Exploring the Impact of Constructionism on Fostering Creative Thinking

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Abstract

In this article, constructionism, a learner-centered learning theory, is explored in terms of how it contributes to the development of creative thinking. It presents the way in which the creativity principles are associated with the active learning, problem-solving, personal relevance, collaboration, and tangible outcomes. It discusses theoretical foundations of constructionism as they relate to cognitive development and creativity: how constructionism enhances both interactive learning and cognitive growth. Plus, it provides practical approaches for instructional designers and educators to effectively integrate constructionism into the educational environment. These approaches included a project-based learning, autonomous learning, and interdisciplinary approaches. The article posits that the integration of constructionism and creativity can foster the development of creative thinking and problem-solving skills in learners. These skills are essential for individuals to cope with the complexities and opportunities of a continuously developing globalized world.

Introduction

The field of education faces constant changes, prompting an equivalent advancement in the skills that students must learn in order to attain success in the 21st century (Trilling & Fadel, 2009). Among those skills, creative thinking and problem-solving skills have a vital role in promoting innovation and aiding adaptation (Dyer et al., 2011; Robinson & Aronica, 2016). To foster these skills in students,

it is essential for educators to endorse pedagogical approaches that facilitate the cultivation of inventive ideas and solutions to sophisticated challenges (Robinson & Aronica, 2016). One such approach is constructionism, an educational theory that has gained popularity in recent decades due to its ability to promote creative ideation (Papert, 2020; Resnick & Kafai, 1996; Tracy, 2014).

According to Seymour Papert's educational theory, known as constructionism, students can achieve the best learning outcomes when they actively participate in the construction of knowledge through the creation of tangible artifacts and participation in project-based activities. This framework was established based on Papert's pioneering work (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). By applying this notion in an educational setting, students can use their cognitive and creative abilities to solve real-world problems more effectively, surpassing the traditional approaches to learning (Martinez & Stager, 2016; Papert, 1991; Resnick & Kafai, 1996).

Throughout history, numerous renowned educational and psychological theories have demonstrated alignment with constructionism, including constructivism, cognitive development, and social learning theories (Ackermann, 2001; Bandura, 1977; Fosnot, 2013; Papert, 2020). They emphasize the importance of active engagement, social interaction, and the role of peers and mentors in the process of learning (Ackermann, 2001; Bandura, 1977; Fosnot, 2013; Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). Constructionism offers an appropriate foundation for understanding the developmental process of students' creative ideation within the framework of these underlying theoretical viewpoints (Gagnon & Collay, 2001; Harel & Papert, 1991; Resnick & Kafai, 1996; Sawyer, 2004).

The goal of this article is to establish an extensive review of the fundamental connection between constructionism and creativity. The study examines the fundamental principles of constructionism as they correspond to established theories of creative thinking and analyzes their impact on the cognitive, psychological, and social dimensions of the learning process.

The comprehension of the association between constructionism, the process of generating creative ideas, and the underlying related theories is of significant importance to educators and practitioners in the field of education. This understanding aids them in their exploration of innovative approaches to equip students with the essential skills required to effectively respond to the demands of the modern world. In addition, based on theoretical insights obtained from constructionism and creativity theories, this study provides both theoretical and practical recommendations for designing constructionist

educational programs, curricula, and classroom practices with the goal of fostering students' creative thinking and problem-solving skills.

What is Constructionism?

Constructionism is an educational theory that places emphasis on the notion that effective learning takes place through active and creative engagement in projects involving the construction, design, or work with tangible objects or intangible-concepts (Ackermann, 2001; Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). Important concepts derived from this theory suggest that students learn most effectively when they actively contribute to the construction of objects, computer programs, artwork, and even abstract concepts (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022).

Fundamental Principles of Constructionism

Harel and Papert (1991), Resnick and Kafai (1996), Ackermann (2001), Kafai and Burke (2016), and Papert (2020) have asserted that the constructionist approach to learning is an effective learning strategy offering many benefits toward learners. They put forth several essential fundamental constructionist ideas, namely, learning by doing, personal relevance, interacting with others, reflecting, producing tangible products, optimizing technology and tools, scaffolding guidance, fostering interdisciplinary learning, and encouraging students to take responsibility for their own learning.

1. Learning by Doing: Ideal learning outcomes are accomplished, according to the constructionist perspective, when students actively engage in the processes of constructing, creating, and problem-solving. Hands-on learning allows students to actively engage in exploration, experimentation, and problem-solving; thereby fostering a deeper understanding of the topic. This strategy facilitates the development of student creativity by providing numerous opportunities for experimentation, risk-taking, and the investigation of diverse ideas.

2. Personal Relevance: Constructionism encourages students to participate in projects that match their interests and are important and relevant to them. When students engage in a project that has personal significance and captures their attention, their learning experience becomes more effective. This fosters intrinsic motivation, which is the internal drive to participate in an activity for its own sake

and enhances creativity. Students who have autonomy and control over their projects are more likely to show increased motivation and creativity.

3. Freedom to Experiment and Take Risks: Constructionist settings provide students the opportunity to engage in experimentation, embrace errors, and implement projects with a sense of freedom. Students have the opportunity to investigate novel approaches without experiencing apprehension over potential setbacks or irritating punishment. The presence of freedom in a given context facilitates the development of creative thinking by establishing a state of psychological safety, whereby individuals are less affected by the fear of making mistakes, thus boosting their creativity.

4. Social Interaction: Collaborative learning and social engagement are fundamental elements that constitute the core of the constructionist approach. Students are actively encouraged to engage in collaborative efforts; foster a culture of sharing their creative outcomes, and mutually benefit from sharing learning experiences. This kind of social engagement fosters a mindset among students that promotes diverse thinking and cognitive flexibility. The presence of a social component serves to strengthen the process of learning and supports the development of collaboration and communication skills.

5. Reflection and Iteration: The activity of making or constructing involves the practice of reflection and modification. Learners are encouraged to engage in critical thinking on their work, facilitating the identification of areas for improvement and the refinement of their work. This process fosters the development of a deeper sense of comprehension. It is strongly encouraged for students to engage in an ongoing process of evaluating their work, implementing necessary modifications, and enhancing their inventions. The iterative process facilitates the cultivation of creativity among students by offering them to produce, evaluate, and refine their ideas.

6. Tangible and Shareable Products: Performing the process of creating project, yields tangible products or artifacts that are capable of being shared to others. These products act as tangible manifestations of obtained knowledge and skills, thereby establishing a sense of accomplishment and confidence in the learners. Making something tends to strengthen the connection between the conceptualization of ideas and the actualization of physical or digital artifacts. In addition, students have the opportunity of sharing their creations among peers and receive comments and acknowledgement for their efforts.

7. Technology and Tools: Although not entirely relying on technology, constructionism often incorporates the use of technological resources, including computers, software, or digital tools, to enhance the process of production. The use of technology has the potential to enhance the opportunities for both construction and creativity.

8. Scaffolding and Guidance: Within the context of constructionist learning settings, educators assume the role of facilitators rather than traditional teachers. Academic instructors provide direction and assistance to students who are engaged in assignments that exceed their present level of competence. With the assistance they need, this scaffolding helps them to think outside the box and be more imaginative; this guideline is intended to facilitate the learning and personal development of individuals, avoiding providing explicit instructions or imposing specific methods.

9. Interdisciplinary Learning: A constructionist project often facilitates the integration of several academic disciplines, fostering a comprehensive approach to education. The use of an interdisciplinary approach in problem–solving and creativity is evidence of its alignment with the real–world circumstances of the world. The combination of many academic disciplines in the learning process fosters creativity among students and provides them with knowledge among numerous courses and highlights the interrelationships between them. Students have the ability to use several areas of knowledge and create novel connections and innovations across different academic fields.

10. Ownership of Learning: When learners engage actively in a learning process, they take on the responsibility for their own education. Individuals possess a certain degree of freedom in determining the nature of their creations, the methodologies used in their production, and the acquisition of knowledge that ensues from those efforts.

Constructionism is an educational philosophy that places a significant emphasis on the active and creative involvement of the learners in the process of developing their own knowledge. Through active participation in projects that have personal significance, foster social interaction, and enhance technology advancements, learners are able to cultivate a profound comprehension of the subject matter at hand as well as gain insights into their own personal growth and development.

Bridging Constructionism and Creativity Theories in Creative Ideation

Constructionism aligns with and complements theories of creativity and creative ideation in several ways, as it provides an educational framework that fosters the development of creative thinking skills (Ali et al., 2019; Holbert et al., 2020; Kynigos, 2015; Martinez & Stager, 2016). The connection between constructionism and theories of creativity is evident through aspects including active learning and creative problem solving, freedom to explore and experiment, personal relevance and intrinsic motivation, collaboration and social interaction, tangible creations as evidence of creativity, reflection and iteration, interdisciplinary learning, and ownership of learning.

1. Active Learning and Creative Problem Solving: Constructionism puts a significant focus on engaging in active and experiential learning. When students participate in the process of constructing, developing, and fabricating physical items or projects, they are actively engaged in the cognitive process of problem-solving (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). This is consistent with theories of creativity that prioritize problem-solving as a fundamental aspect of creative cognition (Amabile, 1983a, 1983b; Csikszentmihalyi, 2013; Newell et al., 1962; Runco, 1997; Sternberg, 1999). Creativity frequently encompasses the discovery of innovative approaches to overcome obstacles, and constructionist activities serve to foster students' ability to approach difficulties with creativity.

2. Freedom to Explore and Experiment: Constructionism, promotes and encourages learners to engage in activities that include exploration, experimentation, and the willingness to take risks. The freedom to experiment and the potential for mistakes are fundamental elements in cultivating creativity (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). The significance of divergent thinking, which refers to the capacity to produce an extensive variety of ideas, is emphasized in several theories of creativity (Acar & Runco, 2019; Baer, 2014; Hornberg & Reiter-Palmon, 2017; Runco, 1990; Runco & Acar, 2019; Sternberg, 2018; Torrance, 1962). Constructionism creates an ideal setting for fostering novel thinking via the facilitation of student inquiry and the exploration of a number of solutions.

3. Personal Relevance and Intrinsic Motivation: The presence of personal engagement and motivation has been identified as a catalyst for the prospering of creativity, as supported by numerous researchers (Amabile, 1996; Csikszentmihalyi, 2013; Hennessey, 2019; Ryan & Deci, 2000; Saether, 2020). Constructionism is in accordance with this idea since it enables students to engage in project-based learning that has personal significance to them. When students have the freedom to

choose subjects or projects that align with their own interests, they are more inclined to exhibit intrinsic motivation, a factor that has been recognized to positively impact creativity.

4. Collaboration and Social Interaction: Numerous theoretical frameworks of creativity, stress the significance of collaborative efforts and social interaction (Barrett et al., 2021; Jacobs & Lawson, 2017; Sawyer, 2019). Constructionism promotes collaborative learning, fostering an environment that students engage in collective efforts, exchange ideas, and acquire knowledge via mutual interaction (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). Collaborative projects can expose students to diverse perspectives and inspire innovative solutions (Barrett et al., 2021; Hundschell et al., 2022; Soomro et al., 2023). Constructing and creating together also promote the exchange of ideas and constructive feedback (Papert, 2020; Resnick & Kafai, 1996).

5. Tangible Creations as Evidence of Creativity: Creative ideation often results in tangible products or artifacts (Henriksen et al., 2018; Kind, 2022; Sawyer, 2004a). In constructionism, the creation process leads to the development of tangible objects, whether they are physical or digital (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). These products provide students with tangible indicators of their creative thinking and a sense of fulfillment.

6. Reflection and Iteration: Constructionist learning encompasses a reflective procedure in which students evaluate their work, recognize areas that need improvement, and engage in iterative processes to refine their creations (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). The iterative technique is consistent with theories of creativity that highlight the need of continuous refining and rewriting of ideas in order to attain a high level of creative excellence (Busse & Mansfield, 1980; Kozbelt et al., 2010; Runco, 2009).

7. Interdisciplinary Learning: Numerous theories pertaining to creativity, propose that the formulation of innovative ideas often occurs when different disciplines or domains of knowledge interact (Csikszentmihalyi, 2013; Johansson, 2017; Johnson, 2010; Weisberg & Reeves, 2013). Constructionism often adopts an interdisciplinary methodology that promotes the use of many domains of knowledge by students in order to address complicated challenges (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). The interdisciplinary nature of this approach is consistent with theories that highlight the integration of many forms of information to foster innovative thinking.

8. Ownership of Learning: Both constructionism and theories of creativity, acknowledge the significance of giving learners autonomy and responsibility in their educational pursuits. Constructionism is an educational approach that students engage in active involvement in the process of defining their projects, therefore fostering a feeling of ownership (Papert, 2020; Resnick & Kafai, 1996; Tep & Tanprasertkul, 2022). The importance of autonomy and human agency in the creative process is also emphasized in other theories of creativity (Amabile, 2011; Pink, 2010; Rejskind, 1982; Wang, 2013).

In brief, constructionism aligns with theories of creativity that propose an educational approach emphasizing active involvement, personal relevance, the opportunity to explore, collaborative endeavors, and the production of tangible results. Constructionism is an educational approach that fosters an atmosphere that contributes to the cultivation and enrichment of creative problem-solving skills. This concept is consistent with the foundational principles of theories on creativity and promotes the development of creative thinking in individuals.

Constructionist Education, Curriculum, and Classroom Practices Promote Creativity

The enhancement of constructionism's efficacy in fostering creative thinking among students may be achieved by integrating theories of creativity into the design of constructionist educational programs, curriculum, and classroom practices. This implies that educational programs, curriculum, and classroom practices should align with the principles and approaches derived from the theories of creativity and constructionist learning.

One of the ways to promote divergent thinking and creativity in students using constructionist educational programs, curriculum, and classroom practices is to emphasize project-based learning (PBL; Harel & Papert, 1991; Holbert et al., 2020; Markham et al., 1999; Resnick & Kafai, 1996). PBL engages students in open-ended, exploratory projects that allow for a range of creative responses and solutions to real-world challenges (Kokotsaki et al., 2016; Markham et al., 1999). To implement PBL effectively in a constructionist learning context, curriculum design and classroom practices should be informed by theories of creativity that suggest various ways to foster creative thinking and problem-solving skills in students.

Some of the activities that can encourage students to generate multiple ideas, solutions, or interpretations for a given problem are brainstorming (Rawlinson, 2017), mind mapping (Anderson,

2020), sketching (Gallagher, 2017), prototyping (Agustiana et al., 2018), etc. These activities can stimulate their imagination and help them discover new possibilities (Agustiana et al., 2018; Anderson, 2020; Gallagher, 2017). An additional strategy for creativity enhancement is the combination of real-world and open-ended problems or challenges that can be addressed using innovative or creative solutions (Dulac-Arnold et al., 2021; Nilimaa, 2023; Ritter & Mostert, 2017; Sarathy, 2018). The enduring issue or challenge plays a role as a motivational resource for students that encourages them to apply their knowledge and talents in a creative and innovative manner (Bartholomew & Strimel, 2018; Dulac-Arnold et al., 2021; Nilimaa, 2023). For instance, learners may try to address any problems or issues or fulfil specific needs in their community using their creative abilities to construct a diverse range of projects, including games, computer applications, robots, or musical instruments.

It is crucial for instructors to offer students with autonomy, the decision making, and opportunities to work on projects that are aligned with their interests which in response foster a stimulating and engaging learning environment. (Jang et al., 2010; Nave, 2015; OECD, 2009; Ryan & Deci, 2000). This has the potential to enhance learners' intrinsic motivation and cultivate their passion for the process of acquiring knowledge (Tep & Tanprasertkul, 2022). Numerous studies have shown a positive correlation between intrinsic motivation and creativity (de Jesus et al., 2013; Fischer et al., 2019; Hennessey, 2016, 2019; Kaufman & Sternberg, 2021). Furthermore, the process of giving students the autonomy to choose their projects and shape the direction of their learning can effectively create an attitude of empowerment within them, fostering a greater sense of responsibility for their own learning and enabling them to actively follow their own interests.

An additional suggested approach for cultivating creativity within a constructionist environment is the utilization of interdisciplinary, which enables students to integrate a wide range of knowledge domains into their project-based tasks (Aguilera & Ortiz-Revilla, 2021; Clark & Wallace, 2015; Tan, 2017; Tang, 2019). When students engage in this method, they have the potential to broaden their learning horizons through the combination of various perspectives and academic disciplines (Oudenampsen et al., 2023; Strachan & Block, 2020). For instance, students might incorporate a range of academic disciplines, including art and science, music and mathematics, literature and history, among others, into their projects. Interdisciplinary approaches could also enhance collaboration, effective communication, and the understanding and acceptance of differences among students of all ages (Clark & Wallace, 2015; O'Rourke et al., 2014).

Facilitators should extend their full guidance and support to students during their involvement in creative ideation process (Beghetto, 2021; Sternberg et al., 2015). Some strategies include, leading brainstorming sessions, providing constructive feedback, and helping students in facing the difficulties encountered during their project development. Incorporating scaffolding techniques into constructionist setting, can support student learning journey and promote their learning achievement goals.

The constructionism-based educational programs, developed through the integration of these approaches, strategies, techniques, and concepts, not only foster creative thinking and problem-solving abilities among students, but also emphasize on knowledge acquisition and its innovative and creative application to the real world. This intervention, as a result, equips students with necessary skills to thrive in the current fast-changing world where it consistently prioritizes on creative thinking skills.

Conclusion

This paper provides a thorough overview of bringing together creativity theories within the broader context of constructionism, a theory of education that prioritizes learner-centered approaches, experiential learning, and innovation. The main objective is to explore how constructionism interacts with all theories of creativity in a theoretical and rational way. This exploration, provide practical educational benefits in developing an engaged and effective educational intervention. The fundamental principles of constructionism closely align with the primary premise of the creativity theory, including active engagement, problem-solving, collaboration, personal relevance, and reflection. This alignment theoretically affirms, that it strengthens cognitive capacities and fosters the cultivation of creative thinking skills in learners. Educators are able to apply this alignment of concept in the development of constructionist curricula and the implementation of classroom activities. These educational interventions provide students with opportunities to engage in open-ended, multidisciplinary projects, embrace rational risks, and foster reflective behaviors pertaining to their academic pursuits.

To attain success in an ever evolving and complex global landscape, individuals must acquire essential competencies in creative thinking and problem-solving. Constructionism, a pedagogical approach that draws inspiration from theories of creativity, offers an educational framework that facilitates the acquisition of knowledge as well as the generation of innovative solutions by learners. This method promotes a sense of ownership over one's learning process and facilitates a more profound

comprehension of both oneself and the subject matter. Combining the concepts of constructionism with theories of creativity has the potential to enhance the quality and efficacy of educational experiences, therefore equipping students with the skills to think creatively and solve problems in a more dynamic and complicated global context. Hence, the potential connection of constructionism and creativity presents an opportunity for the domain of education, whereby fostering the development of individuals with creative thinking abilities has significant importance in building a more positive future.

References

Acar, S., & Runco, M. A. (2019). Divergent thinking: New methods, recent research, and extended theory. *Psychology of Aesthetics, Creativity, and the Arts*, *13*(2), 153–158.

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference. *Future of learning group publication*, *5*(3), 438.

Aguilera, D., & Ortiz-Revilla, J. (2021). STEM vs. STEAM Education and Student Creativity: A Systematic Literature Review. *Education Sciences*, *11*(7), 331.

Agustiana, I. G. A. T., Agustini, R., & Ibrahim, M. (2018). The Prototype Development of Creative Thinking Skills Model's Book. *SHS Web Conf.*, *42*, 00116. https://doi.org/10.1051/shsconf/20184200116

Ali, S., Payne, B. H., Williams, R., Park, H. W., & Breazeal, C. (2019). *Constructionism, ethics, and creativity: developing primary and middle school artificial intelligence education* Paper presented at International Workshop on Education in Artificial Intelligence (EDUAI), Palo Alto, CA, USA.

Amabile, T. M. (1983a). *The Social Psychology of Creativity*. Springer. https://doi.org/10.1007/978-1-4612-5533-8

Amabile, T. M. (1983b). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, *45*(2), 357–376. https://doi.org/10.1037/0022-3514.45.2.357

Amabile, T. M. (1996). *Creativity in context: Update to "The Social Psychology of Creativity"*. Westview Press.

Amabile, T. M. (2011). *Componential Theory of Creativity*. Harvard Business School.

Anderson, D. (2020). *Creative Thinking Enhancement Skills Using Mind Mapping Techniques*. Estalontech.

Baer, J. (2014). *Creativity and Divergent Thinking: A Task-Specific Approach*. Psychology Press.

Bandura, A. (1977). *Social Learning Theory*. Prentice Hall.

Barrett, M. S., Creech, A., & Zhukov, K. (2021). Creative Collaboration and Collaborative Creativity: A Systematic Literature Review [Systematic Review]. *Frontiers in Psychology, 12.* https://doi.org/10.3389/fpsyg.2021.713445

Bartholomew, S. R., & Strimel, G. J. (2018). Factors influencing student success on open-ended design problems. *International Journal of Technology and Design Education, 28*(3), 753-770. https://doi.org/10.1007/s10798-017-9415-2

Beghetto, R. A. (2021). Creative Learning in Education. In M. L. Kern & M. L. Wehmeyer (Eds.), *The Palgrave Handbook of Positive Education* (pp. 473-491). Springer International Publishing.

Busse, T. V., & Mansfield, R. S. (1980). Theories of the Creative Process: A Review and a Perspective. *The Journal of Creative Behavior, 14*(2), 91-132. https://doi.org/10.1002/j.2162-6057.1980.tb00232.x

Clark, S. G., & Wallace, R. L. (2015). Integration and interdisciplinarity: concepts, frameworks, and education. *Policy Sciences, 48*(2), 233-255. https://doi.org/10.1007/s11077-015-9210-4

Csikszentmihalyi, M. (2013). *Creativity: Flow and the Psychology of Discovery and Invention.* Harper Collins.

de Jesus, S. N., Rus, C. L., Lens, W., & Imaginário, S. (2013). Intrinsic Motivation and Creativity Related to Product: A Meta-analysis of the Studies Published Between 1990–2010. *Creativity Research Journal, 25*(1), 80-84. https://doi.org/10.1080/10400419.2013.752235

Dulac-Arnold, G., Levine, N., Mankowitz, D. J., Li, J., Paduraru, C., Gowal, S., & Hester, T. (2021). Challenges of real-world reinforcement learning: definitions, benchmarks and analysis. *Machine Learning, 110*(9), 2419-2468. https://doi.org/10.1007/s10994-021-05961-4

Dyer, J., Gregersen, H., & Christensen, C. M. (2011). *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators.* Harvard Business Review Press.

Fischer, C., Malycha, C. P., & Schafmann, E. (2019). The Influence of Intrinsic Motivation and Synergistic Extrinsic Motivators on Creativity and Innovation [Original Research]. *Frontiers in Psychology, 10.* https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00137

Fosnot, C. T. (2013). *Constructivism: Theory, Perspectives, and Practice, Second Edition*. Teachers College Press.

Gagnon, G. W., & Collay, M. (2001). *Designing for Learning: Six Elements in Constructivist Classrooms.* Corwin Press.

Gallagher, C. L. (2017). *Sketching for Ideation: A Structured Approach for Increasing Divergent Thinking.* Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems, Denver, Colorado, USA.

Harel, I., & Papert, S. (1991). *Constructionism.* Ablex.

Hennessey, B. A. (2016). Intrinsic Motivation and Creativity in the Classroom: Have We Come Full Circle? In J. C. Kaufman & R. A. Beghetto (Eds.), *Nurturing Creativity in the Classroom* (2 ed., pp. 227–264). Cambridge University Press. https://doi.org/10.1017/9781316212899.015

Hennessey, B. A. (2019). Motivation and Creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (2 ed., pp. 374–395). Cambridge University Press. https://doi.org/10.1017/9781316979839.020

Henriksen, D., Mishra, P., & The Deep-Play Research, G. (2018). Creativity as Invention, Discovery, Innovation and Intuition: an Interview with Dr. Richard Buchanan. *TechTrends, 62*(3), 215–220. https://doi.org/10.1007/s11528-018-0279-4

Holbert, N., Berland, M., & Kafai, Y. B. (2020). *Designing Constructionist Futures: The Art, Theory, and Practice of Learning Designs.* MIT Press.

Hornberg, J., & Reiter-Palmon, R. (2017). Creativity and the Big Five Personality Traits: Is the Relationship Dependent on the Creativity Measure? In G. J. Feist, J. C. Kaufman, & R. Reiter-Palmon (Eds.), *The Cambridge Handbook of Creativity and Personality Research* (pp. 275–293). Cambridge University Press. https://doi.org/10.1017/9781316228036.015

Hundschell, A., Razinskas, S., Backmann, J., & Hoegl, M. (2022). The effects of diversity on creativity: A literature review and synthesis. *Applied Psychology, 71*(4), 1598–1634. https://doi.org/10.1111/apps.12365

Jacobs, G. M., & Lawson, N. D. (2017). *Collaboration Can Promote Students' Creativity.* https://files.eric.ed.gov/fulltext/ED591105.pdf

Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology, 102*(3), 588–600. https://doi.org/10.1037/a0019682

Johansson, F. (2017). *The Medici Effect: What Elephants and Epidemics Can Teach Us about Innovation.* Harvard Business Review Press.

Johnson, S. (2010). *Where Good Ideas Come From: The Natural History of Innovation*. Penguin Publishing Group.

Kafai, Y. B., & Burke, Q. (2016). *Connected Code: Why Children Need to Learn Programming*. MIT Press.

Kaufman, J. C., & Sternberg, R. J. (2021). *Creativity: An Introduction*. Cambridge University Press.

Kind, A. (2022). *Imagination and Creative Thinking*. Cambridge University Press.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools, 19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Kozbelt, A., Beghetto, R. A., & Runco, M. A. (2010). Theories of Creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (pp. 20–47). Cambridge University Press. https://doi.org/10.1017/CBO9780511763205.004

Kynigos, C. (2015). Constructionism: Theory of Learning or Theory of Design? In S. J. Cho (Ed.), *Selected Regular Lectures from the 12th International Congress on Mathematical Education* (pp. 417–438). Springer International Publishing. https://doi.org/10.1007/978-3-319-17187-6_24

Markham, T., Larmer, J., & Ravitz, J. (1999). *Project Based Learning Handbook: A Guide to Standards-Focused Project Based Learning for Middle and High School Teachers*. The Buck Institute for Education.

Martinez, S. L., & Stager, G. S. (2016). *Invent to Learn: Making, Tinkering, and Engineering in the Classroom*. Constructing Modern Knowledge Press.

Nave, B. (2015). *Student-centered Learning: Nine Classrooms in Action*. Harvard Education Press.

Newell, A., Shaw, J. C., & Simon, H. A. (1962). The processes of creative thinking. In *Contemporary approaches to creative thinking: A symposium held at the University of Colorado.* (pp. 63–119). Atherton Press. https://doi.org/10.1037/13117-003

Nilimaa, J. (2023). New Examination Approach for Real-World Creativity and Problem-Solving Skills in Mathematics. *Trends in Higher Education, 2*(3), 477–495. https://www.mdpi.com/2813-4346/2/3/28

O'Rourke, M., Crowley, S., Eigenbrode, S., & Wulfhorst, J. (2014). *Enhancing Communication & Collaboration in Interdisciplinary Research* https://doi.org/10.4135/9781483352947

OECD. (2009). *Creating Effective Teaching and Learning Environments First Results from TALIS: First Results from TALIS*. OECD Publishing.

Oudenampsen, J., van de Pol, M., Blijlevens, N., & Das, E. (2023). Interdisciplinary education affects student learning: a focus group study. *BMC Medical Education, 23*(1), 169. https://doi.org/10.1186/s12909-023-04103-9

Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism*. Ablex.

Papert, S. (2020). *Mindstorms: Children, Computers, And Powerful Ideas*. Basic Books.

Pink, D. H. (2010). *Drive: The Surprising Truth About What Motivates Us*. Penguin Random House Audio Publishing Group.

Rawlinson, J. G. (2017). *Creative Thinking and Brainstorming*. Routledge.

Rejskind, F. G. (1982). Autonomy and Creativity in Children. *The Journal of Creative Behavior, 16*(1), 58–67. https://doi.org/10.1002/j.2162-6057.1982.tb00322.x

Resnick, M., & Kafai, Y. B. (1996). *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World*. Lawrence Erlbaum Associates.

Ritter, S. M., & Mostert, N. (2017). Enhancement of Creative Thinking Skills Using a Cognitive-Based Creativity Training. *Journal of Cognitive Enhancement, 1*(3), 243–253. https://doi.org/10.1007/s41465-016-0002-3

Robinson, K., & Aronica, L. (2016). *Creative Schools: The Grassroots Revolution That's Transforming Education*. Penguin Publishing Group.

Runco, M. A. (1990). The Divergent Thinking of Young Children: Implications of the Research. *Gifted Child Today Magazine, 13*(4), 37–39. https://doi.org/10.1177/107621759001300411

Runco, M. A. (1997). *The Creativity Research Handbook*. Hampton Press.

Runco, M. A. (2009). Simplifying Theories of Creativity and Revisiting the Criterion Problem: A Comment on Simonton's (2009) Hierarchical Model of Domain-Specific Disposition, Development, and Achievement. *Perspectives on Psychological Science, 4*(5), 462–465. http://www.jstor.org/stable/40645665

Runco, M. A., & Acar, S. (2019). Divergent Thinking. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (2 ed., pp. 224–254). Cambridge University Press. https://doi.org/10.1017/9781316979839.013

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Saether, E. A. (2020). Creativity-Contingent Rewards, Intrinsic Motivation, and Creativity: The Importance of Fair Reward Evaluation Procedures [Brief Research Report]. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.00974

Sarathy, V. (2018). Real World Problem-Solving [Hypothesis and Theory]. *Frontiers in Human Neuroscience*, *12*. https://doi.org/10.3389/fnhum.2018.00261

Sawyer, R. K. (2004a). Acting. In J. C. Kaufman & J. Baer (Eds.), *Creativity Across Domains: Faces of the Muse*. Psychology Press.

Sawyer, R. K. (2004b). Creative Teaching: Collaborative Discussion as Disciplined Improvisation. *Educational Researcher*, *33*(2), 12-20. https://doi.org/10.3102/0013189x033002012

Sawyer, R. K. (2019). Individual and Group Creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (2 ed., pp. 567-586). Cambridge University Press. https://doi.org/10.1017/9781316979839.028

Soomro, S. A., Casakin, H., Nanjappan, V., & Georgiev, G. V. (2023). Makerspaces Fostering Creativity: A Systematic Literature Review. *Journal of Science Education and Technology*, *32*(4), 530-548. https://doi.org/10.1007/s10956-023-10041-4

Sternberg, R. J. (1999). *Handbook of Creativity*. Cambridge University Press.

Sternberg, R. J. (2018). *The nature of human intelligence*. Cambridge University Press. https://doi.org/10.1017/9781316817049

Sternberg, R. J., Grigorenko, E., & Jarvin, L. (2015). *Teaching for Wisdom, Intelligence, Creativity, and Success*. Simon and Schuster.

Strachan, S. L., & Block, M. K. (2020). Approaching Interdisciplinary Teaching Using Informational Texts During Social Studies. *YC Young Children*, *75*(4), 38-45.

Tan, A.-G. (2017). Cross-Disciplinary Creativity and Design Thinking. In F. Darbellay, Z. Moody, & T. Lubart (Eds.), *Creativity, Design Thinking and Interdisciplinarity* (pp. 69-82). Springer Singapore. https://doi.org/10.1007/978-981-10-7524-7_5

Tang, M. (2019). Fostering Creativity in Intercultural and Interdisciplinary Teams: The VICTORY Model [Review]. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.02020

Tep, P., & Tanprasertkul, S. (2022). Passion Under Constructionism: An Example of Darunsikkhalai School of Innovative Learning. *Asian Journal of Research in Education and Social Sciences*, *4*(2), 50-58. https://doi.org/10.55057/ajress.2022.4.2.5

Torrance, E. P. (1962). *Guiding creative talent*. Prentice-Hall, Inc. https://doi.org/10.1037/13134-000

Tracy, B. (2014). *Creativity and Problem Solving (The Brian Tracy Success Library)*. AMACOM.

Trilling, B., & Fadel, C. (2009). *21st Century Skills: Learning for Life in Our Times*. Wiley.

Wang, K. (2013, 28 July-1 Aug. 2013). *The effect of autonomy on team creativity and the moderating variables*. 2013 Proceedings of PICMET '13: Technology Management in the IT-Driven Services (PICMET),

Weisberg, R. W., & Reeves, L. M. (2013). *Cognition: From Memory to Creativity*. Wiley.