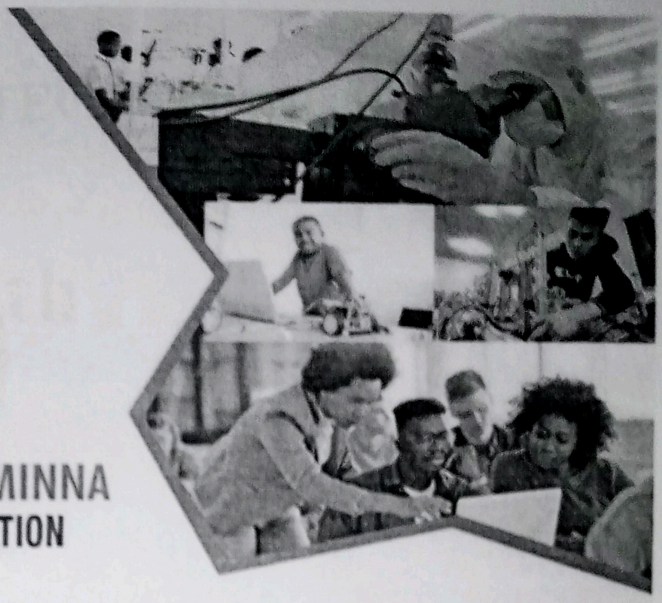

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

9TH SSTE HYBRID International Conference

THEME:
RE-THINKING THE FUTURE THROUGH STEM AND TVET FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

Conference PROCEEDINGS

Monday, 2nd to Friday, 6th October, 2023

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

9th

INTERNATIONAL CONFERENCE OF SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION (SSTE)

ISBN: 979-978-52341-0-7

CONFERENCE PROCEEDINGS

THEME:
"RE- THINKING THE FUTURE THROUGH STEM AND TVET FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS"

DATE: 2ND-6TH OCTOBER, 2023.

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

9th INTERNATIONAL CONFERENCE OF SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION (SSTE)

HYBRID CONFERENCE

ISBN: 979-978-52341-0-7

MEMBERS OF EDITORIAL BOARD

1.	Prof. A. I. Gambari	Dean SSTE
2.	Prof. A. M. Idris	Deputy Dean SSTE
3.	Dr. I. Y. Umar	Chairman LOC
4.	Dr. O. C. Falode	Member
5.	Dr. (Mrs.) F. C. Okoli	Member
6.	Dr. M. U. S. Koroka	Member
7.	Prof. E. Raymond	Member
8.	Dr. A. A. Yaki	Secretary LOC

29. Creative Thinking Skills of Students through Design-Based Learning: A Mandate for Junior Secondary Schools in Nigeria. ***Saliha Musa Abubukar; Yaki, Akawo. A.; Koroka, M. U S., & Umar, M. A.*** 230

30. Effects of Moodle Platform-Enhanced Instruction on Motivation Among Chemistry Undergraduate Students in Taraba State Universities, Nigeria. ***Ezekiel Piusnyatirimoh, Chado A. M., Dalhatu B. M., Sobowale, F. M. &Saifullahi, M.*** 237

31. Effect Of Educational Outcomes On Postgraduate Students' Persistence In Abubakar Tafawa Balewa University, Bauchi. ***Saidu Mansur Adam, Ibrahim Umar Aliyu, Dahiru Usman Jibrin Umar Inuwa,***.....244

32. Impact of Science, Technology, Engineering and Mathematics (STEM) and Technical and Vocational Education Training (TVET) in Alleviating Hunger and Poverty for Sustainable Socio-Economic Development in Nigeria. ***Koleoso, Akinpelu Olujide Ph.D***.....253

33. Challenges of Effective Teaching and Learning in Nigerian Schools inthe Twenty-First Century: The Way Forward. ***Aniah, Anthony, & Mohammed, Umar Masalachi***.....259

34. Chemistry Teachers' Emotional Intelligence Factors as Correlates of Chemistry Students' Performance in Kwara State Senior Secondary Schools. ***Idirisu Jibril Limangba, Dantani Ibrahim Wushishi, Sulaiman Adam, Adigun Olubunmi Peace, Jamilu Usman, Mohammed Shehu, Ambrose Albert, Haruna Hajarat Ozozoma, Yahaya Ibrahim Alfa, & Ibrahim Ibn Ibrahim***.....264

35. Survey of Basic Science and Mathematics Teachers' Readiness to Adopt Mother Tongue Language at Basic Education Grade Level inMinna Metropolis. ***Mohammed, K., Bello, M. R., Bashir, A. U. & Abdurrahman M. A.*** 272

36. Assessment Availability and Utilization Level of Science Laboratory Equipment by Secondary School Science Teachers and Students in Gombe Metropolis, Gombe State. ***Mohammed Alhaji Mohammed, Abdullahi Salami Magaji, Fatima Ibrahim, Adamu Sajeh Daudu, & Daniel Buba Mshelia***.....283

37. Mathematics Mastery and Problem-Solving Ability as Predictors of Senior Secondary School Physics Students in Abaji Area Council. ***Haruna, Sulaiman Salihu, Gana C. S., Gimba R. W.,***.....291

38. Effects of Virtual Laboratory Package on Achievement and Retention in Chemistry among Senior Secondary School Students in Minna Metropolis. ***Mohammed Shehu., Usman, Jamilu., Ibrahim Ibn Ibrahim., Yusuf Adamu Kuta, &Adamu Amina***.....299

39. Connected Learning for STEM (Cl4 STEM) Lesson Plan Approach and Quality STEM Education. ***Zakariya A. A., Obaje N. G., Mustapha M. T., Adelabu S. A., Garba S., & Umar A.***.....308

40. Effect of Self-Directed Learning Strategy on Students' Achievement and Interest in Basic Technology for Sustainable Development. ***Abdullahi H. Muhammad., Shuaibu Saminu., Karfe, Roseline Yusuf., Zakari Mohammed., Kabiru Bala & Umar Jiya***.....314

CREATIVE THINKING SKILLS OF STUDENTS THROUGH DESIGN-BASED LEARNING: A MANDATE FOR JUNIOR SECONDARY SCHOOLS IN NIGERIA

SALIHA MUSA ABUBUKAR[1]; YAKI, AKAWO. A.[2]; KOROKA, M. U S[3]., UMAR, M. A.
Department of Science Education School of Science and Technology Education
Federal University of Technology Minna, Niger State
Corresponding E-mail; salihamusa07@gmail.com./ +234 805 771 9039

Abstract

This paper explores the importance of equipping students with Creative thinking skills in response to the growing demand from employers in the 21st century. Specifically focusing on junior secondary schools in Nigeria, the study investigates strategies for restructuring the educational system to foster the development of Creative thinking abilities among young learners using design-based learning, to make them problems solvers; hence they become asset in the society rather than liabilities to the Nigerian society. This paper in clear terms examined the concept of Creative thinking, the importance of Creative thinking to the nation, Design-Based Learning as a methods of inculcating Creative thinking skills in students specifically in junior secondary educational level. It was concluded that Creative thinking skills are critical for personal success, national peace, progress and development, it should be integrated at all level of education especially at the secondary level of education for the common good of all. It was recommended among others that teachers should adopt innovative and suitable methods of teaching such as design-based learning that are consistent with the development of Creative thinking skills in students.

Keywords; Creative thinking skills, Design-based Learning, and Secondary education

Introduction

The world is fraught with myriad of problems. These problems, created by man in his daily interactions with both his physical and social environments, are getting more and more complex by the day. According to Adeyemi (2012), in any society, human life is a series of confrontations- confrontation with oneself, with other people, with societal institutions and with one's environment. These leave man with limitless problems to battle with in the society. The person who can successfully deal with these problems and issues and that can face them squarely with self-confidence is the one imbued with the right type of knowledge, skills and competencies required to solve these problems. Education definitely has an obligation and function to equip the learners with the mechanisms of dealing with the problems and emerging dilemmas, in order to make them live a happy and fulfilled life in the society. This is why the most challenging role of education generally today, is to equip the students with the ability and capability to deal successfully with the fast dynamic world and the unknown future. Obviously, current situations and problems may become obsolete when students of today face the world as adult's tomorrow. One of the tools which education (particularly higher education) can perfectly provide for these youngsters is Creative thinking which provides them with the needed skills to solve problems and issues in the environment regardless of their nature. More than ever before in Nigeria today, there is the need for commitment to the resolution of the ensuing societal problems through appropriate education. The individuals who seek to resolve issues and problems without the appropriate skills, abilities and proper understanding of the problems, often tend not only to behave irresponsibly and erratically, but also in ways that damage their own future and the human condition in the society.

Education, the world over, remains the most potent weapon of development. This is why in the National policy on education; it has been described as an instrument "par excellence" for effecting national development (FRN, 2013). Experts in the field of education have given various definitions to the term 'education'. Suffice it to give a simple and functional definition of the term, as it constitutes one of the key words of the title of this paper.

Angel-Fernandez and Vincze (2018), Lévesque and Clark (2018) define education as "the process of development of an independent and integrated personality, which entails the training and acquisition of special knowledge, skills, attitudes and values needed by an individual to be responsible and which would enable him to contribute his own quota to the growth of the society of which he is a member".

When subjected to proper analysis, it is discovered that this definition perfectly agrees with the driving force of Nigeria's philosophy of education which are:

a. the development of the individual into a sound and effective citizen;
b. the full integration of the individual into the community; and
c. the provision of equal access to educational opportunities for all citizens of the country at the primary, secondary and tertiary levels, both inside and outside the formal school system (NPE, 2004).

However, the goals which the Nigerian nation is set to achieve through the provision of sound education to her citizens include:

a. the inculcation of national consciousness and national unity;
b. the inculcation of the mind type of values and attitudes for the survival of the individual
c. and the Nigerian Society;
d. the training of the mind in the understanding of the world around; and
e. the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as equipment for the individual to live in and contribute to the development of the society, (FRN, 2013).
f. As it can be observed, the needs and aspirations of the nation have been aptly captured by these goals. This goes to say that, any form of education provided in any country must take cognizance of the needs of its people for that education to be seen to be functional. Education is a life-long process, which aims at imparting skills and knowledge needed to lead a purposeful life and equip the learners so as to be able to adjust to the remote and immediate environment in which he finds himself.

Therefore, if education must be seen as performing its expected roles in the society, it must provide the learner with the relevant body of knowledge, skills, attitudes and values that would make him an active and effective member of his society. One of such skills or abilities the learner is expected to be imbued with is Creative thinking, which is the focus of this paper. It is believed that the learner imbued with Creative thinking ability would be able to solve his personal problem(s), the problem(s) in his family and by extension, solve societal problem(s) in whatever sphere of life such problems may manifest (Adeyemi, 2012). This way, the learner becomes a problem – solver rather than problem – creator. And these are the kind of individuals the society desires to raise, which is in consonance with the goals of education mentioned above.

Concept of Creative thinking

Creative thinking features prominently in all the skills or abilities learners are expected to acquire through the type of education being provided. One, who cannot think, may not be able to solve even the minutest problem. We now live in a world of problems – social problem, economic problem, political problem, ethnic problem, religious problem, educational problem, Science and technologically related problems to mention a few. It only takes a sound mind, a mind imbued with reflective thinking, which can engage in deep analysis, to come up with causes of the problem at hand and generate possible solutions or options to arrive at a decision; to solve or get out of the problem (Adeyemi, 2012).

Creative thinking like the concept of education has been defined in so many ways by writers and researchers. According to Oyler and Romanelli (2014) Creative thinking is regarded as a type of critical analysis has been described as "disciplined intellectual criticism that combines research, knowledge of historical context and balanced judgment: It is the ability to think logically and analytically. In other words, Creative thinking is the purposeful and reflective judgement about what to believe or what to do in response to observation, experience, verbal or written expressions or arguments. Thus, Creative thinking involves determining the meaning and significance of what is observed or expressed, or concerning a given inference or argument, determining whether there is adequate justification to accept the conclusion as true. This definition agrees with the one given by Bobkina and Stefanova (2016) as: "skilled and active interpretation and evaluation of observations, communications, information and argumentation". Creative thinking therefore gives due consideration to the evidence, the context of judgement, the relevant criteria for making the judgment well, the applicable methods or techniques for forming the judgment and the applicable theoretical construct for understanding the problem and the

question at hand. Creative thinking employs not only logic but broad intellectual criteria such as clarity, credibility, accuracy, precision, relevance, depth, breath, fairness and significance. In contemporary usage, the word "critical" may connote expressing disapproval, which is not always true of Creative thinking. A critical evaluation of an argument, for instance, might conclude that it is valid.

Similarly, Afsahi and Afghari (2017) has defined it as: "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, the foundation claimed that it is based on universal intellectual values of clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth and fairness. In its simplest form, Creative thinking may be conceived of as that mode of thinking about any subject, content or problem, in which the thinker improves the quality of his thinking by skillfully taking charge of the structures inherent in thinking, and imposing intellectual standards upon them.

It may be observed from the above that Creative thinking entails those structures or elements of thought implicit in all reasoning such as purpose, problem or question – at - issue, assumptions, concepts, empirical grounding, reasoning leading to conclusions, implications and consequences, objections from alternative viewpoints and frame of reference. Creative thinking, being responsive to various subject matters, issues and purposes, is incorporated in a family of interwoven modes of thinking which include: scientific thinking, mathematical thinking, historical thinking, anthropological thinking, economic thinking, moral thinking and philosophical thinking (Afsahi and Afghari, 2017).

Creative thinking may be seen as having two components i) the skills to generate and process information and beliefs, ii) the habit of using those skills to guide behaviors, based on intellectual commitment. These components should be contrasted with:

a. the mere acquisition and retention of information alone, this is because it involves a particular way in which information is sought and treated;
b. the mere possession of a set of skills, because it involves the continual use of them; and
c. The mere use of those skills ("as an exercise") without acceptance of them

Consequent upon the foregoing, it may be summarized therefore that, Creative thinking is self-guided, self-disciplined, self-directed, self-monitored and self-corrective thinking, which attempts to reason at the highest level of quality in a fair-minded way. Thus, people, who think critically consistently, attempt to live rationally, reasonably and empathically. They are keenly aware of the inherent flawed nature of human thinking when left unguided. They strive to diminish the power of their egocentric and socio-centric tendencies. They use the intellectual tools offered by Creative thinking such as concepts and principles that enable them to analyze, assess and improve thinking. They work diligently to develop the intellectual virtues of intellectual integrity, intellectual humility, intellectual civility, intellectual empathy, intellectual sense of justice and confidence in reason. They realized that no matter how skilled they are as thinkers, they can always improve their reasoning abilities and that they can at times fall prey to mistakes in reasoning, human irrationality, prejudices, biases, distortions, uncritical accepted social rules and taboos, self-interest and vested-interest. People who can think critically strive to improve the world in whatever ways they can and contribute to a more rational and civilized society. Even at that, they recognize the complexites that are inherent in doing so. They avoid thinking simplistically about complicated issues and strive to appropriately consider the rights and needs of relevant others. They also are aware of the complexities in developing as thinkers, and as such got committed to life-long practice toward self-improvement. The critical thinkers exemplify the Socratic principle: "The unexamined life is not worth living", because of their belief that many unexamined lives together result in an uncritical, unjust, and dangerous world (Achilov, 2017).

Importance of Creative thinking to the Nation

Implicit in the few definitions of Creative thinking attempted above is the importance of Creative thinking to the individuals in particular and the nation in general. No doubt, everybody thinks, and it is our nature to do so. However, thinking is often casual and informal. Most of our thinking if left to itself is biased, distorted, partial, uninformed or down-right prejudiced. Yet the quality of our lives and that

of what we produce, make or build depends precisely on the quality of our thought. Shoddy thinking is costly, both in money and in quality of life. This fact underpins the importance of Creative thinking in the life of a nation and that of the individual (McPeck, 2016). This is because Creative thinking enables one to analyze, evaluate, explain and restructure his thinking, thereby reducing the risk of adopting, acting on, or thinking with a false belief. However, even with knowledge of the method of logical inquiry and reasoning, mistakes can happen due to a thinker's inability to apply the methods or because of character traits such as egocentricism (Padmanabha, 2018). Creative thinking includes identification of prejudice, bias, propaganda, self-deception, distortion, and misinformation and among others. We live in a world of problems, and it is imperative for the individual, particularly students in the country to be equipped with the skills, abilities and capabilities to get their problems and those of the society solved, thereby, making the nation a worthwhile place to live in

Effecting Creative Thinking Skill in the Students through Basic Education

One pertinent question that comes to mind at this juncture is: "how to develop Creative thinking skills in students". It is interesting to note that Creative thinking ability can be inculcated in the learner at any point of the educational hierarchy (from primary school to tertiary institutions). What varies is the level of engagement at each level. Thus, while it is important to start developing Creative thinking in the learner right from the primary school, it is better affected in students at the tertiary level (Huang *et al.*, 2017). This is because students at this level are more mentally matured to cope with the rigors involved.

However, the question on how to develop the ability in students still remains. This is a methodological issue. What method do we adopt in order to effectively develop Creative thinking in the students? As may be observed, Creative thinking is about being both willing and able to evaluate one's thinking, and could be affected through the teaching and learning of any subject on the school curriculum.

Developing Creative thinking skills in students, involves learning the art of suspending judgement (for example, when reading a novel, watching a movie, engaging in dialogical/dialectical reasoning) (Vincent-Lancrin, 2023). To do this successfully, one should adopt a perspective rather than judgmental orientation; that is, avoiding moving from perception to judgment as one applies Creative thinking to issues. Creative thinking is based on concepts and principles, not on hard and fast rules. These concepts are exemplified in: identification of problem, rational inquiry, conceptual analysis, logical reasoning, nature of argument, identification of premises, and conclusion; while principles involved in Creative thinking include: acquisition of knowledge through thinking, reasoning and questioning based on facts; learning what to think through how to think; judgment of effectiveness of argument through reflective thinking; Creative thinking as a search for meaning and Creative thinking as a skill that can be learned among others.

It employs not only logic (formal/informal), but broad intellectual criteria of clarity, credibility, accuracy, precision, relevance, depth, breadth and significance. Creative thinking is highly significant to learning (Vincent-Lancrin, 2023). There are two phases to the learning of content. The first occurs when learners construct in their minds the basic ideas, principles and theories that are inherent in the content, for the first time. This is a process of internalization. The second phase occurs when learners effectively use those ideas, principles and theories as they become relevant in the learners' lives - known as the process of application. Good teachers cultivate Creative thinking, that is, intellectually engaged thinking, at every stage of learning (Gunawardena & Wilson, 2021). The teacher questions the students often in a Socratic manner. The point here is that, the teacher who fosters Creative thinking fosters reflectiveness in students, by asking questions that stimulate thinking which is essential to the construction of knowledge.

Each discipline adapts the use of Creative thinking concepts and principles. The core concepts are embedded in the content of each subject. For students to learn content, intellectual engagement is crucial. All students must do their own thinking and construction of knowledge. Good teachers are aware of this, and therefore focus all teaching and learning activities in the class to stimulate the mind to master key concepts, principles and generalizations underlying the subject.

Design-based Learning

Design- based learning has been defined by so many scholars in many ways and there is no consensus in the definition of DBL. DBL has been referred to as a "model", "approach" or a "technique", or as "learning" or "teaching". Design-based learning according to Geitz and de Geus (2019) Design- based learning (DBL) is a model of instruction that exposes students' with real life, multidisciplinary problems that require Creative thinking, hands on activities and collaboration (Liang, 2022) Buck institute define DBL as a systematic pedagogy that engages students' in learning knowledge and skills through an extended inquiry process structured around complex, authentic question and carefully designed product and task. Zhang *et al.* (2020) define design-based learning as a student centered approach that engages students' as they use the inquiry process as they are given a real world situation or problem to solve while also being aligned to content standards. In fact as long as there is a tendency that the teachers do not have time to develop a learning device that is capable of integrating the issues in real life by planting a character that can improve Creative thinking skills of student in defining the problem, taking action to get findings, taking decisions and evaluating issues in real life is also a sensitive issue and it contains a moral dilemma, which is supposed to be a valuable learning resource for the character development of students' in school (Duran & Sendag, 2012). Sahin (2015) pointed out the goal of DBL is to make students' become aware of the connections between the academic knowledge and its applications in real life while gaining a deeper understanding of concepts. The genesis of a DBL is inquiry, in a design-based learning environment, the focus in the classroom shifts from teacher led instruction to student-led instructions. The students' become the navigators directing their learning through the inquiry process and the development of design- based learning experiences. The teacher becomes more of a facilitator as the focus in the classroom moves from the instructors teaching the content to students' learning the content through the inquiry process and problem solving (Sahin, 2015). The instructor provides the students with a list of guidelines, a time line, and helps them create a plan of action for the project (Silberman *et al.*, 2021). The students' will decide how they will solve the design-based learning project through the use of the inquiry process. Due to the nature of design-based learning, the students' may arrive at a solution which is not an area of expertise for the instructor (Silberman *et al.*, 2021). These situations create discussion opportunities and the possibility of a new and exciting solution to the problem (Silberman *et al.*, 2021). Thus, creating a learning environment that is conducive and exciting for learners. The main focus of DBL is an emphasis on students' having autonomy to make decisions about the direction of their project (Boss & Stefanou *et al.* 2021). DBL begins with a student- driving question and uses an integrated curriculum approach to investigate the question, or problem. In this way the teacher facilitates the process but the learner is in the 'driver's seat' and is guided through each step of the process by the teacher (Bell, 2010).

Conclusion and Recommendations

From the discourse above, it can be concluded that since Creative thinking is a precursor to personal success, national peace, progress and development, it should be addressed with all the seriousness it requires by all stake holders for the common good of all. To this end, it is hereby recommended that:

a. Creative thinking is introduced as a separate subject or course in our learning institutions.
b. Teachers should be encouraged to operate more in classroom, at higher level of cognition than the lower level.
c. Teachers should adopt suitable methods of teaching such as Socratic method, Inquiry method, problem-solving method etc. that are consistent with the development of Creative thinking skill in students.
d. Both teachers and students should imbibe the attitude of intellectual empathy and intellectual humility, culminating in broad-mindedness needed for the development of the skill.
e. It is not just enough to acquire the knowledge and the skills involved in Creative thinking, learners should be encouraged to apply such skills in their daily lives.

In summary, according to Patton *et al.,* (2013) ability to think critically involves three things namely;

a. An attitude of being disposed (that is, the state of the mind regarding something) to consider in a thoughtful way the problems and subjects that come within the range of one's experiences;
b. Knowledge of the methods of logical inquiry and reasoning; and
c. Some skills in applying those methods

Creative thinking calls for a persistent effort to examine any belief or any form of knowledge in the light of the evidence that support it and the further conclusions to which it tends

References

Achilov, O. R. (2017). Improving students' Creative thinking through creative writing tasks. In *International Scientific and Practical Conference World science* (Vol. 4, No. 4, pp. 19-23).

Adeyemi, S. B. (2012). Developing Creative thinking skills in students: A mandate for higher education in Nigeria. *European journal of educational research*, *1*(2), 155-161.

Afsahi, S. E., & Afghari, A. (2017). The relationship between mother tongue, age, gender and Creative thinking level. *Journal of Applied Linguistics and Language Research*, *4*(1), 116-124.

Angel-Fernandez, J. M., & Vincze, M. (2018). Towards a definition of educational robotics. In *Austrian Robotics Workshop 2018* (Vol. 37).

Bobkina, J., & Stefanova, S. (2016). Literature and critical literacy pedagogy in the EFL classroom: Towards a model of teaching Creative thinking skills. *Studies in second language learning and teaching*, *6*(4), 677-696.

Duran, M., & Sendag, S. (2012). A preliminary investigation into Creative thinking skills of urban high school students: Role of an IT/STEM program. *Creative education*, *3*(02), 241.

Federal Republic of Nigeria, FRN, (2013). *National Policy on Education*, (6th Edition) Federal Republic of Nigeria, Lagos: Federal Ministry of Education.

Geitz, G., & de Geus, J. (2019). Design-based education, sustainable teaching, and learning. *Cogent Education*, *6*(1), 1647919.

Gunawardena, M., & Wilson, K. (2021). Scaffolding students' Creative thinking: A process not an end game. *Thinking Skills and Creativity*, *41*, 100848.

Huang, M. Y., Tu, H. Y., Wang, W. Y., Chen, J. F., Yu, Y. T., & Chou, C. C. (2017). Effects of cooperative learning and concept mapping intervention on Creative thinking and basketball skills in elementary school. *Thinking Skills and Creativity*, *23*, 207-216.

Lévesque, S., & Clark, P. (2018). Historical thinking: Definitions and educational applications. *The Wiley international handbook of history teaching and learning*, 117-148.

Liang, W. (2022). Towards a set of design principles for technology-assisted critical-thinking cultivation: A synthesis of research in English language education. *Thinking Skills and Creativity*, 101203.

McPeck, J. E. (2016). *Creative thinking and education*. Routledge.

Oyler, D. R., & Romanelli, F. (2014). The Fact of Ignorance Revisiting the Socratic Method as a Tool for Teaching Creative thinking. *American Journal of Pharmaceutical Education*, *78*(7).

Padmanabha, C. H. (2018). Creative thinking: Conceptual Framework. *Journal on Educational Psychology*, *11*(4), 45-53.

Patton, K., Parker, M., & Pratt, E. (2013). Meaningful learning in professional development: Teaching without telling. *Journal of Teaching in Physical Education*, *32*(4), 441-459.

Sahin, A. (2015). STEM students on the stage (SOS): Promoting student voice and choice in STEM education through an interdisciplinary, standards-focused project based learning approach. *Journal of STEM Education*, *16*(3).

Silberman, D., Carpenter, R., Takemoto, J. K., & Coyne, L. (2021). The impact of team-based learning on the Creative thinking skills of pharmacy students. *Currents in Pharmacy Teaching and Learning*, *13*(2), 116-121.

Stefanou, C., Stolk, J. D., Prince, M., Chen, J. C., & Lord, S. M. (2013). Self-regulation and autonomy in problem-and project-based learning environments. *Active Learning in Higher Education*, *14*(2), 109-122.

Vincent-Lancrin, S. (2023). Fostering and assessing student Creative thinking: From theory to teaching practice. *European Journal of Education*, *58*(3), 354-368.

Zhang, F., Markopoulos, P., Bekker, T., Paule-Ruíz, M., & Schüll, M. (2020). Understanding design-based learning context and the associated emotional experience. *International Journal of Technology and Design Education*, 1-38.