: The I/D model of curiosity; p. 149–156.
- [33] Duman B. The effect of brain-based instruction to improve on students' academic achievement in social studies instruction. Paper presented at: 9th International Conference on Engineering Education in San Juan, Puerto Riko 23–28 July; 2006 .
- [34] Taniguchi ST. Outdoor education and meaningful learning: Finding the attributes of meaningful learning experiences in an outdoor education

- program. United State: Brigham Young University; 2004. Available from: <https://scholarsarchive.byu.edu/etd/164>
- [35] Cercone K. Enhancing learning through technology. Chicago: Idea Group Inc; 2006. Brain-based learning; p. 292–322.
- [36] The British Neuroscience Association. Neuroscience, the science of the brain: An introduction for young students. Liverpool: British Neuroscience Association; 2003.
- [37] Browne MN, Keeley SM. Asking the right questions: A guide to critical thinking. 8th ed. New Jersey: Pearson Education; 2007.
- [38] Urban KK. Assessing creativity: The test for creative thinking - Drawing production (TCT-DP). *International Education Journal*. 2005;6(2):272–280.
- [39] Meintjes H, Grosser M. Creative thinking in prospective teachers: The status quo and the impact of contextual factors. *South African Journal of Education*. 2010;30:361–386.
- [40] Bahr N. Thinking critically about critical thinking in higher education. *International Journal for the Scholarship of Teaching and Learning*. 2010;4(2):1–17. <https://doi.org/10.20429/ijstl.2010.040209>.