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UNLOCKING POTENTIAL: 17 literature reviews to promote creative thinking, innovation & STEAM in the classroom and in the cloud

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Title

UNLOCKING POTENTIAL: 17 literature reviews to promote creative thinking, innovation & STEAM in the classroom and in the cloud

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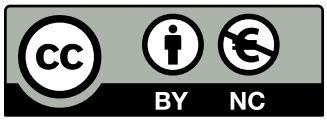

ANNOTATED

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INTRODUCTION

We are pleased to welcome you to this collection of 17 literature reviews of creative thinking, innovation, and STEAM in the university classroom and in the cloud. The articles have been prepared by the eight partner universities of the Erasmus+ project ***CT.uni: Creative Thinking – Taking an Innovative and STEAM Approach for a Transdisciplinary University*** (n° 2021-1-SK01-KA220-HED-000023022 – Cooperation partnerships in higher education) and some gracious guest authors.

Unlocking Potential: 17 Literature Reviews to Promote Creative Thinking, Innovation & STEAM in the Classroom and in the cloud presents this comprehensive collection of articles on the multifaceted realms of innovative learning environments, creative thinking, and transformative educational practices. Spanning diverse perspectives and contexts, the contributing authors represent the CT.uni consortium of eight universities from seven countries – Iceland, the Netherlands, Germany, Poland, Slovakia, Italy, and Portugal – the authors have focused on some of their areas of expertise and, in the spirit of a transdisciplinary university, have ventured into other areas as well. The 17 articles offer a combination of theory, practice, and thought-provoking discussions aimed at inspiring educators, administrators, researchers, and policymakers in the field of education.

Note that, as explored in the companion volume ***Unlocking Potential: 17 case studies in creative thinking, innovation & STEAM in the classroom*** and in the cloud, the articles aim for a holistic approach to learning that integrates Science, Technology, Engineering, the Arts (and Letters and Humanities), and Mathematics to cultivate creativity, critical thinking, and innovation in STEAM education. In this context, creating learning experiences that integrate diverse disciplines encourages students to explore complex problems from multiple perspectives and practice dealing with unbounded challenges. Transcending disciplinary boundaries while

fostering teamwork, creative thinking, and innovation across diverse fields of study, the STEAM approach encourages individuals to leverage their unique skills and perspectives to tackle complex issues collaboratively, which can lead to creative solutions and surprising discoveries. As learners engage in fully-considered environments within the STEAM framework, they are empowered to embrace complexity, think critically, and approach challenges with creative thinking and resilience. Through interdisciplinary and transdisciplinary approaches, STEAM education expands the horizons of learning, equipping individuals with the skills and mindset needed to thrive in an ever-evolving global landscape.

To unlock potential at your university and, more specifically in your classroom, the literature reviews in this publication represent research – from theory to classroom activity – in three interrelated areas:

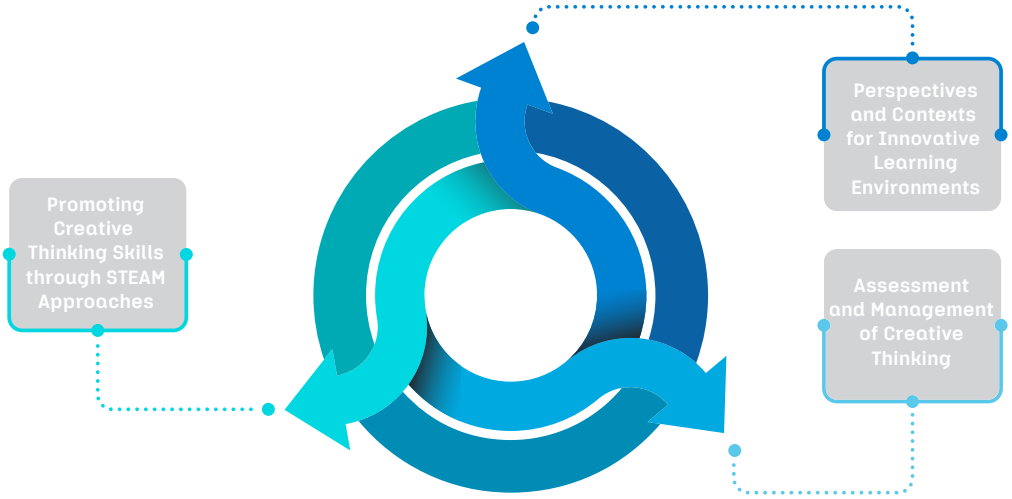

Figure 1.
Interrelated areas of creativity, critical thinking, and innovation in STEAM education

The collection begins with the section dedicated to *Perspectives and Contexts for Innovative Learning Environments*, where the foundational theories of creative thinking draw from the pioneering work of John E. Arnold to examine the application of design thinking principles in higher education. Then the spotlight is directed to innovative learning environments – whether outdoor education or classroom design – and their potential for fostering collaboration, creativity, and critical thinking skills among learners. The consideration for a small 'c' creativity framework

leads up to ideas for leading innovation through learning-by-doing and the impact of changes in routine to build more creative problem-solving skills before looking to real-world insights from the entertainment industry to improve the university classroom through creative thinking.

The second section of the collection addresses *Assessment and Management of Creative Thinking*. Assessing and managing creative thinking are integral activities for promoting and cultivating creativity, where the valuable feed forward for students and educators can contribute to ensuring accountability and quality in educational programs. Assessment and management of creative thinking together require methods and tools for measuring whether students are achieving the intended learning outcomes related to creativity and enhancing students' creative thinking skills as covered in these articles, ranging from specific tools to strategies for storing and transferring creative ideas.

In the final section, *Promoting Creative Thinking Skills through STEAM Approaches*, the third key focus of this collection, the articles showcase innovative teaching methods, transformative innovation labs, and interdisciplinary project-based learning initiatives. From social sciences education to problem-solving in the sciences and technology classrooms, these articles highlight the importance of active learning, inquiry-based thinking, and transdisciplinary approaches in fostering creativity and critical thinking skills. The collection concludes with reflections on the future of creative thinking in education, drawing from scenario thinking, future thinking, and futures thinking.

Together, these 17 articles serve as a testament to the theory and practice supporting the transformative power of creative thinking and innovative education practices, inspiring readers to reimagine teaching and learning in ways that empower students and foster lifelong learning. Ultimately, the interconnected themes underscore the transformative power of participation in creative and interdisciplinary settings, where transdisciplinary work opens horizons to unexpected results.

The links included in the *Table of Contents* can be followed to meet specific interests or the literature reviews can be appreciated sequentially. Specially designed for teacher training in unlocking potential through creative

thinking, creativity, innovation, and STEAM, these literature reviews offer perspectives, syntheses, and insights, making the collection a valuable resource for educators, researchers, and policymakers alike. Through these articles, readers will gain a deeper understanding of theory and practice in contemporary education and discover innovative approaches for their universities. As part of the collection *Unlocking Potential*, the 17 articles collectively can be a guiding light for educational change, encouraging readers to envision teaching and learning through the prism of creative thinking.

To help readers interpret views that might be new, we have practiced storytelling so that complex concepts are engaging and relatable. Other strategies we have applied in creating this collection of literature reviews follow:

- We have included insight on creativity drawn from specialist articles and projects. These insights are applied to the results initial research and the reviews of the selected articles.
- For best use as material for teacher training, we focus on inquiry-based learning, including project- and problem-based learning, to identify the best practices and barriers.
- In some of these literature reviews, the authors have included the researchers and their affiliation so that, in teacher training and autonomous learning contexts, identification of the studies contributes to deeper learning by bringing the examples to life.
- To boost understanding, we have selected images when possible or created our own.
- The writing style is friendly, marked with signposts along the way.
- We have brought the examples to life through a balanced use of language to include academics in every field of inquiry.
- Mindful of our transdisciplinary objectives, a CT.Uni style guide for the references synthesizes the best aspects of the myriad academic styles. As a result, you will find complete names whenever possible and a listing in order of appearance at the end of each article.

- The article template, collaboratively created and approved by the CT.Uni consortium, aimed for enhancing understand and included sections on materials and approaches, primary conclusions, relevance and recommendations, and even further reading suggestions.

We are also honored to have worked with the CT.uni Panel of Experts in Creative Thinking. Responding to our individual invitations, representatives of diverse study areas kindly accepted the invitation to read, edit, and offer constructive criticism as part of the collaborative peer review with the consortium partners. We would like to thank the following for their generous contributions:

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- Susana Celina, Literary Specialist

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UNLOCKING POTENTIAL

17 literature reviews to promote creative thinking, innovation & STEAM in the classroom and in the cloud

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We wish you moments of enjoyment as you read and reflect on how to adapt the theory and practice to your local educational context.

The IPG editors

María del Carmen ARAU RIBEIRO, Clara SILVEIRA, Fernando MARCOS, Natália GOMES, Noel LOPES, and Paula COUTINHO

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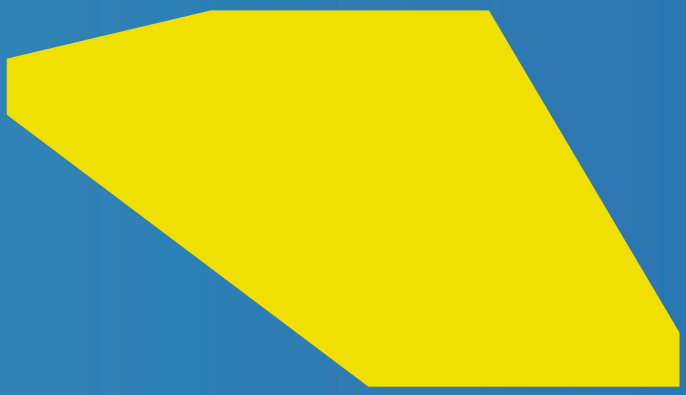

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER ONE

A SIMPLIFIED REVIEW OF "THEORETICAL FOUNDATIONS OF DESIGN THINKING PART I: JOHN E. ARNOLD'S CREATIVE THINKING THEORIES"

ABSTRACT

Design thinking is a widely accepted approach to creative problem solving which leads to human-centered innovations. The article "Theoretical Foundations of Design Thinking" deals with "Part I: John E. Arnold's Creative Thinking Theories" to explain the scientific knowledge of the past that informs design thinking practices today. The authors offer a summary of the theories of creative thinking that were brought by John E. Arnold to Engineering at Stanford University in the 1950s. They focus on creative mindset, thinking modes, problem types and creativity blocks, definition of creativity, theory of the creative process, classification of creativity approaches, educational theory, and usage of the term design thinking. They confirm that creativity can be learned and improved. Through this review of their review, this quick reference to Arnold's theory might help teachers not only to evaluate and develop their students' creativity skills but also to overcome their own creativity blocks as well.

Keywords: design thinking, creative thinking, creative engineering, creative mindset, creativity approaches

University of Economics in Bratislava

✉ Veronika ORFÁNUSOVÁ

✉ Anna VESZPRÉMI SIROTKOVÁ

INTRODUCTION

The concept of creative thinking was firstly launched in the 1950s at Stanford University in Creative Engineering seminars by John E. Arnold (1914-1964). In our review we would like to briefly introduce a revision of his theories related to creativity, definitions, and assumptions. Considered one of the first authors in this field of study, he was Associate Professor at MIT and later at Stanford University, where he was appointed professor of Mechanical Engineering and Professor of Business Administration in 1957. He was leading Creative Engineering and Product Design courses at MIT and he was founding Director of the Design Division at the Mechanical Engineering Department at Stanford University.

Arnold used an interdisciplinary approach in his work; he brought several leading creativity experts to his seminars on Creative Engineering as guest lecturers – the psychologists Joy Paul Guilford and Abraham Maslow, the philosopher Robert Hartman and the architect Buckminster Fuller. Arnold regularly held seminars for the industry, using case studies of significant innovators, empirical creativity studies, and his personal experiences as an educator. He liked to experiment with divergent teaching styles.

The article "Theoretical Foundations of Design Thinking – Part I: John E. Arnold's Creative Thinking Theories" [1] explains the scientific knowledge of the past. The identify specifically what informs design thinking practices today, focusing on Arnold's collection of seminars published as Creative Engineering: Promoting innovation by thinking differently [2].

Arnold's seminal work is divided into three main parts.

The first part, Background, deals with creativity theories, where he explains creative engineering, imaginary oppositions in the relation of art, science and design, imaginary oppositions manifested as culture blocks in organizations, design thinking theories, tools and collaborations, personal development in a team and the challenge of groupthink.

The second part on Creative Engineering is dedicated to his understanding of creativity, factors influencing creativity, creative techniques, and creative product design with a creative engineering bibliography.

The third part, Readings, includes texts by his guest lecturers – J. P. Guilford, *Psychology of Thinking* (pp. 152-166); R. S. Hartman, *The Value Structure of Creativity* (pp. 167-187); A. H. Maslow, Emotional Blocks to Creativity (pp. 188-197); and R. H. McKim, *Designing for the Whole Man* (pp. 198-217). The review article in question [1] deals with the first part of Arnold's book and compares it to opinions of current authors.

SYSTEMIZING THEORY RELATED TO CREATIVITY: A QUICK REFERENCE

In this review, we aim to systemize Arnold's theories of creativity to make it easier to understand, beginning with some of his definitions of creativity and then covering his numerous theories, considering the creative mindset, thinking modes and problem types, as well as creativity blocks, the creative process, and creative thinking education and meta-cognitive control.

DEFINING CREATIVITY

In a part on defining creativity, the authors point out some definitions of creativity by Arnold, who also introduced levels of creativity and creativity metrics. The first definitions are related to creative solutions (pp. 25-26):

- A solution is creative when it is novel and useful.
- A creative solution is useful when it (better) satisfies a human need.
- The creative process ends not with an idea but with a tangible outcome.
- Creative solutions are forwardly oriented in time.

Then, definitions are related to creativity criteria (p. 27):

- Creativity criteria provide ideals to strive for in creative work.
- Creativity criteria help to assess creative achievement: The more criteria a solution fulfills, the higher the level of creative achievement is.

A THEORY OF THE CREATIVE MINDSET

The theory of creative mindset is based on Arnold's interpretation of the factors that prerequisite the creativity that he adopted from Guilford, Maslow, Rogers and Farnsworth. Gilford identified four factors (1 - 4) – problem sensitivity, fluency, flexibility, and originality, Arnold added three emotion-centered variables to describe creative mindsets – (5) daringness, (6) drive and (7) confidence.

1. Definition of Guilford: "**Problem sensitivity** refers to the inclination of a person to notice and tackle problems next to abilities of framing, defining and communicating problems in ways that aid creative solutions" [1] (p. 17). According to Arnold, "problem sensitive people nor only

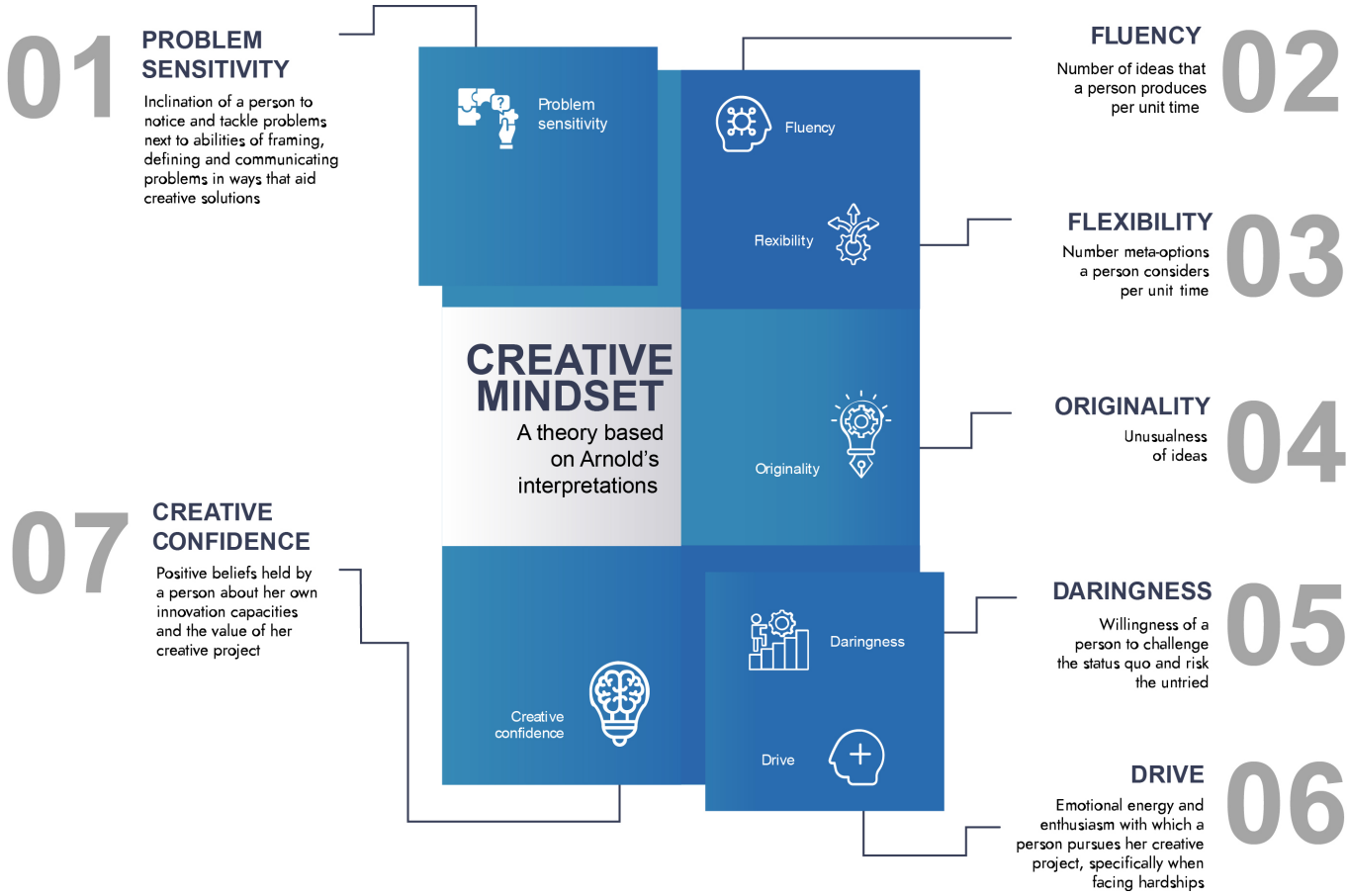

Figure 1.1.
Creative mindset according to John E. Arnold's

notice the problem, but also develop interest and intention as they have the ability of describing problems in clear and fruitful terms" (p. 17). Arnold explained the need for an optimal balance between focus and degrees of freedom in the motto: "Craft Clarity [:] Produce a coherent vision out of messy problems. Frame it in a way to inspire others and to fuel ideation" (p. 17)

2. "**Fluency** refers to the number of ideas that a person produces per unit time" [1]. Arnold stated, that "general or loosely constrained problem statements increase fluency; narrow or highly constrained problem statements reduce fluency; and disregarding practical limitations when generating ideas increases fluency" (p. 18).

3. "**Flexibility** refers to the number of meta-options a person considers per unit time." "Flexibility is the opposite of rigidity. Meta options include categories, points of view, approaches, solutions, etc" [1]. Arnold gave examples of some domains, where flexibility is important: Object Use, Work and Solution Approaches, Action-Reflection-Role-Repertoire, Work Pace, Perspective-Taking, and Perceptual Inclinations (p. 18).

4. "**Originality** refers to the unusualness of ideas" [1]. Arnold brought the concept of "habitually incompatible ideas" from Arthur Koestler, meaning ideas that most people normally would not associate with each other, though it is possible to do so" (p. 19).

5. "**Daringness** refers to the willingness of a person to challenge the status quo and risk the untried." People who are creative, have to be daring, they take calculated risks in the process of reaching the solution. Creating also involves destroying the present and people are usually afraid of giving up "the old, familiar and seemingly adequate ideas that they have held for some time" [1] (p. 19).

6. "**Drive** refers to the emotional energy and enthusiasm with which a person pursues her creative project, specifically when facing hardships. … Drive is observable as perseverance, specifically when facing hardships or immediate but moderately helpful solutions" [1]. Arnold finds out that really creative thinkers "love to solve problems" and that "drive is a major predictor for creative achievement" (p. 20).

7. "**Creative confidence** refers to positive beliefs held by a person about her own innovation capacities and the value of her creative project" [1]. Confidence "affects whether or not people maintain drive in the face of obstacles, with high levels of creative confidence people retain more drive in times of hardship" (p. 20).

Arnold also discusses how creativity and happiness are correlated. He states that "happiness depends on personal achievements in the sense of making contributions to society and realizing personal potential" (p. 21).

A THEORY OF THINKING MODES

Arnold defines "three basic modes of thinking: Analytical, judicial, and synthetic", where "analytical thinking detects the features and structure of an entity", … judicial thinking compares two or more entities and often ascribed value", and "synthetic thinking combines two or more entities into something new" (p. 21). As he explains, "[c]reative thinking combines analytical, judicial, and synthetic thinking in regulated ways. Thus, creative thinking is not a thinking mode in itself but a combination of thinking modes. Creative work needs a careful "balance between analysis, synthesis, and evaluation. This includes up-regulating and down-regulating the thinking modes at will" (p. 22).

A THEORY OF PROBLEM TYPES

According to Arnold, "there are three basic types of problems: Analytical, judicial and synthetic" [1] (p. 22). "Analytical problems (a) are characterized by precise problem and solution statements that use only a small number of concepts and (b) they have only one correct answer" (p. 22). "Judicial problems (a) are characterized by complex problem and solution statements that require intricately refined concepts and (b) they have more than one correct answer" (p. 23). "Synthetic problems (a) are characterized by an open spectrum of concepts that can be invoked for problem and solution statements and (b) an infinite variety of possible solutions from bad to good" (p. 23). He anticipated wicked problems, which have more than one correct answer and require creativity, and creative problems, which according to Arnold meant to "satisfy basic human needs" (p. 23).

A THEORY OF CREATIVITY BLOCKS

Arnold started the systematization of factors negatively influencing creative work. He described Perceptual Blocks, Cultural Blocks and Emotional Blocks to creative activity, warning that factors "affecting thinking and action rarely if ever appear in pure culture" (p. 24).

A THEORY OF THE CREATIVE PROCESS

Arnold considers the creative process to be a key element "that creativity phenomena in different domains have in common… I think that the creative process itself is unique and also is a universal process that applies to all kinds of creative activity, whether you are an artist, or a poet, or a composer, or an engineer, in the military, in the business world, in the professional world, teaching, and so forth. If you are being creative, if you are looking at and solving problems in a creative fashion, you are using a similar process in all cases. The tools you work with, of course, vary from individual to individual, from group of activity to group of activity" (p. 27).

Arnold defined creative process as "a process of problem solving in which the creative agent seeks a novel solution to better satisfy basic human needs – capitalizing on a creative mindset and balancing all three thinking modes along the way" (p. 28). He advised his students to "familiarize themselves with numerous methods and to experiment with them".

A CLASSIFICATION OF CREATIVITY APPROACHES

Arnold distinguishes two types of creativity approaches, organized and inspired, and their combinations. "Organized creativity approaches follow a step-by-step type rational", while "inspired creativity approaches build on intuition, fantasy or other loosely controlled psychological processes;

they are characterized by relaxed ties to that which is considered possible, advisable, or state of the art in the domain of creative work" (p. 29). He states that "organized creativity approaches bring about incremental change and inspired creativity approaches bring about disruptive change" (p. 30). The authors compare these approaches to those where Maslow distinguished "between secondary creativity (where disciplined rule-following yields gradual progress) versus primary creativity (where unconscious, unconventional thinking yields disruptive breakthroughs) "(p. 30).

"Combined creativity approaches use elements from the organized and the inspired approach" (p. 30). Arnold explained this in examples of Serendipity and the Scientific Hunch. New approaches in Design Thinking theory "combine inspired and organized creativity approaches systematically and comprehensively" (p. 31). This includes approaches like: Big Dreams, Insights, an Empirical Approach, and The Rational Approach (p. 31).

A THEORY OF CREATIVE THINKING EDUCATION AND META-COGNITIVE CONTROL

Arnold was a visionary educator who experimented with curricula and reflected upon his beliefs and assumptions. One of them is "that it is possible to materially increase the degree to which one realizes his total potential by understanding, practice, and exercise. The increase can vary from ten percent to several hundred percent" (p. 31). He believed that "creativity education increases creative achievement, creative potential" and that "practicing creativity methods serves to advance creative mindsets" (p. 31).

Arnold claims that "Education shall endow students with creative confidence as well as competence – and not with inclinations of rigid method use", and that "education shall create experiences of success and

failure for students, which enhance their creative confidence" (p. 32). He states that "students need to learn how to handle possible frustrations along the way; they are a normal part of creative activity" (p. 33).

According to Arnold, students also need to strengthen additional abilities that in present may be summarized as increased "meta-cognitive control", which is defined as "the ability to identify and regulate factors that impact creative process" (p. 33). This control includes: "(a) Monitoring, regulating and balancing the three thinking modes, (b) Monitoring and carefully selecting communication means, (c) Monitoring and adapting one's creative process including 'stages', aims, broadness of scope, pace, and tools, (d) Noticing and overcoming creativity blocks" (pp. 33-34).

One of the design thinking mottos related to this topic is "Show, Don't tell – Communicate your vision in an impactful and meaningful way by creating experiences, using illustrative visuals, and telling good stories" (p. 33).

CONCLUSION

Our literature review is based on systemizing theory related to creativity in the work of Julia von Thienen and her colleagues, who reviewed the first part of John E. Arnold's book, Creative Engineering: Promoting innovation by thinking differently [2], and compared the past knowledge with the present theories on the same topics. We hope this material will help our colleagues to better understand the fundamentals of creativity theories, basic terms and approaches. John E. Arnold is an example of a teacher who implemented transdisciplinarity into his courses, who cooperated with experts from different fields of science, and who was improving his teaching process on the base of his beliefs and past experience.

>> REFERENCES

[1] Julia von Thienen, William Clancey, Giovanni Corazza, and Christoph Meinel, Christoph, "Theoretical Foundations of Design Thinking – Part I: John E. Arnold's Creative Thinking Theories", Hasso Plattner, Christoph Meinel, and Larry Leifer (Eds.), Design Thinking Research – Making Distinctions: Collaboration versus Cooperation, Springer, Cham, 2017, pp 13-40. https://doi.org/10.1007/978-3-319-60967-6_2

[2] John E. Arnold, Creative Engineering: Promoting innovation by thinking differently, Stanford Digital Repository, 2016, 1956. http://purl.stanford.edu/jb100vs5745

>> FURTHER READING SUGGESTIONS

Wimer Hazenberg, 75 Tools for Creative Thinking: A Fun Card Deck for Creative Inspiration, Laurence King Publishing, 2013.

Creativity Portal, https://www.creativity-portal.com/

John Newbegin, "What is the creative economy?" Creative Economy, British Council, 2014. https://creativeconomy.britishcouncil.org/guide/what-creative-economy/

UX Design Books and Articles, IxDF, https://www.interaction-design.org/literature

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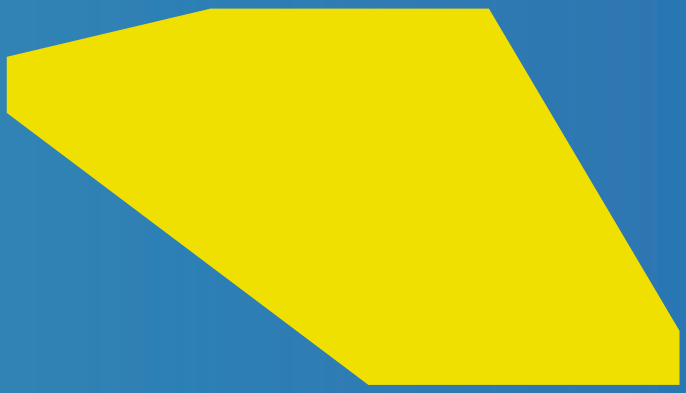

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER TWO

INNOVATIVE LEARNING ENVIRONMENTS: ENHANCING COLLABORATION AND CREATIVITY THROUGH PROBLEM-BASED CLASSROOM DESIGN IN HIGHER EDUCATION

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ABSTRACT

As traditional lecture-based teaching, classroom design in higher education is also challenged. This review aims to assess whether innovative learning environments can improve collaborative learning experiences and enhance creativity among students. Thus, the classroom was transformed into a problem-based learning classroom, aimed to encourage students to collaboratively apply what they have learned to solve problems. New Innovative Learning Environments (ILEs) should be able to offer a wider range of pedagogical content than traditional classrooms. There is a growing recognition that design and practice must be reimagined in order to effectively deliver new learning environments to support contemporary education. It would be appropriate to understand how physical learning environments should be designed, perceived, and implemented for effective teaching and learning. As a result, it has been demonstrated that using interactive learning environments in architectural design education has a positive impact on the level of creativity skills development and contributes to better learning outcomes.

Keywords: learning space design, innovative learning environments, PBL classroom, creative skills.

INTRODUCTION

Higher education institutions are continually evolving in their teaching methodologies. While traditional lecture-based teaching remains prevalent, there is an increasing thrust toward adopting innovative learning environments (ILEs) for fostering creativity and collaboration among students. This review sheds light on the effects of ILEs, especially in architectural design education, emphasizing their influence on student creativity, engagement, and outcomes.

THE SHIFT TO PROBLEM BASED LEARNING (PBL) CLASSROOMS

The growing emphasis on adopting PBL techniques in higher education means that PBL classrooms are set up to motivate students to collaboratively tackle and solve problems, applying what they have learned in real-life situations. By simulating real-world issues, PBL aims to enhance students' critical thinking, creativity, and collaboration skills.

PBL originated in 1969 when educators at the McMaster University School of Medicine felt the need for a more holistic and student-centered approach [1]. Since then, PBL has spread widely across disciplines committed to the grounding principle of using real-world problems as a medium to drive learning [2]. Rather than starting with theories, PBL begins with problems, pushing students to identify what they know and what they need to learn, collaborating with peers to derive potential solutions and reflecting both on the solution and on the learning process.

As evidenced by a body of research PBL offers advantages to students. At the forefront, PBL environments have been shown to significantly enhance critical thinking because students are consistently pushed to analyze, synthesize, and evaluate information in real-life problems and context [3]. By refining their ability to think critically, they are encouraged to venture beyond conventional solutions. Addressing tangible issues not only prompts students to think "outside the box" but also actively

nurtures their creative capacities [4]. Equally noteworthy is the role of PBL in promoting collaboration through group problem-solving, where they develop their teamwork and interpersonal skills, learning the nuances of collective decision-making and collaboration [5].

Despite the myriad benefits, implementing PBL is not without its set of challenges. One primary concern is the preparation of the educators involved. If they are still accustomed to traditional teaching methodologies, they may require comprehensive training to bridge this pedagogical shift, ensuring that educators are adept in harnessing the full potential of this approach [6]. Compounding this challenge is the mismatch between traditional assessment paradigms and PBL outcomes. Given that PBL offers a distinctive learning trajectory that captures holistic learning, innovative evaluation metrics need to be tailored to this growth [7]. Note that, in terms of logistics, implementing PBL can be resource-intensive for the creation of diverse learning materials and, for the purposes of this study, specialized spaces designed for collaborative work and group discussions to ensure the optimization of PBL [8].

DESIGNING AN EFFECTIVE ILE

The shift in pedagogical strategies demands corresponding changes in the physical environment so that the ideal ILE offers a wider range of pedagogical content than traditional classrooms although the transformation of structural aesthetics alone might not guarantee student engagement or improved learning outcomes. Instead, the emphasis should be on how these spaces are perceived, designed, and most importantly, how they are employed for effective teaching and learning.

Studies have highlighted the potential pitfalls of merely focusing on the aesthetic transformation.

For instance, there is essentially no relationship between the quality of school facilities and student performance [9] when other factors known to impact student performance are accounted for. Similarly, while state-of-the-art facilities might attract attention, the pedagogical practices within

those spaces are the determinants of student outcomes [10]. However, when aligned with active and interactive teaching approaches, ILEs can lead to improved student engagement, better learning outcomes, and heightened creativity [11].

IMPACT ON ARCHITECTURAL DESIGN EDUCATION

One domain where ILEs have shown considerable promise is architectural design training. Studies suggest that introducing ILEs in architectural design curricula can significantly impact the development of creativity. A comparative study involving different classroom types, namely stadium, flat, and PBL classrooms, unveiled interesting findings. Historically, architectural education has largely been confined to traditional classroom settings. However, the dynamic nature of architectural design, which demands both theoretical knowledge and hands-on application, has led educators to consider the transformative potential of ILEs [12].

Recent research offers intriguing insights into the performance of ILEs in architectural design pedagogy. A comparative study encompassing various classroom types — from stadium-style layouts to flat configurations and PBL classrooms — presents revealing outcomes. Notably, while the stadium classrooms, which are largely lecture-driven, demonstrated subpar levels of student engagement and outcomes, the PBL classrooms stood out. These environments, characterized by their adaptability and collaborative ethos, seem to resonate well with the demands of architectural education, fostering heightened levels of student engagement and enriched learning experiences [13]. The shift towards ILEs in architectural training aligns well with the discipline's inherent emphasis on creativity, problem-solving, and collaboration. Students exposed to ILEs have displayed enhanced spatial reasoning skills, a better grasp of design principles, and an improved ability to work collaboratively on design projects [14]. Moreover, the interactive nature of ILEs equips students with the tools and environments necessary for innovative design simulations and critiques, which are crucial in the architectural curriculum [15].

FACTORS INFLUENCING STUDENT SATISFACTION

The classroom should be optimized for enhanced interactions and learning experiences although this insight challenges the emphasis on the physical structure of the learning space. Instead, other nuanced factors seem to carry greater weight in the overall satisfaction equation [16].

The type of classroom, however, has not been a major predictor of student satisfaction. Instead, factors like the classroom's capacity for facilitating access to learning material, the potential for student interaction with peers and with teachers are pivotal, indicating that investing exclusively in physical structural modifications might not suffice. Such findings suggest that the classroom's ambience, layout, and the tools provided can significantly influence the ease with which students can collaborate, discuss, and engage with the learning material [17]. The implications of these findings suggest that, to heighten student satisfaction, educators and institutions should consider the broader dynamics of the learning environment. Facilitating clear lines of communication, ensuring accessibility to resources, and crafting spaces that are conducive to both individual reflection and collaborative work become paramount [18].

While the physical aesthetics and design of a classroom are undeniably crucial, they form just a piece of the student satisfaction puzzle. Institutions aiming to optimize learning experiences should approach classroom design holistically, ensuring that both physical and pedagogical aspects work in harmony.

MULTIMEDIA TOOLS AND ILES

Evidence also suggests that the integration of multimedia tools in interactive environments can significantly improve learning outcomes. Thus, incorporating multimedia tools in ILEs should be given priority, amplifying the possibilities of creative thinking and learning. Multimedia learning hinges on the simultaneous processing of verbal and visual information, enhancing the depth of information processing [19]. With the digital evolution, multimedia tools, ranging from interactive videos to virtual simulations, have gained significant traction in academic circles, primarily due to their potential to make learning more immersive and engaging. With their proven ability to enhance learning outcomes, these tools, when combined with the adaptability and interactivity of ILEs, set the stage for a transformative learning experience.

MATERIALS AND APPROACHES

Configurable Furniture: Moveable furniture can be reconfigured to support different group sizes and classroom activities. For example, wheeled desks can be pushed together for group work or separated for individual tasks.

Collaborative Technology Integration: Incorporate smartboards, touchscreens, and wireless screen sharing capabilities, allowing students to collaboratively sketch, design, and present ideas.

Breakout Spaces: Design small breakout spaces adjacent to the main classroom where groups can convene to discuss project work without disturbing others.

Open Design Studios: Open spaces equipped with workbenches, pin-up boards, and digital screens allow architectural students to showcase and critique designs. They provide hands-on environments for iterative design processes.

Tiered Collaborative Spaces: Unlike traditional stadium classrooms, these tiered spaces provide group tables on each tier, allowing students to collaborate in groups while still having a clear view of the front.

Transitional Spaces: Design spaces that can easily transition between a lecture-style setting and a collaborative workspace. Retractable walls, for example, allow for easy transformation based on need.

Natural Elements and Lighting: Incorporating natural elements such as indoor plants, natural wood, and ample daylight can foster creativity and well-being, essential for collaborative problem-based learning.

Figure 2.1.
Amphitheater and PBL Classrooms

By focusing on these specific designs and approaches, architectural design education can further harness the potential of ILEs to cultivate enhanced collaborative and creative learning experiences.

CONCLUSIONS

In the endeavor to review the literature on innovative learning environments to understand the potential for enhancing collaboration and creativity through problem-based classroom design in higher education, we draw inspiration from the realm of social science, where the exploration of human behavior and interactions takes center stage. Configurable furniture and transitional spaces mirror the dynamic nature of human relationships, communities, and societies. Just as societies evolve, the adaptability of these spaces ensures that the learning environment can be molded to best fit the constantly shifting requirements and moods of its users.

This flexibility is akin to the adaptability that modern societies require in our rapidly changing global landscape.

The integration of collaborative technology in classrooms reflects the digitally interconnected world we inhabit. In the context of social science, this tech-integration can be likened to global communication networks and the digital age's effects on societal structures. Just as smartboards and touchscreens facilitate seamless collaboration in the classroom, technologies like social media and instant messaging redefine how individuals in society communicate, collaborate, and form communities.

Societies have always been characterized by the existence of various subgroups and factions. These breakout spaces can be related to the concept of smaller communities or interest groups within a larger societal structure. Such spaces offer an environment where focused, in-depth discussions can happen, reflecting how subgroups in society concentrate on specific issues or ideas.

In social science, the emphasis on the importance of transparency, openness, and public discourse in modern societies is mimicked in open design studios that foster environments of openness and critique. They highlight the significance of constructive criticism, peer review, and the iterative process, all fundamental in social research and policy-making. And while many modern societies advocate for egalitarian principles, hierarchies naturally emerge in various forms. Tiered collaborative spaces,

where every group has clear visibility, parallel the importance of giving every societal subgroup a voice and ensuring that their concerns are heard and addressed.

The inclusion of natural elements in learning environments especially resonates with the increasing awareness in the social sciences about the importance of sustainable living and urban planning that centers on well-being. Societies that prioritize environmental sustainability and holistic well-being of their citizens tend to have more engaged, productive, and happy members. In summary, the innovative materials and approaches being implemented in architectural design education are not isolated concepts. They draw many parallels to key concepts in the field of social science, thereby underlining the interconnectedness of physical space design and societal structures and behaviors.

>> REFERENCES

[1] Howard S. Barrows and Robyn M. Tamblyn, Problem-based Learning: An approach to medical education. New York: Springer Publishing Company, 1980.

[2] Cindy E. Hmelo-Silver, "Problem-based Learning: What and how do students learn?" Educational Psychology Review 16, pp. 235-266, 2004. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

[3] Filip Dochy, Mien Segers, Piet Van den Bossche, and David Gijbels, "Effects of Problem-based Learning: A meta-analysis", Learning and Instruction 13(5), pp. 533-568, 2003. https://doi.org/10.1016/S0959-4752(02)00025-7

[4] Linda Torp and Sara Sage, Problems as Possibilities: Problem-based learning for K-12 education. Alexandria, VA: ASCD – Association for Supervision and Curriculum Development, 1998. https://archive.org/details/problemsaspossib0000torp/page/n1/mode/2up

[5] Maggi Savin-Baden and Claire Howell Major, Foundations of Problem-based Learning. Berkshire: McGraw-Hill Education (UK), 2004. https://archive.org/details/foundationsofpro0000savi

[6] Peggy A. Ertmer and Krista D. Simons, "Jumping the PBL implementation hurdle: Supporting the efforts of K–12 teachers", Interdisciplinary Journal of Problem-based Learning 1(1), pp. 40-54, 2006. https://doi.org/10.7771/1541-5015.1005

[7] David Gijbels, Filip Dochy, Piet Van den Bossche, and Mien Segers, "Effects of Problem-based Learning: A meta-analysis from the angle of assessment", Review of Educational Research 75(1), pp. 27-61, 2005. https://doi.org/10.3102/00346543075001027

[8] Howard S. Barrows, "Problem-based Learning in Medicine and Beyond: A brief overview", New Directions for Teaching and Learning 1996(68), pp. 3-12, 1996. https://doi.org/10.1002/tl.37219966804

[9] Lawrence O. Picus, Scott F. Marion, Naomi Calvo, and William J. Glenn, "Understanding the Relationship between Student Achievement and the Quality of Educational Facilities: Evidence from Wyoming", Peabody Journal of Education 80(3), pp. 71-95, 2015. https://doi.org/10.1207/s15327930pje8003_5

[10] D. Christopher Brooks, "Space matters: The impact of formal learning environments on student learning", British Journal of Educational Technology 42(5), pp. 719-726, 2011. https://doi.org/10.1111/j.1467-8535.2010.01098.x

[11] Diana G. Oblinger, "Space as a change agent", Learning Spaces 1(6), pp. 1-2, 2016. https://er.educause.edu/articles/2009/3/~/media/45e9ef07757d4db1b115d94fe2483c00.ashx

[12] Pamela Woolner, The design of learning spaces. New York: Continuum International Publishing Group, 2010.

[13] John Hattie, "Which strategies best enhance teaching and learning in higher education?" Debra Mashek and Elizabeth Yost Hammer (Eds.), Empirical research in teaching and learning: Contributions from social psychology, pp. 130-142. Wiley Blackwell, 2011. https://doi.org/10.1002/9781444395341.ch8

[14] Dane DeSutter and Mike Stieff, "Teaching Students to Think Spatially through Embodied Actions: Design principles for learning environments in science, technology, engineering, and mathematics", Cognitive Research: Principles and Implications 2, pp. 1-20, 2017. https://doi.org/10.1186/s41235-016-0039-y

[15] Roxana Moreno and Richard Mayer, "Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends", Educational Psychology Review 19, pp. 309-326, 2007. https://psycnet.apa.org/doi/10.1007/s10648-007-9047-2

[16] Robert A. Ellis and Peter Goodyear, "Models of learning space: Integrating research on space, place and learning in higher education", Review of Education 4(2), pp. 149-191, 2016. https://doi.org/10.1002/rev3.3056

[17] Robert R. Weaver and Jiang Qi, "Classroom Organization and Participation: College students' perceptions", The Journal of Higher Education 76(5), pp. 570-601, 2005. https://doi.org/10.1080/00221546.2005.11772299

[18] Peter Jamieson, Kenn Fisher, Tony Gilding, Peter G. Taylor, and A.C.F. (Chris) Trevitt, "Place and Space in the Design of New Learning Environments", Higher Education Research & Development 19(2), pp. 221-236, 2000. https://www.oecd.org/education/innovation-education/2675768.pdf

[19] Richard E. Mayer, "Multimedia learning", Psychology of Learning and Motivation 41, pp. 85-139, 2002. https://doi.org/10.1016/S0079-7421(02)80005-6

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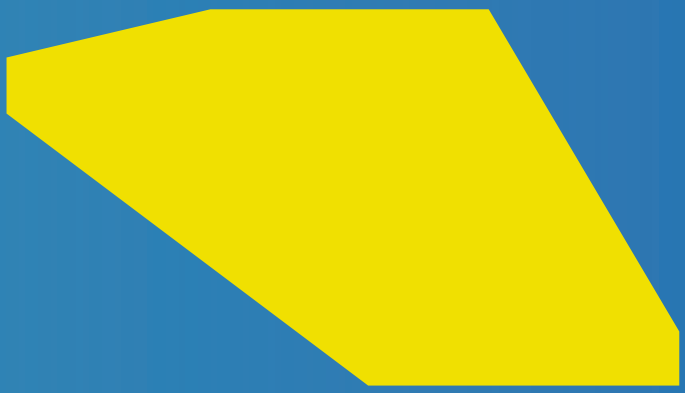

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER THREE

OUTDOOR EDUCATION AND CREATIVITY

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ABSTRACT

Environmental education seeks to illuminate the intricate interplay between human culture and ecosystems. It presents a series of pertinent questions: How should environmental education be defined, and what is its ultimate goal? Should its curriculum blend environmental ethics with ecological concepts? What roles do teachers play in fostering student learning and creativity? Indeed, creativity is a socially valued trait that often finds limited expression in traditional classroom settings. Therefore, this review highlights the evolution of innovative and creative teaching methods tailored to student needs. In recent years, the push for educational experiences in open spaces has grown, aiming not only to enhance learning but also to foster creativity while promoting psychological and social well-being. Outdoor education involves creating and using pathways in natural environments, where learning is hands-on, engages all the senses, and involves the whole body, contributing to a comprehensive educational experience.

Keywords: outdoor education, teaching approaches, creativity

INTRODUCTION

Environmental education, characterized by its comprehensive approach towards understanding the intricate relationships between humans and ecosystems, stands as an essential and continually evolving educational realm. Within this sphere, there lies an intriguing convergence with the concept of creativity. This interplay not only challenges conventional pedagogical methodologies but also highlights the potential of outdoor education as a powerful medium for fostering innovative thought. As we consider the intricacies of environmental education, we are met with a spectrum of questions. Does this domain simply focus on ecosystem comprehension, or does it extend to encompass environmental ethics, championing values that underscore a harmonious relationship between humanity and nature? Central to this discourse is the educator's role. Their pivotal position transcends mere knowledge dissemination; educators play a critical role in igniting the flames of creativity. In contemporary society, creativity is no longer restricted to artistic pursuits. It symbolizes an individual's prowess to think innovatively, addressing challenges with novel solutions. However, the confines and structures of traditional classrooms often stifle the growth of this indispensable skill, as noted by a research team from the Technical University of Munich and the University of Stavanger [1] and another from Great Lakes Aquarium and the University of Minnesota Duluth [2].

OUTDOOR EDUCATION: A PARADIGM SHIFT TOWARD OUTDOOR EDUCATION

In the realm of educational practices, traditional teaching methods, despite their widespread application, have frequently been criticized for their perceived rigidity and lack of adaptability in catering to the evolving needs of students [3]. Emerging from these critiques is the alternative and innovative approach of outdoor education. Championing hands-on, experiential learning, outdoor education capitalizes on the myriad learning opportunities that the natural environment presents, thus providing students with a multifaceted, sensory-rich educational experience [4].

The appeal of outdoor education largely stems from its ability to create complex, challenging environments conducive to deeper, more engaged learning. Research consistently shows that students in outdoor settings exhibit heightened levels of competence, curiosity, and engagement compared to traditional classroom environments [5]. The unpredictable nature of outdoor settings throws up a variety of challenges that inherently require the application of critical thinking, problem-solving skills, and innovative solutions, thereby facilitating cognitive development [6].

One of the standout features of outdoor education is its inherent flexibility. It diverges from the 'one-size-fits-all' pedagogical models, demanding a dynamic and adaptive teaching approach in response to ever-changing outdoor scenarios [7]. This places a significant onus on educators to adopt more responsive, active, and co-constructive teaching methodologies that place the student at the center of the learning process. The emphasis is on experiential learning, where students actively engage with their surroundings, constructing and co-constructing knowledge in tandem with their peers and educators [8].

Given the documented benefits of outdoor education, there is a pressing need for educational institutions to reassess and recalibrate their teaching strategies. Introducing students to the outdoors can foster not only cognitive development but also enhance socio-emotional learning, teamwork, and resilience, making it an essential component of holistic education [9].

RECONCEPTUALIZING LEARNING ENVIRONMENTS

The modern educational landscape, characterized by the necessity for adaptability and relevance within constantly evolving societal contexts, is witnessing a shift towards diversified learning settings. This emerging trend in education advocates moving beyond the traditional confines of a classroom, encompassed by its four walls. In this context, outdoor learning environments refer specifically to educational activities conducted in natural settings, as opposed to simply being outside a building. These environments, such as parks, forests, or other natural landscapes, serve as dynamic and immersive platforms. They are replete with opportunities for experiential learning, where interaction with the natural world enhances the educational experience [10].

The allure of outdoor spaces lies in their inherent unpredictability and novel encounters. Research consistently highlights that the sensory-rich experiences in nature contribute to a deeper and more meaningful engagement with learning materials [11]. Such environments are primed to spark curiosity, leading students to cultivate a genuine passion and thirst for knowledge. Outdoor education is not merely about shifting the learning space; it intertwines with the broader educational aim of fostering creativity. The vastness of nature serves as an expansive canvas, allowing students the liberty to construct, deconstruct, and reconstruct knowledge [12].

Against this backdrop, educators play a pivotal role. They are not just transmitters of knowledge but crucial facilitators, guiding students in their explorations and molding them into innovative thinkers. The synergy of creativity and outdoor learning offers educators an opportunity, or rather a challenge, to reassess their pedagogical strategies. Conventional methodologies may not entirely align with the dynamic nature of outdoor settings. The emphasis shifts from rote memorization to problem-solving, critical thinking, and innovation [13]. Educators, in this context, need to be agile, adjusting their methods to the unique learning opportunities that each outdoor experience presents. The myriad benefits of outdoor education make a compelling argument for its more prominent role in the curriculum [14].

Figure 3.1.
Reflection and relaxation–learners embrace nature.
Source: Photo by Max Horng [15]

METHODS AND MATERIALS

1. Flexible Design Principles for Outdoor Spaces

The use of Universal Design for Learning (UDL) concepts may be implemented in the context of outdoor environments as in classrooms, with t. The objective of this method is to establishing environments that possess the capacity for effortless modification or adaptation in accordance with the requirements of the learners. Hence, outdoor and indoor classes could include adaptable seating configurations, portable planters, and modular constructions that may be reconfigured to accommodate diverse educational encounters [16].

2. Embracing Natural Unpredictability

Rather than adhering to meticulously managed and organized outdoor settings, educators and designers have the option to embrace the growth and natural evolution of certain places. Hence, it is recommended to establish designated areas known as "wild corners" or "natural patches" where natural processes may occur without human intervention. Such spaces can spark inquiries about biodiversity, ecosystems, or the life cycles of plants and animals [17].

3. Multipurpose Outdoor Elements

Design outdoor elements that can serve multiple functions and can be used in diverse ways depending on the learning objective. Therefore, an amphitheater-style seating could serve as a lecture space, a place for dramatic play, or a site for observational studies. Water elements could be used for scientific experiments, sensory play, or aesthetic appreciation [7].

4. Technology Integration

Technology can be integrated to augment the outdoor learning experience. Some examples, like QR codes on plant labels to provide detailed information, weather stations for data collection, or augmented reality apps for interactive flora and fauna identification, can enhance outdoor investigations [18].

5. Regularly Rotate Features and Challenges

Periodically introduce new elements or challenges in the outdoor space to maintain novelty and unpredictability. Seasonal planting, temporary art installations, or rotating outdoor exhibits can keep the learning environment dynamic and responsive to the interests and inquiries of students [19].

6. Stakeholder Participation in Design

Students, teachers, parents, and the local community can be engaged in the design and re-design of outdoor spaces. Promote activities where stakeholders can voice their ideas or suggest changes to the outdoor learning environment in collaborative workshops, brainstorming sessions, or design challenges [20].

THE ROLE OF OUTDOOR EDUCATION

Outdoor education and its associated innovative methods extend beyond the realms of natural science and pedagogical advancements. Within the context of the social sciences, the application and significance of these methods, especially for societal interactions and the evolution of community values, offer rich avenues for investigation of societal interactions and the evolution of community values. The stakeholder participation in designing outdoor spaces, as mentioned, mirrors the participatory approach observed in social research. This democratic approach prioritizes local knowledge and recognizes the inherent value in diverse community voices, facilitating a more holistic understanding of community needs and dynamics [20].

By melding technology into outdoor spaces, like using QR codes or augmented reality, we touch upon the broader theme of digitalization in modern society. Social sciences explore the implications of such technological integrations, exploring issues like the digital divide, technology's role in community engagement, or its implications on privacy and personal interactions [18].

Allowing nature to grow wild, or accepting its inherent unpredictability, presents a fascinating analogy to the acceptance of societal diversity and the unpredictable nature of societal evolution. As society becomes increasingly pluralistic, the social sciences grapple with understanding the complexities and dynamics of diverse groups [17]. The move towards outdoor education reflects a larger societal trend valuing experiential learning, environmental consciousness, and a holistic approach to well-being. The way communities value and interact with natural spaces can provide insights into their cultural, ethical, and societal values [19].

The notion of regularly rotating features to maintain novelty in outdoor spaces has parallels in social science. Societies are in constant flux, adapting to new challenges, technological advancements, and/or cultural shifts. The dynamics emphasized in social science research require us to have flexibility, resilience and adaptability [7], and these qualities are also particularly important in outdoor education. Outdoor education is not only rooted in the environment but also provides a platform for applying these core social science themes to the real world. By practicing environmental principles, we not only learn how to adapt to changing social circumstances, but also learn to find our connection to the world in the evolving natural environment.

Outdoor education is inherently tied to the environment, providing a platform for real-world application of environmental principles., fostering a deeper understanding of sustainable action [19]. The design of outdoor spaces, equipped with technology or built for specific activities, intersects with engineering and architectural disciplines. Creating structures that are sustainable, user-friendly, and harmonious with the natural environment requires an interdisciplinary approach, combining pedagogical, environmental, and design principles [21].

In conclusion, the methods and approaches in reconceptualizing outdoor learning environments have profound relevance in the field of social science. These strategies not only echo the broader societal trends and values but also offer fresh perspectives to understand community dynamics, societal interactions, and the evolving nature of contemporary societies. A noteworthy direction for future research would be to explore

the affordances of these outdoor learning environments to better understand both educators' and students' perceptions to gain a holistic view. Moreover, there is a pressing need to assess the long-term impact of outdoor education on both learning outcomes and the development of creativity. This ensures a comprehensive understanding of its influence on the educational landscape.

>> REFERENCES

[1] Christoph Becker, Gabriele Lauterbach, Sarah Spengler, Ulrich Dettweiler, and Filip Mess, "Effects of Regular Classes in Outdoor Education Settings: A systematic review on students' learning, social and health dimensions", International Journal of Environmental Research and Public Health 14(5), pp. 485, 2017. https://doi.org/10.3390/ijerph14050485

[2] Mandi Wojciehowski and Julie Ernst, "Creative by Nature: Investigating the impact of nature preschools on young children's creative thinking", International Journal of Early Childhood Environmental Education 6(1), pp. 3-20, 2018. https://files.eric.ed.gov/fulltext/EJ1193490.pdf

[3] Greg William Misiaszek, "Ecopedagogy and Citizenship in the Age of Globalisation: Connections between environmental and global citizenship education to save the planet", European Journal of Education 50(3), pp. 280-292, 2015. https://doi.org/10.1111/ejed.12138

[4] Simon Beames, Peter Higgins, and Robbie Nicol, Learning Outside the Classroom: Theory and guidelines for practice. New York: Routledge, 2012. https://doi.org/10.4324/9780203816011

[5] Alison Lugg, "Developing Sustainability-Literate Citizens through Outdoor Learning: Possibilities for outdoor education in higher education", Journal of Adventure Education & Outdoor Learning 7(2), pp. 97-112, 2007. https://doi.org/10.1080/14729670701609456

[6] Gregory A. Smith and David Sobel, Place-and community-based education in schools. New York: Routledge, 2014. https://doi.org/10.4324/9780203858530

[7] Sue Waite, Mads Bølling, and Peter Bentsen, "Comparing apples and pears?: A conceptual framework for understanding forms of outdoor learning through comparison of English Forest Schools and Danish udeskole", Environmental Education Research 22(6), pp. 868-892, 2016. https://doi.org/10.1080/13504622.2015.1075193

[8] Sara Jose, Patricia G. Patrick, and Christine Moseley. "Experiential learning theory: the importance of outdoor classrooms in environmental education", International Journal of Science Education, Part B 7(3), pp. 269-284, 2017. https://doi.org/10.1080/21548455.2016.1272144

[9] Rachel McCormick, "Does access to green space impact the mental well-being of children?: A systematic review", Journal of Pediatric Nursing 37, pp. 3-7, 2017. https://doi.org/10.1016/j.pedn.2017.08.027

[10] Emilia Fägerstam, Space and Place: Perspectives on outdoor teaching and learning. Linköping University Electronic Press, 2012. https://www.diva-portal.org/smash/get/diva2:551531/fulltext01.pdf

[11] Ming Kuo, Matthew H. E. M. Browning, and Milbert L. Penner. "Do lessons in nature boost subsequent classroom engagement? Refueling students in flight", Frontiers in Psychology 8, pp. 2253, 2018. https://doi.org/10.3389/fpsyg.2017.02253

[12] Elizabeth K. Nisbet, John M. Zelenski, and Steven A. Murphy, "The Nature Relatedness Scale: Linking individuals' connection with nature to environmental concern and behavior", Environment and Behavior 41(5), pp. 715-740, 2009. https://doi.org/10.1177/0013916508318748

[13] Pernille Malberg Dyg and Karen Wistoft, "Wellbeing in school gardens — The case of the Gardens for Bellies food and environmental education program", Environmental Education Research 24(8), pp. 1177-1191, 2018. https://doi.org/10.1080/13504622.2018.1434869

[14] Justin Dillon, Mark Rickinson, Kelly Teamey, Marian Morris, Mee Young Choi, Dawn Sanders and Pauline Benefield, "The value of outdoor learning: evidence from research in the UK and elsewhere", Justin Dillon (Ed.), Towards a convergence between science and environmental education: The selected works of Justin Dillon. Abington, UK: Taylor & Francis, 2017, pp. 179-185. https://doi.org/10.4324/9781315730486

[15] Wei-Ta Fang, Arba'at Hassan, and Ben A. LePage, "Outdoor education", The Living Environmental Education: Sound Science Toward a Cleaner, Safer, and Healthier Future. Singapore: Springer Nature Singapore, 2022, pp. 229-260. https://link.springer.com/book/10.1007/978-981-19-4234-1

[16] David H. Rose and Anne Meyer (Eds.), A practical reader in universal design for learning. Cambridge, MA: Harvard Education Press, 2006.

[17] Roy Ballantyne and Jan Packer, "Introducing a fifth pedagogy: Experience-based strategies for facilitating learning in natural environments", Environmental Education Research 15(2), pp. 243-262, 2009. https://doi.org/10.1080/13504620802711282

[18] Amy M. Kamarainen, Shari Metcalf, Tina Grotzer, Allison Browne, Diana Mazzuca, M. Shane Tutwiler, and Chris Dede, "EcoMOBILE: Integrating augmented reality and probeware with environmental education field trips", Computers & Education 68, pp. 545-556, 2013. https://dash.harvard.edu/bitstream/handle/1/37231546/EcoMOBILE_Integrating_Augmented_Reality_and_Probeware_with_Environmental_Education_Field_Trips.pdf

[19] Richard Louv, Last Child in the Woods: Saving our children from nature-deficit disorder. Chapel Hill, NC: Algonquin Books, 2008.

[20] Roger A. Hart, Children's Participation: The theory and practice of involving young citizens in community development and environmental care. London: Routledge, 2013.

[21] David W. Orr, The Nature of Design: Ecology, culture, and human intention. New York: Oxford University Press, 2002. https://doi.org/10.1093/oso/9780195148558.001.0001

4

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER FOUR

A CREATIVE CLASSROOM FOR EVERYONE: INTRODUCING A SMALL 'C' CREATIVITY FRAMEWORK

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ABSTRACT

Based on the article "A creative classroom for everyone: An introduction to a small 'c' creativity framework" (Lasky & Yoon, 2020) [1], this review emphasizes that creativity is not an innate trait but rather a skill that can be taught and developed. A study was conducted to examine the extent to which a "small 'c' creativity framework" reveals teacher practices that influence creativity in classrooms and teaches students to solve real-world problems and think of new ideas. Creativity was confirmed to be encouraged through open-ended assignments, collaboration, presenting new ideas, openness to allow for students to cross disciplinary boundaries, and giving students choices and time ownership. The school culture and context, time management, and teacher practices for creating a creative environment in the classroom were highlighted as was the culture of the school itself.

Keywords: creativity, small 'c' creativity framework, classroom, teaching, multidisciplinarity

INTRODUCTION

The importance of creativity in the classroom and how it can be taught as a skill is discussed. There is a shift in understanding that creativity is not just an innate trait but a skill that can be developed. Research has shown that promoting small 'c' creativity, understood as "the kind of thinking that produces new ideas in the learner [...] not necessarily historically important to the field or domain, like thinking that is large 'C' creative" [2]. However, many teachers still lack the understanding and know-how to foster creativity in their classrooms. They often believe that creativity is an inherent trait in certain students, and some teachers don't see creativity as relevant in today's curriculums. It is crucial for teachers to revise their ideas about creativity and to learn how to foster it in their classrooms.

CONTEXT

The theory of "small 'c' creativity in the classroom" is aimed at improving teacher practices and promoting creative learning. This involves supporting divergent thinking, accepting new and relevant learning artifacts created by students, promoting collaboration and choice, and providing curricular constraints that enhance learning. A theoretical framework was created based on this literature, which states that teachers who foster small 'c' creativity should support divergent thinking, accept novel and relevant learning artifacts, nurture collaboration, provide choices, and include lesson guidelines that enhance learning and self-confidence.

The paper presents a study on the extent to which a small 'c' creativity framework reveals teacher practices that allow for creativity in classrooms. Two cases were selected from a larger study of five cases, focusing on high school science teachers in an urban setting in the Northeastern U.S.A., where teachers participated in a professional development program on nanotechnology and problem-based learning pedagogy.

FRAMEWORK

A theoretical framework was created, identifying five specific teacher characteristics for those who foster small 'c' creativity. These teachers tend to:

- support divergent thinking that is grounded in the lesson's activities or concept
- accept learning artifacts that are novel and relevant to the lesson
- nurture collaboration among small group members in which individual kinds of creativity within the group are supported
- provide choices on what is an acceptable response (learning artifact or discussion point) to a lesson
- include lesson guidelines that enhance, rather than restrict, learning and self-confidence

DATA COLLECTION AND ANALYSIS

The study collected data through classroom observations, student and teacher interviews, and student artifacts to provide information about the teacher's creativity stance, including a full-length creativity interview, observations, student interviews, and a problem-based learning scenario.

The observations used a qualitative approach and were focused on identifying elements of the framework. The data was collected and

analyzed for each teacher to form a "creativity in practice" portfolio, where the student artifactss were scored using the Consensual Assessment Technique (CAT), as shown in the following table:

Framework Component 1 Score	Example of Teacher Practice
High Score	The teacher gave students open-ended assignments that required them to create a product completely on their own. In the interview, he or she expressed that he or she valued divergent thinking and gave clear examples of past and present students who exhibited creativity.
Medium-high score	The teacher provided loose guidelines and valued work that was created within a certain amount of constraint. These teachers referred to students either in past or present classes who exhibited creativity.
Medium score	The teacher provided guidelines that allowed for some divergent thinking, but the assignment necessitated a majority of conformity to the guidelines. This teacher could name a student in their present classes who exhibited creativity.
Low-Medium score	The teacher provided assignment guidelines that most of time had one correct answer and did not explicitly ask students to think creatively. He or she might have an assignment that allowed for students to have novel thinking or to create a novel product. These teachers could think of a student who exhibited creativity in their present class, although the description was unspecific.
Low score	The teacher presented assignments to students that included guidelines that were looking for one correct answer and did not ask students to think creatively. These teachers could not name a student who exhibited creativity in their interview.

Table 4.1.
Framework scoring [1]

FINDINGS

Selected from the same professional development program on nanotechnology concepts and problem-based learning pedagogy, a comparison of student perception of the practices of the two teachers promoting creativity in the classroom resulted in clear differences. The first teacher encouraged creativity by assigning open-ended assignments, promoting collaboration in small groups, and allowing students to apply knowledge to new ideas. Students felt that this teacher nurtured their individual creativity and made the classroom a place for different perspectives. The second teacher did not create an environment that promotes creativity, as his lessons mostly consisted of worksheets and textbook questions that only allowed for one right answer. In this case, students felt disengaged, as the lessons lacked group work and opportunities for divergent and creative thinking.

CONCLUSION

The study highlighted the following factors for creating a creative environment in the classroom:

- the school culture and context – teachers in higher-performing schools, with more resources and administrative support, were better able to foster creativity in their classrooms;
- time management – giving students ownership over their time is crucial to fostering creativity;
- teacher practices – openness to allow cross-disciplinary work and group organization are important influences on students.

Note that "the culture of schools influences teachers' participation in activities that help to build creative classrooms, as much as their beliefs in the importance of creativity in the science classroom" [2]. Note also that micro-level creativity, termed "mini-c" creativity [3], may still prove to have a place in advancing creativity theory and research. Distinguished from both everyday (small c or little-c) and eminent (Big-C) creativity, mini-c creativity was posited to describe the inventive processes inherent in the formation of individual knowledge and comprehension. Mini-c creativity may help to fill in the voids within existing notions of creativity, furnishing researchers with a fresh and significant analytical unit to refine inquiries into creativity research.

>> REFERENCES

[1] Dorothea Lasky and Susan Yoon, "A creative classroom for everyone: An introduction to a small 'c' creativity framework", Thinking Skills and Creativity 36, Jun 2020. https://www.sciencedirect.com/science/article/pii/S1871187119301968.

[2] Erica McWilliam and Shane Dawson, "Teaching for creativity: Towards sustainable and replicable pedagogical practice", Higher Education: The International Journal of Higher Education and Educational Planning, 56(6), pp. 633-643, Dec 2008. https://link.springer.com/article/10.1007/s10734-008-9115-7

[3] Ronald A. Beghetto and James C. Kaufman, "Toward a broader conception of creativity: A case for 'mini-c' creativity", Psychology of Aesthetics, Creativity, and the Arts 1(2), p. 73, 2007. https://www.researchgate.net/publication/232461925_Toward_a_Broader_Conception_of_Creativity_A_Case_for_mini-c_Creativity

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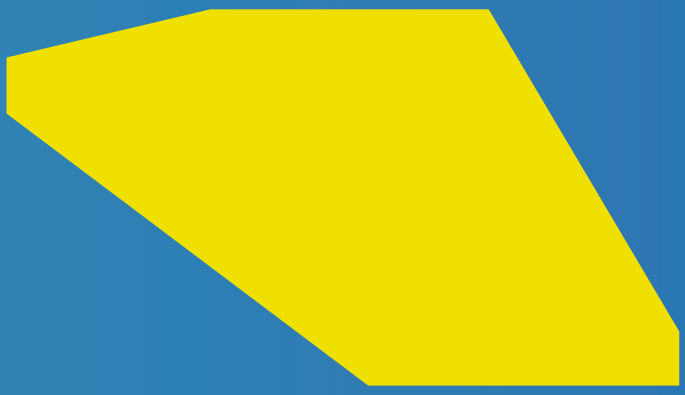

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER FIVE

CREATIVE AND COLLABORATIVE THINKING FOSTERS INNOVATION

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ABSTRACT

The book *Collective Genius: The Art and Practice of Leading Innovation* deals in part with team leadership towards innovative and creative solutions. The authors connect innovation and leadership. It is the role of a leader, teacher, boss to create an organization that innovates more than others do. It is not enough to be a good leader; one has to be a good leader of innovations. Innovation - as the fruit of a truly creative process - is a team sport, where individual efforts become something more valuable. Truly innovative teams are able to harness and combine the separate slices of genius into one collective genius.

Keywords: creative abrasion, creative agility, creative resolution, innovation, interdisciplinarity

INTRODUCTION

The book *Collective Genius: The Art and Practice of Leading Innovation* [1] describes the approach towards innovation – innovation as a creative output of collaborative efforts of people with different expertise, background and views. The authors studied businesses and organizations from different fields – from Pixar to Google as well as a social enterprise in Africa, a luxury brand in Korea, and an Islamic Bank in Dubai – across the globe and looked for common patterns that enabled these teams to innovate repeatedly. In this review, we aim to point out:

- the inevitable need of collaborating when looking for innovative and creative solutions;
- that innovation rarely comes as a flash inspiration of the sky; instead, the process has to be well-thought out, messy and iterative;
- that leaders/pedagogues/teachers/bosses are here to "Set the stage, not to perform on it" (Vineet Nayar, HCL Technologies (p. 3).

LEADERS OF INNOVATION

The role of a leader in today's society in recent decades is defined by their ability to identify the vision and to inspire others in order to follow it. This concept is suitable when the solution is clear and the way towards it straight-forward. However, this approach is counterproductive if the solution is vague and nebulous. If the problem calls for a really original answer, nobody can know what the answer – or even a vision – would be.

The true leaders of innovation create a context – they set up the stage where people are willing and able to innovate and deliver outcomes that complex problem-solving requires. If we think of teams as willing to innovate, leaders must create an environment in which team members are firmly bound to a common goal, where they share common values

and respect the established rules of mutual cooperation and personal engagement in the team. For teams to be able to innovate, leaders must focus on key aspects of the innovation process: collaboration, the ability to learn-by-discovery, and the integrative decision-making process, aspects which are often studied in isolation. Effective leaders build a key thinking ability in each of the following areas: creative abrasion (related to cooperation), creative agility (when learning through discovery) and creative resolution (when the focus is on integrative decision-making processes).

COOPERATION, LEARNING-BY DISCOVERY, AND INTEGRATIVE DECISION-MAKING PROCESSES

Cooperation

The authors provide a specific example where the basic tool for team communication and collaboration in the Pixar studios is daily employee meetings, called dailies, to discuss progress on projects. A wide spectrum of production workers participates so that they can comment and contribute with their own ideas regardless of their role or hierarchical position. Furthermore, people also receive feedback on their work, which helps them to understand how the work of others interrelates and also affects their own. According to Ed Catmull, founder of the Pixar studio and president of Pixar and Walt Disney Animation Studios through 2018, "We don't just think about how to make a computer-generated film. We think about how to lead an organization full of different people who — together — can create something that no one could ever do alone" (p. 8).

Learning-by-discovery

The reality that innovation often emerges after a long period of persistent experimenting and trial-and-error contradicts myths linked to innovation, like Great discoveries appear as a flash of inspiration from the sky to the inventor's mind. Believing in "One percent inspiration, 99 percent perspiration", Thomas A. Edison himself tested the idea to see how it works. Then he either rejected it or he improved it (p. 68).

Instead, innovation is a journey, with many failures and false starts. The complex problem-solving approach usually involves people with diverse backgrounds and expertise in a chaotic and iterative process. The authors report that, in commenting on the difficulty of the innovation process, Catmull said that "our appetite has always been greater than our ability". If Pixar had shown "no failures", that would mean the company had lost its passion for creating things at the edge of all possibilities. This is the reason why no one at Pixar has ever been sanctioned for a mistake or for testing something that ended up not working (p. 18).

INTEGRATIVE DECISION-MAKING

The authors identify three ways to solve problems, disagreements, or conflicts:

- The first option gives the responsibility to the leader or other authority.
- The second way is a compromise, which actually mutes different options and opposing views. The solution can be found through voting, reasoned by the democratic principle of seeking consensus although this process often leads to unsatisfactory solutions, adopted by no one.
- The third way, integration of ideas, tends to bring the most innovative solutions. The combination of option A and option B that creates a new option C, which is better than A or B. The power of integrative choices that often combine opposing ideas allows differences, conflict and experiment to be included in the final solution.

MATERIALS AND APPROACHES: KEY PRINCIPLES OF LEADING INNOVATION

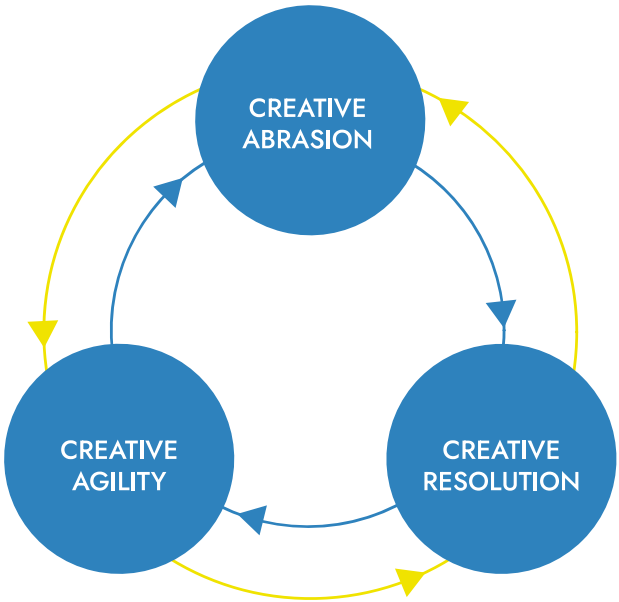

Figure 5.1.
Key aspects of the innovation process [1]

Ability to Innovate no. 1: Creative Abrasion

Creative abrasion is the ability of a team or organization to create a market of ideas. Through discussion, debate and sometimes conflict, alternatives are being generated, improved and developed. Possible solutions emerge from this process. The authors warn us not to confuse creative abrasion with brainstorming. Although both serve to generate a quantity of ideas, the difference is that abrasion involves unrelenting discussion, evaluation and critical comparison of ideas, while brainstorming prohibits critical comments when generating lots of ideas.

Innovation results from the collision of different ideas, perspectives and ways of processing information. For innovation to happen, we need to have ideas; many ideas. The abrasion refers to the process when two or several particles rub against each other. This is the key dynamics of a collaborative platform on which individual ideas collide and wrestle. Ideas

change, improve and create soil for new, better ideas, much as Edison said, "To have a great idea, have a lot of them" (pp.138).

Creative abrasion also includes a certain degree of conflict. This is the reason why it works best in a diverse community whose members are bound by a common goal for the "common good", share common values and keep to the rules of the game. While maintaining conflict on a productive level, relationships are not destroyed and people do not take the feedback personally.

Important ingredients in the process of the creative abrasion are therefore diversity and questioning. Diversity requires both variety in intellectual thinking and conflict in the cognitive sense – no interpersonal conflict, no winners or losers, just learning and improving. Effective leaders nurture diversity through questions they ask. For example, if they believe that the alternative has not yet been well evaluated, they use What about…? questions. If someone has not been sufficiently heard or understood, leaders will notice this and give them an opportunity. If they believe that the team has not considered all possible conditions, they ask What if…? questions.

Ability to Innovate no. 2: Creative Agility

Creative agility is the organizational ability to regularly test and improve alternatives through experiments, subsequent reflection, adaptation and new attempts in the second aspect of the innovation process – learning-by-discovery. The best solution is created by an energetic and proactive method of trial and error and gaining the knowledge the process brings along.

Creative agility is the iterative and recursive process when the team:

- pursues (quickly trying out new ideas via multiple experiments),
- reflects (analyze experiments and test output),
- adjusts (follow-up actions and choices based on knowledge gained from the test).

The number of iterations depends on the complexity of the problem. The value of repeated trial and error is frequently ignored and companies/teams/leaders tend to prefer quick elimination of alternatives to focus on just one or two possibilities. They focus more on planning rather than active action, mistakenly hoping for this plan to bring innovation. They also try to define how innovation should look. They compile a sequence of steps to achieve the result through lists of parameters and requirements. However, innovation cannot be defined in advance.

Innovative teams focus on alternating short planning periods and longer implementation periods (when they build prototypes) and improvisations. Speed matters: the more ideas we try, the faster we learn. However, it must be balanced with patience. Reflection and review are exactly the points where knowledge is acquired. Experiments are a valuable source of learning even when they fail. Good reflection includes active data-collection and demand for feedback.

Ability to Innovate no. 3: Creative Resolution

Creative resolution is the organizational ability to make integrative decisions. Innovative companies are able to decide on a choice that unites incompatible, sometimes conflicting ideas into one better/master solution. Many innovations are the result of such decisions: a new combination of existing ideas, which initially seemed mutually exclusive

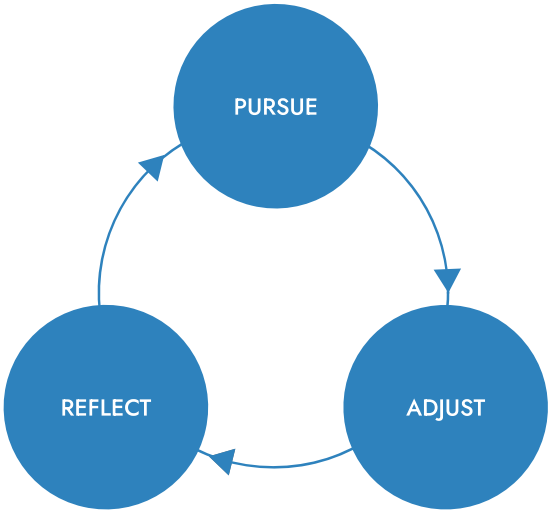

Figure 5.2.
Infinite iterations: the core of the creative thinking process [2]

or incompatible with exclusionary ones. A synthesis of ideas can be much better than either option alone. The ability to make integrative decisions is the key. If it is not cultivated, innovation does not come despite the brilliantly mastered process of creative abrasion and agility.

The leader must play the role of social architect rather than an arbiter distributing directive instructions. The best solutions emerge when teams are open to the thinking approach of both/and rather than either/or. The ability to keep in mind and work with several opposing alternatives at once is crucial AND uncomfortable for individuals and teams. The internal tension that results from the chaos should be embraced; without the mess. A natural human reaction leads to the simplification – as soon and as much as possible, which hinders creative and innovative thinking.

Leaders and teams that can sustain working with multiple options are able to withstand the pressure of performing fast choices and move forward. They are patient enough to deal with chaos and complexity and they are strong enough to admit that they have no immediate answers. They are convinced that the best solution will appear. They believe the process will create something better.

CONCLUSION

Soft-skills are gaining importance in the job market. According to the *Future of Jobs Report, 2020* [2] released by the World Economic Forum, the key competences for the 21st century are critical thinking, cooperation, creativity and communication. The authors of the book *Collective Genius: The Art and Practice of Leading Innovation* analyzes leadership paths towards innovation in businesses and organizations ranging from corporations like Google, Pfizer, and Volkswagen to small companies, social enterprises and NGOs. The pattern they have discovered harnesses the contributions of individual people in an organization. We have seen that:

- Human creativity is a key parameter/skill in the world where machines, technology and AI are replacing human power.
- Collaboration and teamwork help solve complex problems the society is facing.
- Interdisciplinary knowledge reinforces and amplifies the qualitative aspects of outputs and guarantees that more issues are being covered.

The diverse range of businesses studied, their fields of expertise, scope and size, and their presence across the globe, gives their research an interdisciplinary importance and serves as inspiration for teachers interested incorporating learning and practice related to creativity into their courses in higher education.

>> REFERENCES

[1] Linda Hill, Greg Brandeau, Emily Truelove, and Kent Lineback, Collective Genius: The Art and Practice of Leading Innovation. Boston: Harvard Business Review Press, 2014.

[2] "Future of Jobs Report 2020", World Economic Forum, Geneva, 2020. https://www.weforum.org/reports/the-future-of-jobs-report-2020/

>> FURTHER READING SUGGESTIONS

Links to many of the chapters in [1], one of the top "10 Management Classics for 2022" by Thinkers50, are available at https://books.google.pt/books/about/Collective_Genius.html?id=NVZwAAAAQBAJ&source=kp_book_description&redir_esc=y

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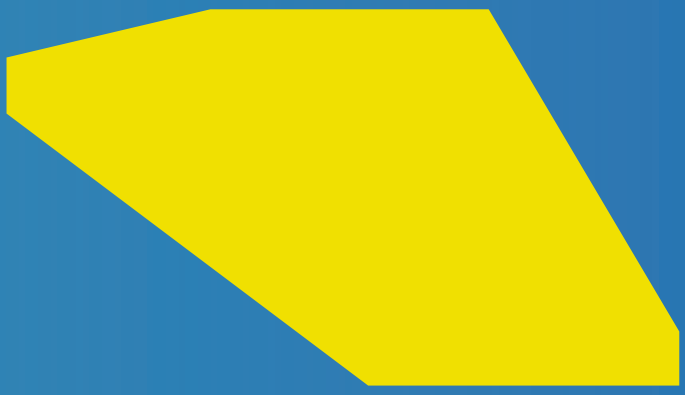

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER SIX

SMALL CHANGES IN ROUTINE PROVIDE EFFECTIVE RESULTS IN DEVELOPING CREATIVE SKILLS

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ABSTRACT

The Creative Nudge: Simple Steps to Help You Think Differently is a book written by two authors active in the creative industry: one as a creative director and the second one as a creative strategist. Mahoney. Chesters teamed up with behavioral scientists and psychologists to reveal how small actions in everyday routines can have a big impact on thinking. They provide almost 50 specific nudges supported by behavioral science that can be easily incorporated in daily practice. The simplicity of these steps makes it an interesting tool in an academic setting where it may provide effective results in developing creative skills. Having evaluated and considered each nudge in context of the educational environment, we propose that these small behavior changes or nudges that help to retrain a way of thinking among students, could be included in various fields of study to promote more creative problem-solving skills.

Keywords: creative skills, creative thinking, behavioral science, creative nudge, originality

INTRODUCTION

Mick Mahoney and Kevin Chesters are renowned figures in the advertising and creative industry. Their book *The Creative Nudge: Simple steps to help you think differently* [1] explores strategies and techniques to boost creativity, particularly within the context of marketing and advertising. Given their experience, readers can anticipate insights drawn from real-world examples, practical exercises, and perhaps anecdotes from their careers.

The title suggests that the book may focus on providing small, actionable steps or prompts to spark creativity. This could be beneficial for individuals looking to enhance their creative thinking or for professionals seeking fresh approaches to problem-solving and idea generation.

It is the simplicity and ease of the individual nudges that makes them easy to incorporate into the academic environment as well. It can be an easy way to bring creative thinking into fields of study that – at the first glance – have little to do with creativity. Knowing the basic techniques and steps, the educator can guide students to more creative performances and more effective problem solving in a simple way.

The individual nudges are divided into nine chapters that characterize nine behaviors that should be challenged in order to improve creative thinking. The authors recommend to choose one small change from each of these that best suits the context and incorporate it into the daily routine.

The authors believe that creativity cannot be taught. This is interesting and provocative. However, for more effective creative outcomes, it is necessary to unlearn the established techniques and procedures in thinking and to get rid of the perceptual blindness and habituation.

APPROACHES

In order to help the brain to get rid of the automatic problem-solving impulses, the authors have summarized in the book almost 50 practices, that are supposed to help in returning to creative thinking. These nudges are small steps, changes in behavior. The point is that these changes are small and simple.

A creative nudge can take various forms, depending on the context and desired outcome. It could be a prompt, a question, a constraint, a visual or auditory stimulus, or even a change in environment. The purpose is to disrupt established patterns of thinking, challenge assumptions, and encourage fresh approaches to problem-solving or idea generation.

These small steps are part of behavioral economics. These small nudges are very widely used to influence buyers in marketing and business. Knowledge of this area helps us to understand how we are influenced by companies when making our buying decisions. They could also be used in the academic environment by educators to guide and influence students to more effective creative outcomes in a non-coercive way. By nudging students out of their comfort zones and providing them with novel inputs or constraints, creative nudges aim to inspire originality and foster innovation.

The book includes RAT tests after each chapter, which can serve as a quick help to kick-start creative thinking as well as a verification of the involvement of creative thinking in solving tasks. According to the authors, "RAT stands for Remote Associates Test. It is a simple method that can scientifically track how creative the solver is. Devised by the much-lauded US psychiatrist Sarnoff A. Mednick and his wife Martha T. Mednick it was first published in 1959 (...) It remains one of the simplest ways of testing one's powers of creative thinking. A person is given a set of three apparently unrelated words and the challenge is to work out what fourth word might link them" (p. 9). For example, given three words – crystal, foot, snow – a fourth word that connect all three could be ball.

NINE BEHAVIORS

As mentioned above, the book is divided into nine chapters, which are characterized by individual behaviors. The authors believe that these behaviors need to be challenged with the help of what they call nudges in each of the nine chapter titles:

1. If you know what you are doing, stop doing it
2. Don't believe what you are told
3. Don't be afraid to be afraid
4. Let chaos in
5. Don't settle
6. Be unreasonable
7. Hate consensus
8. Don't rush it
9. Failure is an option (p. 3)

Each chapter contains six simple instructions. The authors recommend choosing one that best suits the reader and their context. The chapter starts with a description of the problem, an explanation backed by scientific knowledge, and then an antidote that includes the six nudges themselves.

The final, strongest chapter, which can be relevant also for the academic environment, is the chapter on failure. It is in the school environment that failure is often punished with low evaluation and thus forms a habit in students to stick to safe solutions, which are often the less creative ones. The authors call for failure and mistakes to be gradually merged with a different point of view and positive feelings.

The authors suggest that the easiest nudge towards positive connotation in relation to failure is to surround oneself with quotes from successful people who have seen failure as part of their path to success. As Thomas Edison said, "I have not failed. I've just found 10,000 ways that won't work" (p. 116). This simple nudge is also very feasible in an academic setting, where quotes highlighting failure can appear in classrooms and on bulletin boards as encouragement for students to let go of the fear of not succeeding.

Another simple nudge from the "Failure is an option" chapter is the suggestion to "Turn failure into a hobby". This can be done by stepping out of one's comfort zone and choosing a task or hobby that is clearly going to end in failure, for example, when a person who doesn't normally cook tries to prepare a complicated recipe or when a person who does not know how to play a musical instrument tries a piano lesson. Above all, in the university environment, teachers can induce a similarly fun atmosphere by assigning a task that is from a different study area. At a university with a technical focus, students can be given a task with an artistic context; at a university for the arts, students can try solving complicated engineering tasks. The main aim is to promote the association of fun with failure and to build "positive failure muscle memory" (p. 118).

In the chapter "Don't rush it", the subject of the impact of time on creativity is discussed. According to a seminal paper based on the Longitudinal Field Study at Harvard Business School in 2002, "time pressure prevents creative thinking. Under extreme time pressure, the ability to think creatively drops by an alarming 45%" [2]. Mahoney and Chesters identify time pressure as one of the main enemies of creativity and suggests that "some areas of the brain required for creative problem-solving can only be activated when we let our mind wander" (p. 102) [1]. Working under constant pressure, multitasking, and very tight to-do lists do not allow the mind to flow freely and come up with creative solutions. This is also true for academic environments, where students are overwhelmed with many deadlines and assignment submissions. A simple nudge to slow things down is as simple as swapping a keyboard for a pen. The authors recommend using this technique whenever one needs to better understand the problem and delve into the topic. It is also ideal for academic environments, where the lecturer can invite students to use paper and pen instead of a computer to solve a given problem or task.

In the chapter "Don't believe what you are told", the authors point out that we often accept the information without questioning it, taking it as a fact. This is also often encountered in the academic environment where there is very little room to question the facts and information that students are taught. The space for questions from students during the lecture is

often left unused, both because students may not know how to ask the right questions and are taught not to doubt authority. Young children have mastered this technique, questioning everything and asking "and why…?" Gradually, the school environment has resulted in unlearning how to question things.

The book offers simple nudges that can help to learn to ask questions. The authors suggest taking two different markers so that, each time a person hears a piece of wisdom or fact, they can write it down with one marker and then write it as a question with the other, different colored marker. Next, they recommend verifying, searching, and answering the question with facts. This tool can also help to teach students to ask questions after a topic is presented during the lecture. After the lesson, the teacher can ask students to write down all the facts from the lesson that interest them and then turn them into questions. This activity encourages critical thinking of the students. This technique can be improved by hiding "Easter eggs" in the lecture, where the teacher purposely communicates incorrect information and invites the students to find and reveal it.

These were just a few examples of how individual nudges from a book can become an interesting tool for the academic environment. Each chapter offers many similar examples and inspirations of how small changes in everyday behavior can change the way people think.

CONCLUSION

The concept of a creative nudge is based on the understanding that creativity often thrives when individuals are exposed to new stimuli, alternative viewpoints, or unexpected connections. The book *The Creative Nudge* provides a wide range of simple ideas grounded in a scientific background of behavioral science and that are easily applicable in any setting and context. This makes these nudges an effective tool that can be recommended for higher education.

With up to six nudges in each of the nine chapters, educators can choose the most appropriate for a given academic focus and background. The book is written in a funny, simple style that makes it an accessible handbook for any field of study and can bring a fresh breeze into the higher education environment. Creative nudges can be used to stimulate students' creative thinking and generate innovative ideas. Teachers can benefit from this book when creating prompts, constraints, or thought-provoking questions to encourage students to approach problems from different angles and explore alternative solutions.

Similarly, the nudges can assist students in overcoming academic challenges by encouraging them to approach their studies from fresh perspectives, to think creatively, explore diverse perspectives, and develop innovative approaches to problem-solving. For instance, teachers can associate their courses with unconventional study techniques, alternative ways of understanding complex concepts, and engaging prompts that inspire critical thinking and analytical skills.

The goal is to ignite the creative spark and encourage individuals to explore unconventional paths, think beyond conventional boundaries, and discover fresh points of view. It can also foster the culture of innovation, collaboration, and lifelong learning, preparing students for the complex challenges of the future.

>> REFERENCES

[1] Mick Mahoney and Kevin Chesters, The Creative Nudge: Simple steps to help you think differently. London: Laurence King Publishing, 2021.

[2] Teresa M. Amabile, Jennifer S. Mueller, William B. Simpson, Constance N. Hadley, Steven J. Kramer, and Lee Fleming, "Time Pressure and Creativity in Organizations: A Longitudinal Field Study", a substantially revised version of HBS Working Paper #01-023, "The Influence of Time Pressure on Creative Thinking in Organizations", Harvard Business School, 2002. https://www.hbs.edu/ris/Publication%20Files/02-073_03f1ecea-789d4ce1b594-e74aa4057e22.pdf

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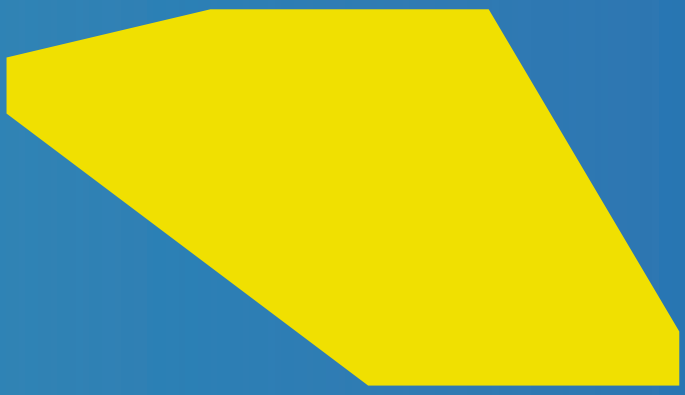

PERSPECTIVES AND CONTEXTS FOR INNOVATIVE LEARNING ENVIRONMENTS

CHAPTER SEVEN

CREATIVITY, INC.: NOTES FROM THE ENTERTAINMENT INDUSTRY TO IMPROVE EDUCATION

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✉ María del Carmen ARAU RIBEIRO

ABSTRACT

This paper summarizes the valuable experience outlined by Ed Catmull with Amy Wallace for creativity in an industrial setting. We wondered how these valuable insights might be transferred to teaching creative thinking and have thus explored this question. This review will consider the pillars at Pixar and Disney to determine what lessons can be learned for education in creative thinking and prepare for any possible pitfalls in trying to learn from industry. Researchers, administrators, policy makers, and teachers interested in integrating a creative thinking mindset in education may appreciate the perspectives shared on how this actually happens in industry, especially given the success of creative thinking in the entertainment industry.

Keywords: thinking, creativity, strategies, education, management

INTRODUCTION

Creativity, Inc. by Ed Catmull, written with Amy Wallace [1], has been regarded as one of the best books on creative thinking approaches because it offers valuable insights into fostering creativity and innovation within organizations. Charles Duhigg, author of the influential best-seller *The Power of Habit: Why we do what we do in life and business* [2], called *Creativity, Inc*. "required reading for any manager" and this author of *Smarter Faster Better: The transformative power of real productivity* [3], and most recently, *Supercommunicators: How to Unlock the Secret Language of Connection* [4].

As the president of Pixar Animation and Disney Animation through 2018, Catmull draws on 40 years of experience in the entertainment industry. Before becoming a subsidiary of Walt Disney Studios in 2006, Pixar Animation Studios was founded in 1986 with major funding from Steve Jobs, although it had begun in California as The Graphics Group in 1979. From this wealth of experience, Catmull's narrative focuses on how to build a creative culture.

THE CORPORATE CULTURE AT PIXAR

The book is divided into four parts that give readers a generous view of the corporate culture at Pixar. In the first part dedicated to "Getting Started", readers become familiar with Pixar's origin story – including the defining goal and identity of the company – and Catmull's engaging storytelling style to learn through anecdotes, case studies, and insights. Particularly significant in part one is the importance of culture, leadership, and environment. In part two, "Protecting the New", the authors explore the challenges and obstacles of bureaucracy, fear of failure, and complacency with their relevance for obstructing creativity. Part three reflects on "Building and Sustaining", where they propose strategies for building, maintaining, and nurturing creativity over the long term. The title of part four, "Testing What We Know", reflects the evaluative perspective of testing, built into all aspects of creating and innovating, and concludes

with the key points of the book and final thoughts on fostering creativity within organizations. Together, the authors have communicated the corporate culture that embraces creativity, which could be a parallel inspiration for education and teacher practice in the classroom.

A CULTURE OF COLLABORATION AND ERROR

At Pixar, the environment supports the open expression of ideas, opinions, and concerns. The culture of collaboration encourages diverse perspectives and inspires further divergent thinking in an environment that recognizes failure as an inevitable part of the creative process [1]. As "a manifestation of learning and interpretation" (p. 109) Catmull's colleague Andrew Stanton, who is best known for writing screenplays and directing movies like *Toy Story*, *Finding Nemo*, and *WALL·E*, is credited with repeating the phrases "fail fast and fail early" and "be wrong as fast as you can" (p. 109).

In the classroom, learners are there to learn, testing hypotheses about what they have learned and practicing new approaches while applying newly acquired competence. The possibility of failure is clearly high when it may, in fact, be the first time that new knowledge is put into action in a problem-based learning environment. As teachers embrace this error culture in their classrooms, learners who participate in this classroom culture learn that they can and should fail pro-actively; they will also deeply sense and feel they are part of the enveloping error culture that sets up failure as an iterative process of learning, as expressed with the tryptic FAIL – first attempt at learning; SAIL – second attempt at learning; and TAIL – third second attempt at learning [3]. With each failure, the opportunity for learning and growth is part of the experimenting and risk-taking that is involved in a supportive community of learning and practice [4].

ITERATION AND FEEDBACK

Recognizing the importance of iteration, the creative process is continually refined and feedback is highly valued at Pixar, especially in dailies, the daily reviews where colleagues participate in a regular practice that Catmull learned at Disney and Lucasfilm's special effects company, Industrial Light & Magic [1]. This dedication to "giving and getting constant feedback in a positive way" [5] explores the potential of meeting and sharing with the team.

Involved in the culture of error established in a culture of collaboration, interaction and thoughtful consideration are regularly part of the ongoing conversation, where the objective of constructive criticism is better suited to the term feed forward. Similarly, the "3i Approach to Design Thinking" [6], where interdisciplinary teams engage in innovation through (re) iteration, develops the competences of communication, collaboration, critical thinking, and creativity. These 4Cs are built in to the core of the Erasmus+ project *DT.uni - Design Thinking Approach for an Interdisciplinary University* [7], an international consortium that united most of the partners of the current CT.uni project reflected in the volumes of *Unlocking Potential*.

LEADERSHIP SUPPORT

The organization's capacity for nurturing creativity and innovation is sustained by dedicated leadership and support, which can be likened to the different roles played out in education, from peer leadership in teamwork to the role of a teacher in a classroom or even the administration in relation to the university vision, mission, and work and study ethos. The issue of support has at its core the empowerment that is required for those involved to learn autonomously and take responsibility for their learning. Considering the *3i Approach to Design Thinking* [6], the 4Cs are being promoted in similar ways to support learner growth in commitment, motivation, and optimism, the three defining characteristics identified throughout the DT.Uni project as key ingredients for the teamwork proposed [7].

CROSS-DISCIPLINARY COLLABORATION AND STORYTELLING

Pixar values collaboration across the corporate departments and amongst professionals from vastly different areas. According to the authors, these diverse teams, where backgrounds and skill sets vary widely, generate more innovative ideas and solutions [1]. Allied to this dedication to diversity, communication is core, not just in Pixar's narratives and characters but also in engaging and inspiring each other through the power of storytelling. Teachers can move these dual objectives into their vision for learning by leveraging diversity and intercultural communicative competences. Learners involved with these learning objectives will look for plurality and actively avoid bias, which they will recognize as a barrier to solutions in a problem-based learning environment. Note for example, the best practices shared in our studies on an international project on leveraging intercultural communicative competence for greater employability [8], [9], learning activities for the interdisciplinary classroom [10], and on the learning activities that were impacted most by a growing intercultural environment, as reflected by the participation of ERASMUS^{+} students in Applied English courses [11].

CONCLUSION

While similarities are appreciable between Catmull's recipe for success at Pixar and for teachers in the classroom building an ambience that supports creative thinking and lifelong learning, resistance to change or a lack of support for innovative teaching methods is always a possible barrier. The existence of innovative projects that explore the research required for transition in education is an advantage. Researcher, educators, administrators, and learners can find partners to forge together the quality movement towards a culture of collaboration and error, supported by enriching iteration and feed forward, immersed in cross-disciplinary collaboration and storytelling, and sustained through leadership support.

>> REFERENCES

[1] Ed Catmull with Amy Wallace, Creativity Inc. – Overcoming the unseen forces that stand in the way of true inspiration. London: Bantam Press, 2014.

[2] Charles Duhigg, The Power of Habit – Why we do what we do in life and business. New York: Random House, 2014.

[3] María del Carmen Arau Ribeiro and Robert Fischer, "Chapter 2 Design Thinking and Digital Organizations", Yashar Salamzadeh (Ed.), Digital Transformation: A human-centric approach. Istanbul: Efe Akademi, 2021, pp. 25-58. https://books.google.pt/books?id=-h1gEAAAQBAJ&printsec=frontcover#v=onepage&q&f=false

[4] Etienne Wenger, Communities of Practice — Learning, Meaning, and Identity. Cambridge: Cambridge University Press, 1998.

[5] Ed Catmull, "How Pixar Fosters Collective Creativity", HBR- Harvard Business Review, Septermber 2008. https://hbr.org/2008/09/how-pixar-fosters-collective-creativity

[6] Design Thinking Model — The 3i Approach to Design Thinking, https://portal.ipg.pt/DtTasks/DTmodel

[7] Design Thinking Learning Tasks — Design Thinking Learning Model and other Resources, https://portal.ipg.pt/DTtasks/

[8] María del Carmen Arau Ribeiro, Ágnes K. Loch, and Ágnes Ibolya Pal, "Intercultural Communication Competence in Foreign Language Courses for University Students: the ICCAGE project (2015-2017) from a Hungarian perspective", L. Lendvai, O. Keresztes Takács, and E. Csereklye (Eds.), Mobilities, Transitions, Transformations: Intercultural Education at the Crossroads: Conference Proceedings IAIE Budapest, 2016, pp. 54-77. file:///C:/Users/User/Dropbox/PC/Downloads/CONFERENCE%20PROCEEDINGS_IAIE_Budapest.pdf

[9] Margarida Morgado, Luís Gomes, and María del Carmen Arau Ribeiro, "Survey of ICC best practice: Transnational Report, 2016. https://00d115e0-5949-4ee9-96a5-e69dcd9c68e6.filesusr.com/ugd/526a9b_c715f29c0f2f43dab28b9c1006886e1c.pdf

[10] María del Carmen Arau Ribeiro, "Crossing Disciplines: Interdisciplinary Practice in Higher Education", CASALC Review 5(1), pp. 5-13, 2015. https://www.journals.muni.cz/casalc-review/article/view/20565

[11] María del Carmen Arau Ribeiro, "Public Speaking for Intercultural Education and Metalinguistic Development in ESP", e-TEALS: An e-journal of Teacher Education and Applied Language Studies 2: pp. 68-80, 2011. https://ler.letras.up.pt/uploads/ficheiros/8757.pdf

>> FURTHER READING SUGGESTIONS

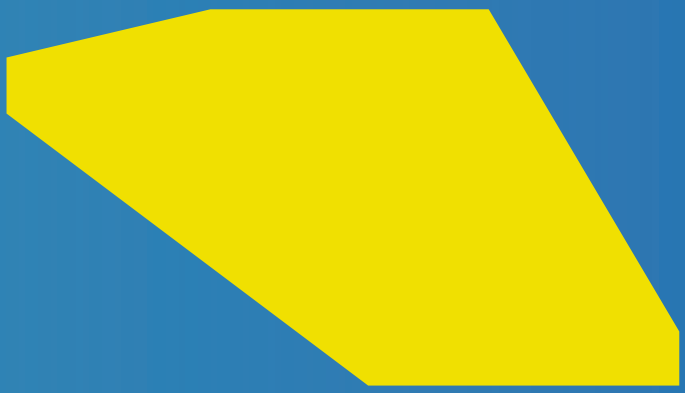
Matthew Arau, Upbeat! — Mindset, mindfulness, and leadership in music education and beyond. Gia Publications, 2022. https://www.upbeatglobal.com/book

Charles Duhigg, Smarter Faster Better – The transformative power of real productivity. New York: Random House, 2017.

Charles Duhigg, Supercommunicators – How to Unlock the Secret Language of Connection. New York: Random House, 2024.

Margarida Morgado, Margarida Coelho, María del Carmen Arau Ribeiro, Alexandra Albuquerque, Manuel Moreira da Silva, Graça Chorão, Suzana Cunha, Ana Gonçalves, Ana Isabel Carvalho, Mónica Régio, Sónia Faria, and Isabel Chumbo, CLIL Training Guide – Creating a CLIL learning community in higher education. Santo Tirso: Printhaus, 2015. https://recles.pt/images/Documentos/CLILTrainingGuide.pdf

8



ASSESSMENT AND MANAGEMENT OF CREATIVE THINKING

CHAPTER EIGHT

MEASURING CREATIVITY IN HIGHER EDUCATION: REMOTE ASSOCIATES TASK (RAT) AND DIVERGENT ASSOCIATION TASK (DAT)

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ABSTRACT

Applying explicit assessment of attained levels of creativity can help to evaluate which teaching activities actually work to enhance creativity of students and thereby improve creativity of teaching practices. This review presents two studies about two relatively simple tests that can be applied across domains (in different curricula) and do not require special expertise or a large time investment from the teaching staff, a novel Divergent Association Task (DAT), and an established Remote Associates Task (RAT). A clear limitation of both tests is that they are verbal oriented and therefore cannot test all relevant aspects of creativity.

Keywords: verbal creativity assessment, divergent, convergent

INTRODUCTION

Creative thinking (henceforth, 'creativity') is explicitly listed as one of the four major 21st century skills and is therefore often emphasized in curricular frameworks around the world (along with critical thinking, communication, and collaboration). Accordingly, we would like to enhance the creativity of our students by providing them with the right training and use some integrated assessment method to measure the attained levels of creativity. In this context we define creativity as "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" [1].

A substantial body of scientific literature on creativity has been produced since the 1950s and its measurement (or assessment) has been an integral part of this (see [2] for a compact overview). Unfortunately, there is no clear consensus on all the relevant dimensions of creativity and how these should ideally be tested, nor an integrated assessment framework. It is perhaps due to this lack of consensus that the explicit assessment of creativity is not commonly practiced in university teaching. Still, we think it would be worthwhile to adopt some form of creativity assessment in university teaching as it can help to evaluate which teaching activities contribute to the attainment of creativity by our students and thereby improve creativity teaching practices.

Adopting a relevant assessment method/approach would be especially attractive to teaching staff and course/program developers if no special expertise or time were required and if the assessment could be applied across domains, and thus in different curricula.

We have scanned the literature on creativity and education with regard to the measurement of creativity to find papers which would:

- describe one or more methods to measure creativity clearly
- provide evidence that the proposed method(s) are valid, and
- provide an easily applicable task to measure levels of creativity in our own setting (i.e. in a broad range of disciplines higher education and also in an inter- or transdisciplinary setting).

The aim of this literature review is to present two creativity assessments that meet these requirements. One assessment focuses on divergent [3] and the other on convergent creativity [4]. A clear limitation of the methods reviewed here is that they are verbal oriented and therefore cannot test all relevant aspects of creativity.

MATERIALS AND APPROACHES

Our first study is by Jay A. Olson, Johnny Nahas, Denis Chmoulevitch, Simon J. Cropper, and Margaret E. Webb [3]. This team from Harvard University, McGill University, and the University of Melbourne introduces their test, named the Divergent Association Task – the DAT – to measure divergent creativity. The DAT consists of asking a participant to generate ten nouns that are as different from each other as possible in all meanings and uses of the words in just four minutes (the full instructions are available at https://osf.io/3wgkt). Throughout the test, the automatic calculation of the semantic distances between these words is carried out by a machine learning method. According to the GloVe algorithm for obtaining global vectors [5], words that are used in similar contexts have smaller distances.

The DAT is based on prior research which suggested that creative people are able to generate more divergent ideas. If this is correct, simply naming unrelated words and then measuring the semantic distance between them could serve as an objective measure of divergent thinking. The validity of the DAT is tested by the authors by comparing its results from almost 9,000 individuals with their results from various established creativity tests, like the Alternative Uses Task and the Bridge-the-Associative-Gap Task. The conclusion is that the DAT is at least as reliable at measuring verbal divergent creativity as any of the alternative tests. The fact that the DAT does not need any prior test-construction or posterior scoring by humans is emphasized as a clear advantage. All the relevant material is available online at https://github.com/jayolson/divergent-association-task and the actual assessment can be taken at https://www.datcreativity.com/.

The second study is by Soghra Akbari Chermahini, Marian Hickendorff, and Bernhard Hommel [4] at Leiden University's Institute for Psychological Research & Leiden Institute for Brain and Cognition. The research team presents a Dutch version of the Remote Associates Test (RAT), which is an interesting contrast with the DAT in terms of novelty because the DAT is new, published in 2021, while the RAT may be the oldest creativity test, presented originally in the late 50s and 60s [6], [7].

The RAT is accepted as a valid measure of creative convergent thinking and has been widely used, relying on a participant's correct understanding of vocabulary (and possession of a sufficiently large active vocabulary). It is therefore most effective if specified in someone's native language. Thus, for application in the Dutch context, the RAT presented by Chermahini's team [4] is a welcome contribution. The study evaluates internal consistency (which appears to be high) of the developed test, comparable to other creativity tests [3]. The RAT-scores agree with other convergent creativity tests although they do not match with scores on divergent creativity tests. This last point supports the idea that these two aspects of creativity are complementary and do, in fact, require separate tests.

CONCLUSIONS

Based on the solid research presented by Olson and colleagues (2021) and Chermahini and colleagues (2012), we find that the DAT and RAT are both relevant and complementary tests for verbal creativity. While these may not represent the ultimate and ideal assessments for university teaching, they do present some advantages.

>> REFERENCES

[1] J.A. Plucker, R.A. Beghetto and, G.T. Dow "Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research", Educational Psychologist, 39, pp. 83-96, 2004. https://doi.org/10.1207/s15326985ep3902_1

[2] Jonathon A. Plucker, Michael C. Makel, and Meihua Qian, "Assessment of Creativity", James C. Kaufman and Robert J. Sternberg (Eds.), Cambridge Handbook of Creativity (2nd ed.). New York: Cambridge University Press, 2010/2019, Ch. 3, pp. 44-68. https://psycnet.apa.org/doi/10.1017/9781316979839.005

[3] Jay A. Olson, Johnny Nahas, Denis Chmoulevitch, Simon J. Cropper, and Margaret E. Webb, "Naming unrelated words predicts creativity", Proceedings of the National Academy of Sciences U.S.A. 118(25), e2022340118, 2021. https://doi.org/10.1073/pnas.2022340118

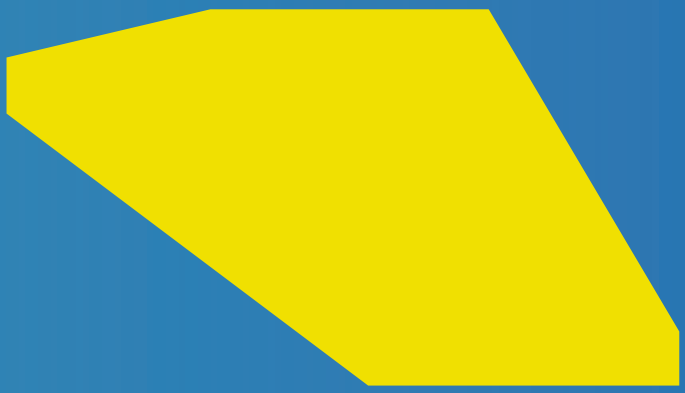
[4] Soghra Akbari Chermahini, Marian Hickendorff, and Bernhard Hommel, "Development and validity of a Dutch version of the Remote Associates Task: An item-response theory approach", Thinking Skills and Creativity 7(3), pp. 177-186, 2012. https://doi.org/10.1016/j.tsc.2012.02.003

[5] Jeffrey Pennington, Richard Socher, and Christopher D. Manning, "GloVe: Global vectors for word representation", Alessandro Moschitti, Bo Pang, Walter Daelemans (Eds.) Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP), Association for Computational Linguistics, Stroudsburg, PA, 2014, pp. 1532-1543. https://doi.org/10.3115/v1/D14-1162

[6] Sarnoff A. Mednick, Martha T. Mednick, and Sharon Halpern, "Remote Associates Test", Journal of Creative Behavior: Publication of the Creative Education Foundation 2(3), pp. 213-214, Summer 1968. Boston. MA: Houghton Mifflin Company. https://doi.org/10.1002/j.2162-6057.1968.tb00104.x

[7] Margaret E. Backman and Bruce W. Tuckman. Journal of Educational Measurement 9(2), pp. 161-162, 1972. http://www.jstor.org/stable/1433810

9



ASSESSMENT AND MANAGEMENT OF CREATIVE THINKING

CHAPTER NINE

FINDING EVIDENCE FOR ENHANCED CREATIVE THINKING SKILLS IN HIGHER EDUCATION

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ABSTRACT

This literature review presents a research methodology to explore creativity within education, particularly in interdisciplinary higher education settings. Despite the abundance of literature on this topic, navigating through theories, ideas, and anecdotal evidence can be daunting. However, amidst this plethora of information, practical materials exist that can be readily adopted and adapted to university contexts. This review aims to shed light on the availability of such materials on enhancing student creative thinking skills. Through rigorous research methodology, the review identifies two exemplary studies by Ritter et al. (2020) and Wu et al. (2020). These studies not only demonstrate effective evaluation techniques but also offer insights into measuring creativity through various tasks such as the Remote Associates Test. By adopting existing modules and leveraging evidence-based practices, universities can enhance their curriculum and foster creative thinking among students.

Keywords: education material, creative thinking, evaluation, experiment, systematic review

INTRODUCTION

The literature on creativity in education (even if we limit ourselves to interdisciplinary higher education) is overwhelming and confusing. This is not only due to the inherent complexity of the topic but also due to the many scientific contributions that focus only on theory development, ideas, or anecdotal evidence.

Within the scientific literature on creativity in higher education, effective and tested training materials are not abundant although some exist. In this large body of material, there are ideas and practical materials that can readily be adopted as well as adapted to specific university contexts.

The aim of this literature review is to present a study that shows that such material exists and how its effectiveness could be studied after adoption (in an experimental setup [1]) or prior to adoption (through a systematic review [2]). We aim to present not only an example of readily available practice-material of proven quality that could be adopted in an interdisciplinary curriculum to enhance student creative thinking skills but also best practice examples of how someone could evaluate (and communicate) whether the use of such material would be effective.

RESEARCH METHODOLOGY

We were aiming to answer the following two research questions:

Q1. Is there readily available practice-material of proven quality that could be adopted in an interdisciplinary undergraduate curriculum to enhance student creative thinking skills?

Q2. How would we evaluate (and communicate) the effectiveness of such material?

Two criteria were applied to a scan of the literature since 2010 on creativity and education for Q1:

- Studies that report on materials that focus on enhancing creative thinking skills in higher education
- Studies that focus on materials that are accessible and useful for classroom use at a reasonable cost

With respect to Q2, the criteria to be included were studies that provide evidence in educational practice through a combination of three characteristics:

- a sufficiently large sample (in case of experimental work, observational data or systematic review)
- high quality analysis
- clear reporting and a critical discussion of results

The two papers selected based on these collected criteria should function as best practice examples of how evidence on the effectiveness of an educational intervention can be collected, analyzed, and presented well.

ADOPTING CREATIVITY MODELS FOR UNIVERSITY CONTEXTS

Even though we would like to develop tailor-made modules to enhance (aspects of) creative thinking in our programs, the possibilities to do so are often limited. Reasons may be the lack of expertise, time, or support from the education organization. Adopting an existing module (or linked set of modules) that does not need (much) adjustment is very convenient because it requires less expertise and saves resources.

We present two studies both published in 2020, a study by Ritter et al. (2020) [1] and a study Wu et al. (2020) [2]. The first study is by Simone M. Ritter, Xiaojing Gu, Maurice Crijns, and Peter Biekens. This Dutch interdisciplinary team from Radboud University, the Brainnovation Foundation, and Fontys University of Applied Sciences shows how a controlled experiment can be set-up, analyzed, and reported to evaluate an intervention. The second study by Ching-Lin Wu, Shih-Yuan Huang, Pei-Zhen Chen, and Hsueh-Chih Chen, also an interdisciplinary team all from National Taiwan Normal University, shows how a systematic literature review can be used for that purpose.

If one would prefer to evaluate the effectiveness of an educational intervention before implementing it, a systematic review is the most appropriate instrument. To show what this entails, we have also included the systematic review selected [2].

THE EVIDENCE

A designed experiment with a control group [1] and a systematic review [2] are two of the most convincing ways to evaluate evidence on the effectiveness of enhancing student creative thinking skills. The two examples show what it takes in terms of resources and expertise to conduct this type of research and also what effect sizes might be expected.

Several tasks (and derived indices) are available for measuring creativity. Ritter's team study [2] explain the following types of tasks: Alternative Uses Task, Visual imagination task, Remote Associates Test, Convergent visual imagination task, Idea selection task, Insight problems, and Number tasks. Wu and colleagues [2] explain variants of the Remote Associates Test.

There is a substantive link between the two studies. Ritter and colleagues [1] introduce teaching material to help students in higher education to enhance their creative thinking ability. The effectiveness of this material is evaluated with various tests, amongst which the Remotes Associates Test (RAT). In the study by Wu and colleagues [2] an overview is given of the use of the RAT to evaluate creativity over the past ten years. This study conducts a content analysis to evaluate which aspects of creativity have been investigated and demonstrates how empirical studies using the RAT have explored the individual differences, internal processes, and external influences of creative thinking.

From courses at https://brainnovation.teachable.com/, the literature provides evidence that this material actually enhances the level of creativity within a student population [1] and illustrates how the effectiveness of such material could be studied after adopting it or prior to adoption through a systematic review [2].

CONCLUSION

Collecting evidence about the degree by which educational goals are achieved or by which interventions in education lead to the desired changes in students' skills, knowledge, behavior or attitudes is hard. Still, we need evidence to inform our decisions and make improvements in our curriculum. Working from existing high-quality examples, by trying to copy their methods entirely or in part is a relatively safe and effective approach to start with this practice of generating evidence to evaluate our interventions.

There is some interesting teaching-material available which has been readily available for use in an interdisciplinary undergraduate curriculum (see the three courses at https://brainnovation.teachable.com/). The preliminary conclusion, based on [1], is that this material does enhance some aspects of students' creative thinking skills. However, more evaluations of the effectiveness would be desirable.

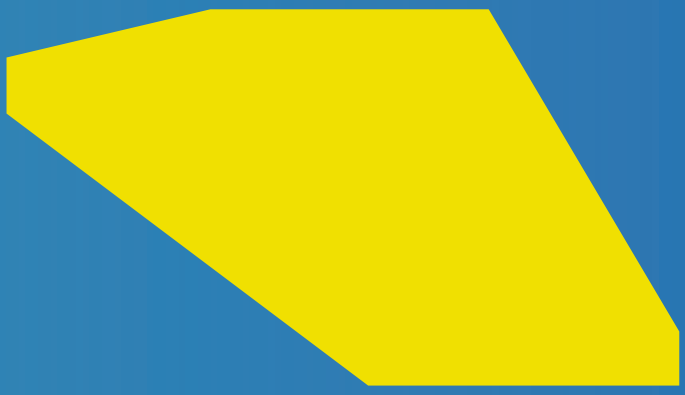
By adopting an existing module which trains students in creative thinking, experience could be gathered that could allow for gradual improvements or develop new materials as a next step. This literature review shows that such resources (which might be useful for other universities) exist and how the effectiveness of adopting such a model could be evaluated in an educational experiment [1].

>> REFERENCES

[1] Simone M. Ritter, Xiaojing Gu, Maurice Crijns, and Peter Biekens (2020) "Fostering students' creative thinking skills by means of a one-year creativity training program", PLoS ONE 15(3), e0229773, 2020. https://doi.org/10.1371/journal.pone.0229773

[2] Ching-Lin Wu, Shih-Yuan Huang, Pei-Zhen Chen, and Hsueh-Chih Chen, "A Systematic Review of Creativity-Related Studies Applying the Remote Associates Test From 2000 to 2019", Frontiers in Psychology 11, e573432, 2020. https://doi.org/10.3389/fpsyg.2020.573432

10



ASSESSMENT AND MANAGEMENT OF CREATIVE THINKING

CHAPTER TEN

STORING AND TRANSFERRING CREATIVE IDEAS

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ABSTRACT

The article "Ideas in the Space Between: Stockpiling and processes for managing ideas in developing a creative portfolio" (Ananth and Harvey, 2023) explores the nuanced dynamics of idea management within creative portfolios. Focusing on the intersection of creativity and organizational strategy, where effectively managing ideas can foster innovation and sustain creative momentum, this review examines idea stockpiling and the processes employed in curating and refining ideas within creative contexts. Distinguishing between strategic management, where ideas are intentionally stockpiled and mobilized across projects, and symbolic management, ideas can be preserved as creative symbols rather than for immediate implementation. The resulting model of idea management offers a new perspective on creativity, portraying creative workers as both creators and curators, with ideas evolving across projects to fuel ongoing innovation.

Keywords: creative portfolio, managing ideas, idea stockpiling

INTRODUCTION

The literature on creativity includes a number of works on different ways to facilitate the generation of ideas. Some people seem more adept at thinking outside of the box and generating ideas that are not only unexpected but also collectively recognized as creative. Then there are methods and activities designed to promote divergent thinking and creativity, such as brainwriting or challenging assumptions. But creativity is a subjective concept, not easily measured, quantified, or recorded. It is therefore interesting to ask to what extent creative ideas can be itemized, stored, and reused at a later point in time. These questions are studied in the article, "Ideas in the Space Between: Stockpiling and processes for managing ideas in developing a creative portfolio", by Poornika Ananth and Sarah Harvey [1].

Respectively from the University of Bath School of Management and the University College London School of Management, this team of researchers shows that people who regularly assume creative roles or tasks can stockpile ideas that they create along the way, saving and storing ideas from one project, turning ideas into resources, and then mobilizing those resources within a new project at a later stage. They find a distinct difference between managing ideas strategically versus symbolically.

From a grounded theory approach, the findings are primarily based on a total of 70 interviews with 40 theater artists and 30 architects, recruited through educational institutions, organizations, and professional bodies in the UK, and further, through references from interviewees. The semi-structured interviews were complemented by a follow-up 12-week diary study of six of the theater artists and four of the architects.

As a starting point, the authors consider models of creativity that allow for creators' engagement with the inherent thoughts and actions that are needed to conclude a creative process that has initiated many divergent paths from its outset. This approach extends the research beyond the more focused approach of considering solely the task of idea generation as signifying creative effort. Through this broader approach, ideas are generated, collected, evaluated, and some are discarded, while others

are allowed to mature and be implemented. After describing these processes, within the scope of the single creative project, the model is expanded to reflect the way that artists, designers, or other creators who work on projects successively can gradually build a portfolio that is the corpus of their work.

Through interviews and the ten diaries collected, the authors find evidence of different practices that creative individuals use. In one style, creative practice moves purposefully from the completion of one project to another and allows these projects together to become a coherent portfolio. In another style, creative practice involves storing and mobilizing specific working ideas from one project to another so that ideas are not discarded, even when they have neither been developed further nor implemented, and instead those ideas become resources for a later venture.

The study also shed light on the motivations of these creators for preserving ideas, recording prior work, and purposefully allowing it to affect their current projects. The diverse motivations were often expressed as concerning the longer-term view on their careers and work, efforts "to derive deeper meaning from their body of work" (p. 486), or "evoke memories or feelings" (p. 487).

MANAGING CREATIVE IDEAS STRATEGICALLY

The authors find examples of practices where creative workers are "managing ideas strategically to build portfolios by realizing stockpiled ideas in new creative products across different opportunities" (p. 465). The act of stockpiling ideas that are born from creative work of some kind, to be used later in an unrelated project, is carried out intentionally. Expectations from allowing ideas to mature range from facilitating future work to reshaping so that earlier ideas can fit the context of a later project. Ideas are managed across projects to initiate, implement, and realize ideas in new projects over time. Creative workers invest in ideas that show promise, whether they are in early development or in the prototype stage. Such seed ideas were brief concepts that creators found interesting, but they may not have had the right platform at the time, so the seed ideas were stored to be mobilized at a later time (p. 482).

MANAGING CREATIVE IDEAS SYMBOLICALLY

Creators also expressed different motivations for storing or holding on to ideas for record keeping. For some, the aim was not to have them available to be mobilized in a near future project, but rather to keep them close as reference points, "symbols of their creative experiences" (p. 486). Prototypes and early versions of ideas had often been set aside as work developed, but not discarded altogether. Even if they were not the finished article, "Creators often considered prototypes to be their most innovative work, unhindered by external constraints" (p. 487). Recording or safeguarding of prior work in this symbolic manner is not meant to lead to later implementation of the specific ideas in question. The process tends to be less organized, "like having a garage full of experiments or prototypes that they knew existed but may never access" (p. 468).

CONCLUSIONS

The resulting model of this holistic creative process, where ideas are managed through stockpiling, transforming, and mobilizing ideas across different projects, offers "a new lens for interpreting what creativity fundamentally means". These findings encourage the view that creative workers are also curators or collectors of ideas, and explain how the life cycle of an idea, conceived, refined and materialized, can stretch across time and space to be repurposed for other projects.

>> REFERENCES

[1] Poornika Ananth and Sarah Harvey, "Ideas in the Space Between: Stockpiling and processes for managing ideas in developing a creative portfolio", Administrative Science Quarterly 68(2), pp. 465-507, June 2023. https://doi.org/10.1177/00018392231154909

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PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER ELEVEN

A TEACHERS' GUIDE TO CRITICAL AND CREATIVE THINKING FOR DECISION-MAKING

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ABSTRACT

In the book *Critical and Creative Thinking: A brief guide for teachers*, published in 2016, Robert DiYanni, a professor of humanities at New York University, argues that critical and creative thinking, despite representing opposite approaches, are closely related and necessary skills that facilitate everyday life and creative problem solving. As both a guide and a popular science, the book brings readers up-to-date on critical thinking and creative thinking, with further chapters outlining their practical application in everyday life, which can also be used in training at various levels of education. Complemented by sections on decision-making thinking and ethical thinking, numerous references are made to the scientific literature on the subject, results of experimental research, suggestions for practical exercises and lists of sources for in-depth independent reading. In this review, we have covered critical and creative thinking with practice suggestions for each case.

Keywords: critical thinking, creative thinking, decision-making thinking, higher education

INTRODUCTION

In addition to the latest theories on thinking and perception, the book *Critical and Creative Thinking: A brief guide for teachers* by Robert DiYanni [1], offers exercises and examples to understand the two fundamental types of thinking and their roles in everyday life and education. This holistic vision of the conditions for thinking with instruments for comprehensively improving the accuracy and effectiveness of perception of the modern world, including the development of one of the key skills – creativity, is complemented with examples and exercises of decision-making and ethical thinking.

DiYanni argues that nurturing continuous development and the need to shape your personality are lifelong tasks. The wide thematic scope of the book means that, in addition to in-depth knowledge and examples of what critical and creative thinking are, readers can try to determine how to shape their creative problem-solving skills; why it is worthwhile to be inspired by observing, processing, and appreciating the achievements of others; why it is worth making mistakes and seeing in them something more than just another failure, but rather a good lesson for the future; how traditional education focused on reproducing information and memorizing data can be an inspiring life lesson, and educational failures – an opportunity for personal development. DiYanni further tries to explain how combining critical and creative thinking enhances self-confidence, improves relationships, is intellectually and emotionally enriching or broadens the intensity of life experiences (p. 9). He aims to convince readers that every person is capable of being creative, where they simultaneously perceive reality attentively and act creatively.

The seven chapters are divided into three thematically distinct parts. The first part is primarily a discussion of the basic concepts of the thinking process, the differences between critical and creative thinking and their relationship. At the same time, the necessity of presenting them one next to the other is emphasized. In the second, practical part of the book, the applications and strategies of critical and creative thinking are discussed. DiYanni shows how to reinforce existing good habits of the mind and

how to modify or remove bad habits, overcoming numerous limitations and thus taking the right path of transformation into a critical and creative thinker. To this end, the author suggests a number of specific techniques and methods that have been selected from the literature, both the results of experimental research and theoretical studies. DiYanni emphasizes that it is not easy to get off the previous track of thinking, to abandon bad habits, to overcome various kinds of thinking blocks – cultural, perceptual, intellectual, emotional, and polarizing – and to start thinking differently, in a revolutionary, novel, innovative and fearless fashion. This last obstacle is, according to the author, the greatest enemy of critical and creative thinking.

However, to avoid being swayed by the potential freedom offered by boundaryless thinking that breaks existing rules, norms, and barriers, in the third part of the book DiYanni includes two chapters on decision-making and ethical issues in the context of critical and creative thinking. The inclusion of issues relating to decision-making thinking and ethical thinking is one of the strengths of the work since it is not enough to learn and dare to think critically and creatively. Instead, thinking requires certain moral principles to act concisely and productively, making timely decisions. While critical and creative thinking play a considerable role in decision-making, two fundamental systems are involved – intuitive-emotional and rational. In the chapter on decision-making, DiYanni writes about numerous determinants, from intuition, rationality, and time constraints to cognitive dissonance, self-justifying choices, and affective forecasting requiring the completeness of the data needed to make a decision or the regularities in predicting consequences. He characterizes the properties of decision-making in personal life and institutional and group decisions.

It is worth noting that each chapter, even the theoretical part, includes exercises at the end. The exercises, their degree of difficulty, and the estimated time dictate the pace of reading. To introduce a complementary issue, phenomenon, or figure succinctly and anecdotally to transition to the next chapter, for example, one chapter ends with a subchapter (intersection) on the status of and the knowledge constructed from facts,

truth, and theory (pp. 52-54). And another chapter deals with curiosity not only as a driving force for thinking and learning, but also for innovation and progress (pp. 85-87).

Extremely valuable to the creative learning process in higher education and the STEAM approach is the embodiment of experience (pp. 129-133), where we experience the world through our bodies by seeing, hearing, touching, tasting, smelling, or catching our balance. When singing, dancing, making music or playing sports, we think with our whole body as integrated rather than compartmentalized entities. DiYanni also mentions mirror neurons, which allow for bodily explanations of empathy and empathy among humans. He gives the example of Leonardo da Vinci as an artist who valued everything physical, especially the human body: he both studied it and cared for his physique. Integration of critical and creative thinking, DiYanni claims, is enhanced with experiencing corporeality in these processes.

DiYanni also encourages the blending of art and science, science and natural sciences, and humanities and arts as solutions, including objects, which should not only be functional but also beautiful and ethical (pp. 171-173). This interdisciplinary approach is reflected in the question: *Was Leonardo da Vinci first and foremost an artist or a scientist?* According to some biographers, Leonardo perceived science from the perspective of art and art from the perspective of science; not only did he draw so well because he knew what he was drawing but he also knew so much because he drew so well. DiYanni proposes the development of more holistic approaches to thinking that include analysis and synthesis, science and art, logic and imagination.

MATERIALS AND APPROACHES

We have selected what we consider to be the most interesting, practical exercises, approaches, and definitions that develop critical, creative, or decision-making thinking to the highest degree. Although we have not included examples of ethical thinking, the benefits of the practice gathered

here as practical exercises will be useful to university and high school students and others interested in developing these types of thinking.

DiYanni's *Critical and Creative Thinking. A brief guide for teachers* presents five basic blocks to critical thinking [2], [1] (pp. 24-29) – perceptual, cultural, intellectual, emotional, and polarizing – which we present here with suggestions for practice for the development of effective intellectual habits, some of which have been proposed by DiYanni. Perceptual blocks to thinking inhibit your understanding of what you are looking at and your ability to see the details, the background, and thus to discover the sense or meaning of objects, phenomena, or the people observed. As DiYanni writes, "In order to overcome perceptual blockages, you have to keep looking until you see meaning in what you are looking at".

Practice recognizing perceptual blocks: Use persistence as you contemplate, for example, Picasso's painting Guernica (www.pablopicasso.org/guernica.jsp). Note that although the subject can be anything, insightful looking involves noticing details and wondering why they have been put together. It involves asking questions about what you see and trying to understand the significance of what you are looking at. The exercise can be complemented by sharing your own observations and conclusions as a group and searching for information.

Cultural blocks to thinking stem from socially fixed perceptions and judgments of ethnic, racial, national, religious, or intellectual traditions, as well as from gender or social class. Recognizing them is difficult, but being aware of your own cultural filters makes it possible to better understand why you see the world one way and why others may see it differently.

Practice recognizing cultural blocks: Reflect on the following illustration: Intellectual blocks to thinking include knowledge and its limitations. The lack, incompleteness, or incorrectness of your information can be joined by insufficient skills to articulate your views effectively. Overcoming intellectual blocks requires acquiring new information or deepening your understanding of what you already know by studying, analyzing, and researching.

Figure 11.1.
Source: https://www.cotidianul.ro/circula-pe-netorient-vs-occident/

Practice recognizing intellectual blocks: Choosing any subject, e.g. history, art, the current political situation of a selected country or any other subject about which we know little or nothing, ask yourself some further questions to develop your knowledge base. (e.g. *How were the pyramids of Egypt built? What is the political system and who is currently in power in Ethiopia?*). Then, search for this information. In teams, a forum can be used to share and add to this knowledge and reflect on why this new knowledge may be important and useful.

Emotional blocks to thinking arise when feelings interfere with thinking. When faced with the fear of being wrong or fear of being judged by others, you can simply allow yourself the luxury of being wrong and forgive yourself for the mistake(s). Many inventions and discoveries have come about as a result of mistakes, failed experiments, or simple chance. Another emotional block is the inability to tolerate confusion, uncertainty, and ambiguity. Nevertheless, these states of uncertainty, chaos, disorder, and rehearsing are very often a prerequisite for a breakthrough in thinking or the development of a final version of a thinking outcome.

Practice recognizing emotional blocks: Search for examples of inventions and discoveries that came about as a result of mistakes and errors, then consider how their inventors and discoverers responded to this process. Check out, for example, the case study of American writer E. B. (Elwyn Brooks) White, who produced six drafts in 25 hours of work before feeling satisfied with a single paragraph on the moon landing that appeared in *The New Yorker* in 1969 [3].

Polarizing blocks to thinking involve opposites such as 'us-them', 'right-left', 'nationalist-cosmopolitan', 'win-lose', 'hard-working-lazy', 'strong-weak', and 'friend-enemy'. Thinking in black-and-white terms leads to exposing mutually exclusive categories and overlooking attitudes and areas in between. Reality is, of course, much more complex and nuanced, and all-or-nothing thinking makes it harder to see the positive and negative aspects of a particular issue.

Practice avoiding polarization: When you look for what lies in between, you not only identify the level of agreement but also ask questions: To what extent is an idea acceptable, a book interesting, a film entertaining, or certain behavior acceptable? Considering degree or range forces you to differentiate, explore, consider possibilities, and different shades of meaning. Beyond the generalities proposed by

DiYanni, choose a controversial topic and indicate the related attitudes/ evaluations/intermediate areas, both positive and negative for a current topic like the migration crisis in the EU, the importance of AI in daily life and the labor market, the protests in France against raising the retirement age.

THREE COGNITIVE TOOLS AND SYLLOGISMS

By using the three cognitive tools (pp. 119-121) – the Pareto Principle, recurring structure, and the concept of duality – you can broaden your perception and enrich your understanding of yourself and the world around you.

The Pareto Principle (20/80 rule) is named after the Italian sociologist and economist Vilfredo Pareto, who discovered that 20% of the richest citizens of a country control 80% of its wealth. The principle has been applied to many situations and experiences. For example, 20% of Internet users visiting a site are responsible for 80% of that site's traffic.

Practice: Find other examples from everyday life where the 20/80 rule may apply.

A recurring structure refers to repetition of the shape of the whole in the shapes of its elements, like Gothic windows or fractals. According to DiYanni, recurring structure allows us to identify and understand the links between art and technology, as it is a principle that is useful in designing objects that we perceive as beautiful.

Practice: Give some examples from everyday life where the recurring structure can apply.

The concept of duality indicates the need to consider two, sometimes extreme, perspectives in explaining phenomena, like light as a particle and a wave. Transforming "or" into "and" or "either/or" into "both/as" takes you beyond the conventional notion of duality as dichotomy or opposition so that you might be able to see two very different things as equally true.

Practice: Give some examples from everyday life where the concept of duality can apply. Alternatively: think and try to explain what it means and when to use the metaphor that every coin has two sides.

Practice with these three cognitive tools and others will be strengthened by making deductive conclusions. An example is arguments that are divided into three parts – a major premise (*All men are mortal*.), a minor premise (*Shakespeare is a man*.), and a conclusion (*Shakespeare is mortal*.). These syllogisms (pp. 148-149) in everyday communication are usually abbreviated to what are called *enthymema*, where one of the premises or the conclusion is omitted. A feature of critical thinking is the ability to evaluate the arguments, which is when, among other things, we are able to recognize the premises or conclusions implicit in the statements.

Practice with syllogisms: Construct syllogisms for the following premises:

- Smoking cigarettes is dangerous to the health of non-smokers who inhale the smoke
- Daily half-hour brisk walking is excellent exercise for the cardiovascular system
- Knowing a foreign language can increase the pleasure of traveling
- Spanish banks are in crisis
- Newspapers and magazines are cutting back on print publications and moving to the Internet
- When in Rome, do as the Romans do.

BASIC STRATEGIES OF CREATIVE THINKING

We have selected six basic creative thinking strategies cited by DiYanni that he identifies as essential (pp. 59-66). These are: seeking alternatives, defining the pool of possibilities, inverting relationships, creating analogies, redirecting attention and denying negativity.

Among other things, creativity is the ability to think about something common and familiar in an unusual way by seeking alternatives. As DiYanni notes, creative thinking can manifest itself in attempts to categorize objects in different ways (e.g., different uses for a brick or a coat hanger) or to perform commonly performed tasks in an unconventional way (e.g., making a sandwich in an unusual way).

Practice seeking alternatives: Suggest three different possible explanations or approaches to these challenges:

- discouraging people from driving their cars into the inner city
- motivating students to work harder in school
- encouraging people to donate money to charity

A creative mindset causes the mind to look for alternatives, different ways to understand a situation, solve a problem or make a decision. The best solutions are chosen from a pool of possibilities that you (and your team) have developed. To generate these possibilities, DiYanni advises not to settle for the first idea that comes to mind. Instead, produce a number of them to reach an imagined quota and consider them all. Even if you end up having chosen the first idea that came to mind, you have the certainty of having thought through other options as well, which has given you the opportunity of examining that initial idea from different perspectives. This simple tool stretches your thinking beyond what is typical, easy, and convenient to broaden perception.

Practice defining a pool of possibilities: Explain this behavior as many ways as possible: *Every morning, a woman takes the elevator to the 10th floor in her office building. Then she gets off and walks up the stairs to the 16th floor, where her office is located. After work, she gets into the elevator on the 16th floor and goes all the way down, where she gets out and heads toward home.*

Another strategy for considering possible solutions is to reverse the relationship, considering the challenge from another person's perspective. Reversing relationships involves considering the pros and cons of a given decision or phenomenon, such as legalizing "illegal immigrants''. DiYanni

recommends, for example, wondering how to go to the river for water or asking why couldn't the river come with water to me?

Practice reversing relationships: Reverse these sayings and consider the consequences of the inversion used.:

- *First duty, then pleasure*
- *Too many cooks spoil the broth*
- *Curiosity killed the cat*

Thinking by analogy is a creative exchange strategy across different fields. For example, using the vocabulary used in a sport like boxing to talk about business, military terminology to comment on social events, or applying concepts from physics to economics or social psychology. This activity stimulates the imagination so that you can see phenomena in new ways and discover new kinds of relationships. By pushing thinking into new and unexpected directions, Michael Michalko's [4] "conceptual mixing" actually combines elements from different areas of reference.

Practicing creative exchange through analogies: Explain how these creative exchanges can work:

- "school as entertainment and school as prison"
- "marriage as partnership and marriage as adventure"
- "shopping as addiction and shopping as social life"

Give three or more justifications and examples for the following analogies:

- *Love is magic/madness/struggle/disease*
- *Ideas are plants/food/money*

The next strategy involves redirecting attention from one aspect of a situation or problem to another in a perceptual shift where you consider multiple points of view. For example, when writing a report on the effects of excessive drinking, you could first consider the effects on a macro

scale, which would include labor productivity and costs to health care then consider the micro scale, with consequences for the family and for the individual.

Practice redirecting attention: Think about how different experts – a soccer coach, a prison guard, a passenger plane pilot, a conductor, or a priest – would approach the challenge of finding solutions to reduce human error associated with hospital procedures, including diagnostic errors, drug dosing, or hospital-acquired/healthcare-associated infections.

Denying negativity is generally about positive thinking, which does not reject any solutions in advance, but tries to follow what is possible, according to the principle that a weak idea taken seriously can lead to a better idea. Questions like what if and why not help reveal possibilities and explore new options.

Practice denying negativity: For part of the day, listen to negative messages, denials, and rejections of ideas, options, and possibilities (by yourself and others). Make a list of your discoveries and think about at least one of them to first determine whether it could, in fact, have been possible then figure out how to make it feasible.

SIX WELL-KNOWN CREATIVE THINKING STRATEGIES

After suggesting six of DiYanni's basic strategies for creative thinking, we will look at six thinking models – SCAMPER, *Imagination First!*, *Visual Thinking*, *Break the Rules*, *What if?*, and the Heath Brothers' *Decision-Making Model*.

SCAMPER [1] (pp. 66-68) starts from the premise that everything new builds on something that already exists. The name of the strategy is an acronym for the names of seven interrelated techniques:

- Substitute – What can be replaced?
- Look for something to replace then substitute that with other people, processes, rules, materials, locations, or times.

- Combine – What can be combined?
- Adapt – How can it be adapted?
- Magnify, minimize, modify – How can it be magnified, minimized, modified?
- Put to other uses – How else can it be used?
- Eliminate – What aspects or elements are unnecessary and can be eliminated?
- Rearrange and reverse – What can be rearranged, reversed, or put in a different order?

Practice with SCAMPER: Choose a few items from your university, workplace, or home that you would like to improve. Use the SCAMPER strategy to figure out how to do it.

DiYanni emphasizes the importance of imagination as a fundamental human ability, a pleasurable practice and a practical skill, without which it is difficult to develop creative thinking. Following Douglas Thomas and John Seely Brown [5], he concludes that play and imagination are essential to succeeding in a world of accelerating change. *Imagination First!* [1] (pp. 175-181) is also necessary to perceive, understand and appreciate the works, ideas and creations of others.

Practicing Imagination First!: Find the painting "Personal Values" by René Magritte on the Internet, look at it, and try to answer the following questions: *What did the artist do to change everyday reality? What surprises and surprising sensations does the work trigger? What could be the purpose for such an application of imagination?*

- Imagine a world in which a person can be a man for half a year and a woman for the other half (a case described in Ursula K. Le Guin's 1969 sci-fi novel, *The Left Hand of Darkness*).
- Visual thinking (pp. 188-189) is not based on language where

you think in terms of concepts. Instead, purposefully thinking with images triggers an additional way of finding ideas.

Practice visual thinking: Using graphic materials like colorful newspapers, make a moodboard on the topic of "The university classroom where I would like to learn".

- Make a mind map on the topic "University of the future" using only images.
- Freeing yourself from constraints and existing rules can give a sense of liberation and result in acting in innovative ways. Even if it is only in your mind, breaking the rules (pp. 190-191) is an excellent creative exercise to develop imagination.

Practice breaking the rules: Choose a sport that your team knows well and invent five rules that will change the standard rules of the game. Discuss the consequences of these changes.

- The strategy of asking *What if?* (pp. 198-201) to move away from realistic and practical thinking is essential for challenging conventional thinking. This simple and effective way to have fun is a safe way to develop the habit of fantasizing and taking a step towards creativity and innovation.

Suggested exercise: Think about the consequences of the following situations:

- *What if animals become smarter than humans?*
- *What if men could bear children?*
- *What if politicians were elected by lottery?*
- *What if people spent every third year in a different country?*

Chip and Dan Heath wrote the best-selling book, *Made to Stick: Why some ideas survive and others die* (2007) [6], and followed that in 2013 with *Decisive: How to make better choices in life and work* [7]. DiYanni covers their techniques to support better decision-making based on consideration of four sequential steps [1] (pp. 240-243) that involve questions to ask yourself and some corresponding strategies as follows.

Step 1: Expanding possibilities

- How can I broaden the set of possibilities so as not to narrow the choices?
  - Strategies: Avoid a narrow view of the problem. Create multiple threads. Find someone who has already solved this or a similar problem.
- How can I avoid collecting only the pieces of information that confirm my assumptions?
  - Strategy: Avoid the confirmation bias (i.e., seeing only evidence that confirms your thinking and avoiding any evidence that contradicts it).

Step 2: Checking the feasibility of your assumptions

- How can I gather reliable information to verify my assumptions?
  - Strategies: Consider the opposite assumption. Look at the problem from afar and zoom in again. Use caution and lean into the details before investing too much too soon.

Step 3: Taking the distance

- How can I avoid making a bad decision under the influence of emotion?
- How can I avoid being overconfident about the rightness of my own decision?
  - Strategies: Overcome current emotions. Respect the most important priorities.

Step 4: Preparing to be wrong

- How can I avoid being overconfident about the future consequences of my choice?
  - Strategies: Prepare alternative scenarios for the future. Set alarm signals and define what you will take as a sign that you might be making a mistake.

Practice the Heath Brothers' *Decision-Making Model*: Imagine that you have to make an important choice about your career, personal affairs, or education, like taking a second master's degree at a particular university. Use the Heath brothers' model to make your final decision.

Additional materials aimed at high school and college teachers have been posted at www.wiley.com/go/diyanni/guidetocriticalcreativethinking [8] although access requires registration. These lessons have been prepared by DiYanni and his team to practice critical thinking skills and creative thinking beyond what is included in the book.

RELEVANCE OF THE MATERIAL AND APPROACHES

DiYanni relies on the knowledge of other scientists and researchers, including neurologists, psychiatrists, psychologists, sociologists, ethicists, and philosophers. Rather than one dominant research current, the popular science approach attempts to show creative and critical thinking within the complementary broad background of the natural, health, and social sciences. DiYanni's originality resides in his panorama of different critical and creative thinking approaches and techniques for decision-making and ethical thinking. This holistic approach to the issues of learning and teaching illustrates both the transdisciplinarity and interdisciplinarity of contemporary science and the practical guidance that comes from it. As a result, the book can be useful not only for audiences concerned with personal development and students, but especially for all those who teach – teachers, trainers, educators and lecturers.

>> REFERENCES

[1] Robert DiYanni, "Critical and Creative Thinking. A Brief Guide for Teachers", 1st ed. Oxford: Wiley-Blackwell, 2016. https://download.e-bookshelf.de/download/0003/6422/56/L-G-0003642256-0007213179.pdf

[2] James L. Adams, Conceptual Blockbusting, New York: Basic Books, 2001.

[3] Elwyn B. White, "Notes and Comment", The New Yorker, July 26, 1969. https://www.newyorker.com/magazine/1969/07/26/comment-5238

[4] Michael Michalko, Creative Thinkering. San Francisco: New World Library, 2011.

[5] Douglas Thomas and John Seely Brown, A New Culture of Learning: Cultivating the Imagination for a World of Constant. CreateSpace, 2011.

[6] Chip Heath and Dan Heath, Made to Stick. Why Some Ideas Survive and Others Die. New York: Random House USA Inc., 2007.

[7] Chip Heath and Dan Heath, Decisive: How to make better choices in life and work. New York: Crown Business, 2013.

[8] Instructor Companion Site for Critical and Creative Thinking: A Brief Guide for Teachers, www.wiley.com/go/diyanni/guidetocriticalcreativethinking

>> FURTHER READING SUGGESTIONS

Edward de Bono, "Serious Creativity", Harper Business, New York, 1993.

12

PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER TWELVE

CREATING LEARNING AND TEACHING SPACES FOR TRANSFORMATIVE AND TRANSDISCIPLINARY RESEARCH: THE TRANSFORMATIVE INNOVATION LAB

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ABSTRACT

Education for sustainable development (ESD) focuses on developing the key competencies that enable individuals to help shape and guide societal development processes in a sustainable direction. One way to do so is through the Transformative Innovation Lab (TIL), where students in higher education learn how to understand the complexity, uncertainties, trade-offs, and risks associated with local and global sustainability challenges. The TIL is considered crucial to foster sustainable social development. The core of the TIL concept is the integration of theoretical/methodological knowledge, experience, and reflection. In a TIL, students learn about the thematic complexes of sustainability and transformative research and are encouraged to specifically address systems, target, and transformation knowledge in the course of a self-selected project. This is a handbook for designing a TIL that takes place in the last two semesters of a Master's degree program, with key knowledge and step-by-step-instructions as well as tips on how to administrate, implement, and organize a TIL.

Keywords: education for sustainable development, transdisciplinarity, transformative research, Real-World Laboratories, Futures Studies, Key Competencies for Sustainability

INTRODUCTION

The reviewed article introduces the transformative innovation lab (TIL): a combination of a transdisciplinary and transformative real-world laboratory. By introducing a cyclical concept of real-world laboratories, the ideal process with the phases – co-design, co-production, and co-evaluation – are covered. The goal is that students become able to shape transformation processes that are effective in terms of sustainability by testing, developing, and applying collaborative and experimental processes. Students use their research projects instead of working on new study program they can recourse to existing study program that may already be part of the university.

REAL-WORLD LABORATORIES

In adaption to the Cyclical Concept of Real-World Laboratories [1] (p. 52), the framework for conducting transdisciplinary research practices aims at advancing sustainability transitions, illustrated in figure 1.

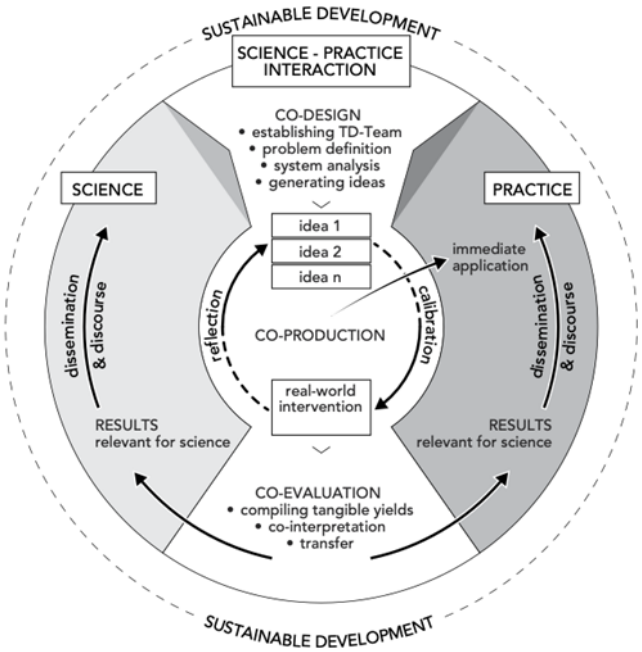

Figure 12.1.
Cyclical concept for a transdisciplinary and transformative real-world lab process focused on learning from experiment

This concept is designed to address complex and pressing sustainability challenges by bringing together a diverse group of stakeholders, including researchers, practitioners, and the public, to collaborate on real-world problems in a cyclical and iterative manner. The key components of this concept can be broken down as follows:

Transdisciplinarity: Real-World Laboratories (RWLs) embrace a transdisciplinary approach, which means they go beyond traditional disciplinary boundaries. They involve experts from various fields, such as natural and social sciences, engineering, economics, and the humanities, to tackle complex sustainability issues from multiple angles.

Real-World Context: RWLs operate in real-world settings, which means they are embedded in the communities and environments where the sustainability challenges exist. This allows for a better understanding of the complexities of the issues and ensures that the research outcomes are relevant and applicable to the real world.

Sustainability Transitions: The primary focus of RWLs is on facilitating sustainability transitions. This refers to a fundamental and long-term shift towards more sustainable practices, policies, and systems. Sustainability transitions involve changing current unsustainable patterns in areas such as energy production, transportation, urban planning, and consumption.

Cyclical Process: The Cyclical Concept emphasizes that the work in RWLs should be ongoing and iterative, rather than linear, in a process that typically involves the following stages:

- Problem Identification: Stakeholders identify a specific sustainability challenge that needs to be addressed.
- Co-Design: Researchers, practitioners, and the community collaborate to design solutions and interventions that can address the challenge.
- Implementation: These solutions are implemented in the real world to test their effectiveness and feasibility.

- Monitoring and Evaluation: The outcomes and impacts of the interventions are continuously monitored and evaluated to determine their success and to inform further iterations.
- **Adaptation and Learning:** Findings from the monitoring and evaluation stage are used to adapt and refine the interventions as needed.

Participatory Approach: The Cyclical Concept emphasizes the active involvement of stakeholders throughout the entire process. This includes not only experts and researchers but also local communities, policymakers, businesses, and other relevant actors that promote inclusive and democratic decision-making.

Knowledge Integration: The concept encourages the integration of different forms of knowledge, including academic, experiential, and local knowledge, to foster a more comprehensive understanding of sustainability challenges and potential solutions.

Systemic Change: RWLs aim for systemic change by addressing the root causes of sustainability challenges. They seek to transform existing systems and practices rather than merely applying incremental solutions.

Feedback Loops: The cyclical process incorporates feedback loops, enabling ongoing learning and adaptation. This iterative approach allows for continuous improvement and the ability to respond to changing circumstances and emerging insights.

PLANNING A TIL

The handbook aims to make a useful and effective contribution to embed the teaching of transdisciplinary and transformative research in higher education to achieve the sustainable development goals in applied research formats. An ideal TIL is shown in figure 2 (p. 54).

According to figure 2, a kick-off retreat marks the beginning of the TIL, followed by exchange sessions and reflection seminars at the transition from design to implementation. The concluding seminar marks the completion of the TIL program with the graduates (publicly) presenting their research projects, ideally with their practitioner partners, and a joint celebration.

The TIL takes place in two semesters of a Master's degree program: In the first semester the focus lies on teaching basic theoretical and methodological knowledge, with students starting a research project and, in parallel, co-designing it together with practitioners. In the second semester, the main focus is on implementation (co-production) and co-evaluation, for example as part of a Master's thesis. At the end of the second semester, students round off the TIL by completing their project assignment.

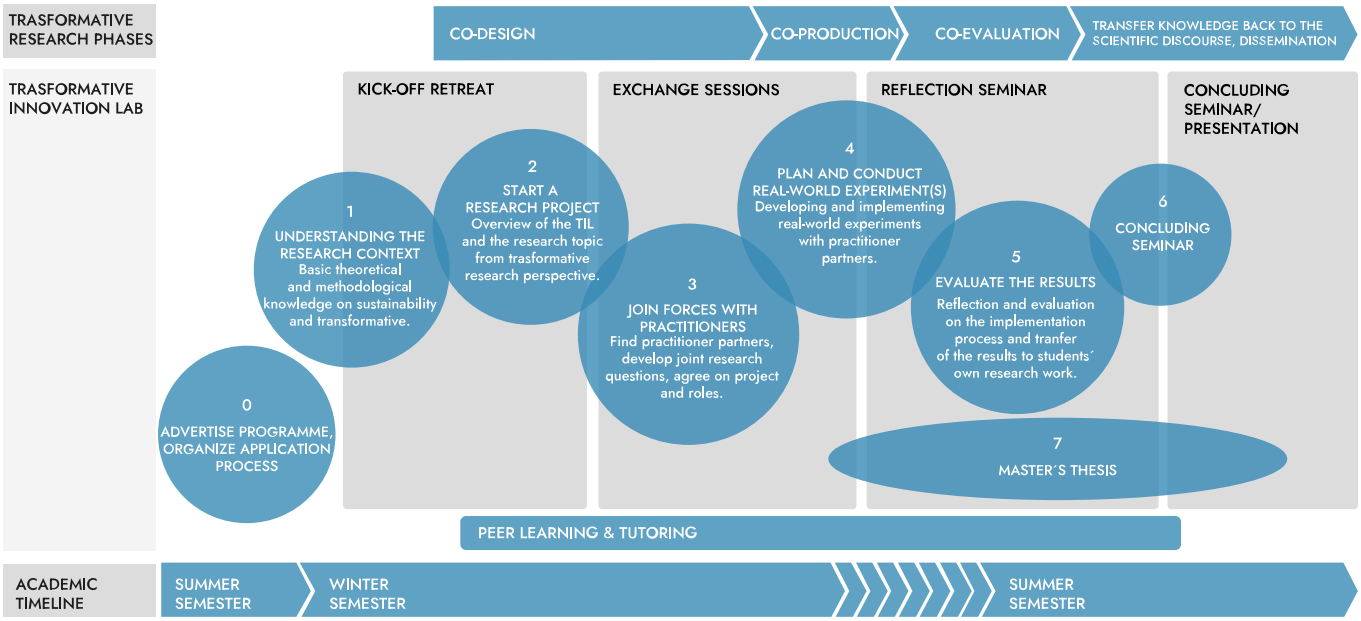

Figure 12.2.
Integrated schematic of an ideal-typical TIL

The individual phases of the TIL are shown in the coloured circles at the centre. In the grey-coloured background, the event formats are shown as they are deployed over the course of the project. With regard to methodology, the transformative research phases are outlined in the upper bar, while the lower bar shows the chronological sequence, broken down by parts of the academic year.

Adapted from: "Transformative Innovation Lab: Handbook to Facilitate Students' Real-World Laboratory Projects to Promote Transformative and Transdisciplinary Competencies", by M. Wanner, M. Schmitt, N. Fischer & P. Bernert, 2020, Wuppertal Institute for Climate, Environment and Energy, pp. 34-35

The handbook presents a brief FAQ-section, where questions like Advertising and Planning a TIL in an existing study program are covered. Some points to mention are:

- Create a common knowledge base at the beginning of the TIL by giving theoretical inputs on transformative sustainability.
- Promote peer learning teams on a voluntary basis.
- Mix variety and flexibility.
- Avoid what many participants report, that it is easy to fall into a one-sided service delivery role, lacking any personal research interest, or the traditional "objective" analyzing role or the role of an activist.
- Provide input and individual exercises on emotional coping techniques.

CONCLUSION

In summary, the Cyclical Concept of Real-World Laboratories represents an innovative and holistic approach to addressing complex sustainability challenges. By bringing together diverse stakeholders, operating in real-world contexts, and embracing a transdisciplinary, participatory, and iterative approach, RWLs aim to drive meaningful and lasting sustainability transitions. This concept recognizes the interconnectedness of environmental, social, and economic aspects of sustainability and strives to make a positive impact on all these dimensions.

>> REFERENCES

[1] Matthias Wanner, Philip Bernert, Nele Fischer, Martina Schmitt, "Creating Learning and Teaching Spaces for Transformative and Transdisciplinary Research: The Transformative Innovation Lab", Didac 78: pp. 49-59, 2021. https://epub.wupperinst.org/frontdoor/deliver/index/docId/7795/file/7795_Wanner.pdf

[2] Matthias Wanner, Annaliesa Hilger, Janina Westerkowski, Michael Rose, Franziska Stelzer, and Niko Schäpke, Towards a Cyclical Concept of Real-World Laboratories: A Transdisciplinary Research Practice for Sustainability Transitions. disP - The Planning Review 54(2), pp. 94-114, 2018. https://doi.org/10.1080/02513625.2018.1487651

[3] Matthias Wanner, Martina Schmitt, Nele Fischer, and Philip Bernart in collaboration with Franca Kruppa and Annika Lomberg,Transformative Innovation Lab: Handbook to facilitate students' real-world laboratory projects to promote transformative and transdisciplinary competencies (German and English version available). https://epub.wupperinst.org/frontdoor/index/index/docId/7685

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PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER THIRTEEN

CRITICAL AND CREATIVE THINKING IN EDUCATING STUDENTS OF SOCIAL STUDIES: THE REFLECT LAB CASE

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ABSTRACT

The review discusses the Reflect Lab platform, created a few years ago as a result of an international educational project financed by Erasmus+. The teaching methods advocated by Reflect Lab aim to support students of social studies in developing their ability to explore issues that are discussed in a confrontational way. Reflect Labs are thought-provoking, critical and creative thinking laboratories. Methodology is based on the idea of self-study, as well as inquiry-based learning (IBL) and problem-based learning (PBL), perspectives that help to prepare young people to face the challenges of a globalized world, build resilience in the face of various crises, and innovate actively and creatively in diverse areas of knowledge and social life. The review outlines the key principles of Reflect Lab, evaluates its strengths and weaknesses, and explores the available resources for both educators and students.

Keywords: critical thinking, inquiry-based learning, problem-based learning

INTRODUCTION

The article by Magdalena Mateja [1] of the Nicolaus Copernicus University's Faculty of Philosophy and Social Sciences, Department of Communication, Media & Journalism explores the Reflect Lab platform, which was created as a result of the implementation of an international educational project financed by Erasmus+ in 2016-2019, called *Reflect Lab – Supporting lecturers in applying inquiry-based learning*. The project consortium was comprised of five European universities from Germany, England, Poland, Romania, and Spain [2].

The Reflect Lab project, developed by a community of sociologists, was aimed at supporting universities, and more specifically lecturers, in implementing currently important inquiry-based learning (IBL) and problem-based learning (PBL). This in turn is closely connected to fostering critical thinking about social phenomena among EU students. Such a perspective is deemed vital for personal development as it equips students to learn to face the challenges of a globalized world, build resilience in the face of various crises, and support active and creative innovation in various areas of knowledge and social life.

TEACHING IN THE REFLECT LAB

The teaching method advocated by Reflect Lab aims, in broad terms, to support students in developing skills necessary for reflecting on controversial and urgent issues discussed in a confrontational way. Reflect Labs are thought-provoking and critical thinking laboratories grounded on socio-scientific teaching and the concept of self-study. Their essence is the assumption that students conduct independent research in laboratories using socio-scientific methods in order to solve pressing social problems. Lecturers guide students in this process and foster a critical approach, utilizing the principles of critical design. The project is, therefore, a counterpoint to the widely-criticized practice of limiting learning to mere knowledge transfer in education [2].

The German partner (University Leibniz in Hannover) of Reflect Lab implemented the "Politik-Labore" for high school students of the Hanover region. The participating students and their teachers were able to use the university's infrastructure and were provided with access to ongoing research in social sciences and humanities as well as university lecturers. Students and their teachers spent a whole day at the university observing scientists, particularly sociologists, as they carried out their research duties and engaged in discussions about the problems being solved. Positive conclusions from this initial local project prompted its authors to expand and supplement the project with new approaches and tools, as well as a new target group – university students [3].

TEACHING WITH STIMULATING MATERIALS

Reflect Lab includes a package of educational solutions aimed at lecturers of social sciences based on the above-mentioned "Politik-Labore" project and the identification of needs in the field of IBL and PBL in HEI. Central elements are two textbooks dedicated to lecturers and to students. The textbook for lecturers introduces the methodology and tools of Reflect Lab and provides guidance on working with students. It covers topics such as preparing the infrastructure, outlining the lecturer's role, and explaining the grading system [4]. The handbook for students introduces the concept of a required portfolio, i.e. a set of materials collected by a student, including notes on the undertaken activities and reflection on the learning process, stimulating materials, research projects under development, drawings, diagrams and other documents in the form of a large, thin case. The portfolio, along with pertinent readings, analyses and discussions, is intended to aid students in gaining key knowledge about the selected issue and enable a broader view of the matter. It should serve as a catalyst, inspiring students to meticulously develop research questions and detailed research plans. Together, these elements constitute a process that empower students to find their own path in social research, thereby making a positive contribution to solving urgent problems discussed in today's society.

The student handbook also contains information on selection of research methods that can be used in creating a portfolio. Moreover, the handbook explains what scientific process is about: encompassing its purpose and various stages - from formulating the topic and research questions to the analysis and interpretation of data, drawing conclusions and preparing a research report [5]. Additionally, it provides guidance on creating "stimulus material" designed to bolster the effective integration of Reflect Lab into seminars and other courses.

"Stimulating Materials" are critical to Reflect Labs because they introduce the research process and allow students to develop a wide variety of research questions. Stimulating materials can be in the form of a comic book, an article or a press report, scientific article, etc. They should be provocative and controversial, but also topical and engaging, compelling readers to pose questions and analyze the problem from various perspectives and opinions. The Reflect-Lab website proposes three examples of such topics: the EU crisis, right-wing movements, and migration and refugees [6].

With the main goal of fostering reflection and inquiry in the environment of polarized debate, students are divided into small teams to conduct their respective work, establish criteria and select tools for the analysis of research done and published by others. Teacher activity and the use of stimulating materials/other tools should compel students to think critically and creatively.

MATERIALS AND APPROACHES

- Reflect Lab Platform http://reflectlab.info.uaic.ro/
- Easy-to-implement-Kit http://reflectlab.info.uaic.ro/wp-content/uploads/2019/05/EN_Easy-to-implement-Kit.pdf
  A synthetic, short manual designed for a quick introduction to the Reflect Lab platform. Also available in German, Romanian, Spanish, and Polish.
- Instructions for creating Stimulus Material http://reflectlab.info.uaic.ro/wp-content/uploads/2019/06/stimulus__engl.pdf
  Also available in German, Romanian, Spanish, and Polish.
- Manual for Learners http://reflectlab.info.uaic.ro/wp-content/uploads/2019/05/EN_manual-for-students.pdf
  Also available in German, Romanian, Spanish and Polish.
- Webinars for Lecturers for the Implementation of Reflect Labs Portfolio http://reflectlab.info.uaic.ro/wp-content/uploads/2019/06/IO2_Presentation_portfolios_useful_tool.pdf Small Groups, http://reflectlab.info.uaic.ro/wp-content/uploads/2019/06/IO2_Presentation_learning_in_small_groups.pdf
- Manual for Lectures for the Implementation of Reflect Labs, http://reflectlab.info.uaic.ro/wp-content/uploads/2019/05/EN_manual-for-lecturers.pdf
  The manual comprises guidance and responses to FAQs related to implementing inquiry-based and problem-based learning in the form of Reflect Labs. Also available in German, Romanian, Spanish and Polish.
- Needs Analysis for Implementation of Inquiry-based learning projects, http://reflectlab.info.uaic.ro/wp-content/uploads/2019/05/EN_Needs-Analysis-Full-Report.pdf
  The analysis is based on 100 questionnaires and 10 interviews with lecturers from universities in Spain, Romania, England, Poland, and Germany. The research aimed to examine the existing landscape of inquiry- and problem-based learning within

universities, serving as the foundational concepts for Reflect Labs. Summary also available in German, Romanian, Spanish and Polish.

- ICT Tools for Teaching, http://reflectlab.info.uaic.ro/index.php/ict/ This toolkit includes various resources, including links to internet-based tools such as Answer Garden Brainstorming, Collaborative writing board, Cartoon Maker, Movie Maker, Animation Creator, Creating Mind Maps, Visualising Noise in the classroom, Creating multimedia posters, Explore the world, Creating QR Codes, Drawing and sharing maps, Create Crosswords, and Creating Comics.

CONCLUSIONS

In her article, Magdalena Mateja draws conclusions from the implementation of the Reflect Lab methodology at the universities within the project consortium. According to lecturers, the key benefits of Reflect Labs were in-depth learning opportunities. For example, students broadened their knowledge due to stimulating materials and applied theoretical concepts in practical exercises. According to educators, the platform fosters teamwork, cooperation, and argumentation, proving particularly valuable in addressing critical and creative problem solving, especially concerning issues involving moral, ethical, or social dilemmas. She concludes that Reflect Labs are more effective when students receive a reasonable amount of stimulating material (at least 2 pages in A4 format). Additionally, visual elements such as illustrations, pictures, and photos, and excerpts from magazine/press articles are also useful. Students also appreciate citations from academic books, when they relate to specific conceptual and theoretical ideas.

She points out that project teams should not be large, as smaller groups, consisting of 4 or 5 members, foster greater involvement among all students. The challenge of the Reflect Labs though, is to ensure lasting reflection and creativity. Preparation of appropriate materials and supervision of the teaching/learning process also prove to be time-

consuming. Students agreed that the Reflect Lab platform deepened their knowledge and understanding of social reality. It also gave them a sense of usefulness of how to incorporate the acquired information and skills in professional work. Lastly, students found that the platform increased their motivation to learn through exciting and inspiring materials. They also found that the drawback was the need for a lot of involvement in the learning process, which prevented students with a passive attitude from withdrawing and "blurring into the crowd".

MAIN TAKE-AWAYS OF THE REFLECT LAB

- The main goal of Reflect Lab methodology is "to establish a special course structure that would promote innovative learning at universities to enable students to carry out independent research using socio-scientific methods regarding urgent political and social problems" [1] (p. 147).
- Fostering both individual and collaborative inquiry-based learning is essential.
- Creativity in university education is largely on the side of the students, not only the faculty.
- The role of lecturers is to effectively curate stimulating materials, oversee the educational process, and intervene only when necessary.
- Project teams (student teams) should not be too small or too large - optimal team size fosters creativity and enhances engagement, contributing to the attainment of learning outcomes.

RELEVANCE AND RECOMMENDATIONS

We have focused on the Reflect Lab platform in the context of inquiry-based (IBL) and problem-based learning (PBL), both pivotal strategies in social sciences education. These strategies can be traced back to Auguste Comte's vision of sociology as a scientific discipline [8], and Charles Wright Mills' concept of sociological imagination, which serves to solve issues defined as "matters that transcend these local environments of the individual and the range of her inner life. They have to do with the organization of many such milieu into the institutions of an historical society as a whole, with the ways in which various milieux overlap and interpenetrate to form the larger structure of social and historical life" [9].

With the escalating interest in IBL and PBL in the arts, humanities, and social science [10, 11], it is noteworthy that these approaches are equally valuable in STEM disciplines [12]. Consequently, they foster interdisciplinary exploration in the research of contemporary challenges [13], such as climate change, energy crises, public health, population density etc. The Reflect Lab platform in any discipline may be an effective creative thinking solution for our CT.uni project partners. Specifically in the social sciences, Reflect Lab stands as a valuable resource for teaching quantitative and qualitative methods in sociological studies to facilitate students' ability to critically apply their methodological skills in research practice [14]. In addition, the multitude of issues analyzed within various subdisciplines of sociology opens up limitless possibilities for application.

The Reflect Lab platform, as a practical and proven example of IBL and PBL, affects students' perception of their role in the learning process and increases their creativity and awareness. Patrick Blessinger and John M. Carfora argue that "education should serve as an incubator where students are part of a learning community and where they are encouraged to grow cognitively, emotionally, and socially by taking increasing responsibility for their own learning" [10].

Taking responsibility requires critical thinking skills, which are crucial in scientific research, especially in social sciences. Reflect Lab involves both self-study and teamwork as well as cooperation, learning-by-doing,

and, above all, concentration on a pressing problem. In this context, a portfolio as a tool for documenting the process seems to support combining theory with practice [15], relate experience to knowledge and stimulate self-reflection [16]. From a practical point of view, a portfolio also helps organize work, record the outcomes, and obtain peer and teacher feedback, which is particularly feasible with an e-portfolio [17].

>> REFERENCES

[1] Magdalena Mateja, "Benefits from the use of inquiry-based learning: the REFLECT LAB method as a proposal for lecturers of social sciences", Innovative Teachings Methods. Practical Teaching in Higher Education, Lidia Pokrzycka (ed.), Lublin: Maria Curie-Skłodowska University Press, 2020, pp. 145-155. https://www.researchgate.net/publication/346785124_Innovative_Teaching_Methods

[2] Reflect-Lab - Supporting lecturers in applying inquiry-based learning, https://www.idd.uni-hannover.de/en/research/projekte/reflect-lab/

[3] http://reflectlab.info.uaic.ro/index.php/aboutreflectlab/

[4] Dirk Lange, Das Politik-Labor: Forschendes Lernen in der Politischen Bildung, Baltmannsweiler: Schneider Hohengehren, 2012.

[5] Leon Billerbeck, Hannah Merkel, and Christoph Wolf, Intellectual Output 2: Manual for Lectures, https://www.idd.uni-hannover.de/fileadmin/idd/Projekte/Reflect-Lab/IO2_en.pdf

[6] http://reflectlab.info.uaic.ro/wp-content/uploads/2019/05/EN_manual-for-students.pdf

[7] http://reflectlab.info.uaic.ro/wp-content/uploads/2019/06/stimulus__engl.pdf

[8] Auguste Comte, Cours de philosophie positive 4, Paris: Bachelier, Imprimeur - Libraire pour le Sciences, 1839.

[9] Charles Wright Mills, Sociological Imagination, New York: Oxford University Press, 1959.

[10] Patrick Blessinger and John M. Carfora, "Innovative Approaches in Teaching and Learning: An Introduction to Inquiry-Based Learning for the Arts, Humanities, and Social Sciences", Inquiry-Based Learning for the Arts, Humanities, and Social Sciences: A Conceptual and Practical Resource for Educators (Innovations in Higher Education Teaching and Learning, Vol. 2), Bingley: Emerald Group Publishing Limited, 2014, pp. 3-25. https://doi.org/10.1108/S2055-364120140000002030

[11] Jakob E. Feldt and Eva B. Petersen, "Inquiry-based learning in the Humanities: Moving from topics to problems using the 'Humanities imagination'", Arts and Humanities in Higher Education, vol. 20, no. 2, pp. 155-171, March 2020. https://doi.org/10.1177/1474022220910368

[12] Aaron M. McCright, "Enhancing Students' Scientific and Quantitative Literacies through an Inquiry-Based Learning Project on Climate Change", Journal of the Scholarship of Teaching and Learning, pp. 86-101, December 2012. https://files.eric.ed.gov/fulltext/EJ992129.pdf

[13] Richard M. Schlenker and Karl R. Schlenker, "Integrating Science, Mathematics, and Sociology in an Inquiry-Based Study of Changing Population Density", Science Activities, pp. 16-19, April 2010. https://doi.org/10.1080/00368120009601060

[14] Liam Foster Liam and Tom Clark, "An inquiry-based approach to teaching quantitative secondary survey methods in sociological studies", Compendium of Effective Practice, 2nd ed. York: HEA, 2013, pp. 55–57. https://www.researchgate.net/profile/Liam-Foster-2/publication/351871915_An_inquiry-based_approach_to_teaching_quantitative_secondary_survey_methods_in_sociological_studies/links/60ae3a3da6fdcc647edc4d56/An-inquiry-based-approach-to-teaching-quantitative-secondary-survey-methods-in-sociological-studies.pdf

[15] Eva Cendon, "Bridging Theory and Practice: Reflective Learning in Higher Education", Handbook of Research on Quality Assurance and Value Management in Higher Education, Hershley: IGI Global, 2016, pp. 304-324. https://www.researchgate.net/publication/313862339_Bridging_Theory_and_Practice

[16] Jordi Colomer, Maria Pallisera, Judit Fullana, Marc Pérez Burriel, Rosario Fernández, "Reflective learning in higher education: A comparative analysis", Procedia - Social and Behavioral Sciences 93, pp. 364-370, October 2013. https://doi.org/10.1016/j.sbspro.2013.09.204

[17] Lorraine Stefani, Robin Mason, Chris Pegler, The Educational Potential of e-Portfolios. Supporting Personal Development and Reflective Learning, 1st ed. London: Routledge, 2007. https://doi.org/10.4324/9780203961292

>> FURTHER READING SUGGESTIONS

Lidia Pokrzycka (Ed.), Innovative Teachings Methods: Practical Teaching in Higher Education. Maria Curie-Skłodowska University Press, Lublin, 2020.

Lidia Pokrzycka and Robert Wallace Vaagan (Eds.), Innovative Teachings Methods: Project Management. Maria Curie-Skłodowska University Press, Lublin, 2022.

Lidia Pokrzycka and Bruno De Lièvre (Eds.), Innovative Teachings Methods: E-learning in Practice. Maria Curie-Skłodowska University Press, Lublin, 2022.

Lidia Pokrzycka (Eds.), Innovative Teachings Methods: Project Management in Practice. Maria Curie-Skłodowska University Press, Lublin, 2022.

Robert Di Yanni, Critical and Creative Thinking. A Brief Guide for Teachers, Wiley-Blackwell, Chichester, West Sussex UK, 2015. https://download.e-bookshelf.de/download/0003/6422/56/L-G-0003642256-0007213179.pdf

14

PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER FOURTEEN

PROBLEM AND PROJECT-BASED LEARNING FOR CREATIVE THINKING IN SCIENCE AND TECHNOLOGY

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ABSTRACT

Problem- and project-based learning (PBL and PjBL) are explored here as forms of inquiry-based learning that are a reliable source for developing creative thinking. Especially due to their contribution toward understanding concepts and developing skills, learners gain knowledge of the entire scientific method in a relevant and stimulating environment and with greater engagement and satisfaction. To actively involve students in hands- and minds-on activities that deliver this range of potential, innovative teaching in the sciences demonstrates that students can learn not only content knowledge but also instrumental skills and diverse scientific competences related to research and communication. These reports on the potential of inquiry -based learning identify how focus and independence are promoted, empowering students to become active participants in their learning. To conclude, we consider science and technology-related projects involving creative thinking to propose a model for integrating creative thinking into education.

Keywords: problem-based learning (PBL), project-based learning (PjBL), inquiry-based learning (IBL), creative thinking, higher education

INTRODUCTION

Developing scientific thinking includes the ability to formulate hypotheses, communicate fundamental concepts effectively, and analyze and interpret experimental results. To accomplish these objectives, education in math and the sciences can develop creativity and collaboration to improve academic performance and, simultaneously, overcome negative perceptions and learning difficulties.

To actively engage students in hands- and minds-on activities that deliver this range of potential, innovative teaching in the sciences demonstrates that students can learn not only content knowledge but also instrumental skills and diverse scientific competences related to research and communication. While we know that collaborative learning enhances engagement, effectively preparing students for professional team work in evidence-based practice, the challenge for research-oriented training in higher education, according to Beatrix Fahnert at Cardiff University is "how to incorporate beneficial approaches that give students an opportunity to exercise their creative thinking as they take on an active role so that their learning is 'flexible, adaptable, and resilient'" [1], [2].

In this article we examine the integration of creativity in science classes in higher education, specifically through problem-based learning (PBL), project-based learning (PjBL), and inquiry-based learning (IBL). We will also consider how STEAM approaches – involving the sciences, technology, engineering, arts, and math – based on the integration of creativity into science classes can "transfer enthusiasm, support individual self-sufficiency, and encourage [further] creative and critical thinking" [3].

As cross-disciplinary forms of inquiry-based learning where formulating questions is foregrounded within the framing of the real world, PBL and PjBL will be considered for their contributions to creative and critical thinking, problem-solving, information literacy, and the development of empathy. Although the approaches overlap, Sara Segar, founder of the Experiential Learning Depot and a former biology teacher in Minnesota, points out the authenticity of PjBL, where the learner is integrated into the solution, illustrates the different processes involved [4]. When you access

Sara's page, you will see that her nomenclature differs from ours; we have elected to favor the J as a distinguishing letter in the initialism.

PBL is explored here as a source for developing creative thinking because of the powerful opportunities to understand the concepts and to develop skills, gaining knowledge of the whole scientific method in a relevant and stimulating environment and with greater engagement and satisfaction. PjBL is also described as a rich approach for overcoming the students' difficulty in mastering conceptual knowledge on complex topics based on their involvement in learning contexts.

LESSONS FROM PROBLEM-BASED LEARNING (PBL) IN MICROBIOLOGY

Like other scientific areas of study, medical microbiology requires a successful conceptual understanding for further application in clinical practice. The first reports on the use of PBL in microbiology courses involved the use of videoed case studies designed for small-group discussions at the Philadelphia College of Osteopathic Medicine [5] and the biochemical and microscopic identification of microorganisms, or "food-borne pathogens" at Monash University [6], as part of the practical microbiology component in a Pharmacy degree where students applied previous knowledge toward a clinical approach. These reports on the potential of PBL identify how focus and independence are promoted, empowering students to become active participants in their learning.

Other comparative studies, like the research team from the Universidad Nacional del Nordeste in Argentina [7], confirmed the value of PBL as a new approach to enhancing the student's commitment and motivation, although without statistically significant differences between the groups in terms of knowledge gained. Ten years later, researchers at the Arabian Gulf University in Manama [8] found PBL-derived improvements in practical and intellectual skills for using microscopy, laboratory procedures and lab manuals.

Using a semester-long PBL case study on food-poisoning gave students at the University of Nicosia in Cyprus the opportunity to develop a coherent series of inquiry-based experiments to learn about and practice common techniques in microbial physiology, depicted in figure 14.1 [9].

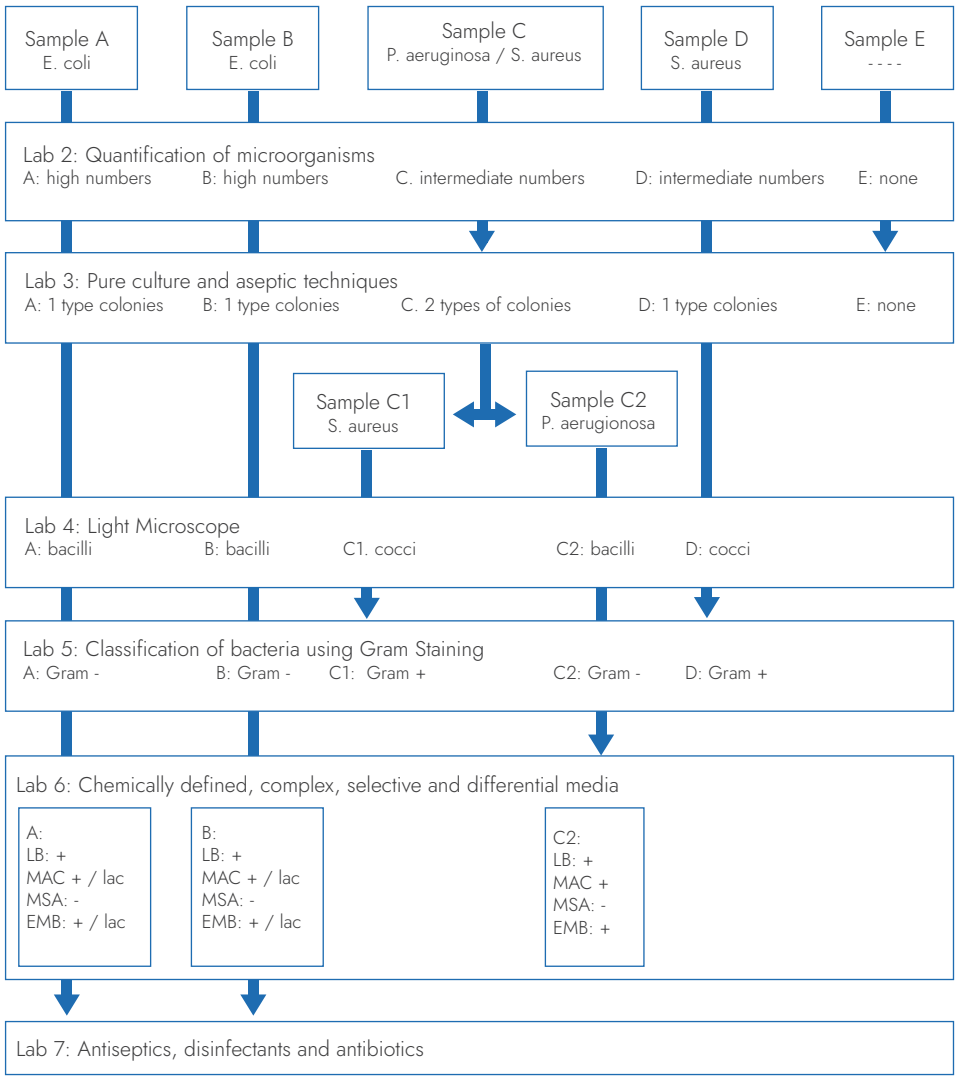

Figure 14.1.
Adapted flow chart indicating expected results of each experiment [9]

Through the coherent iterations of labs (1-7) above, these students at the University of Nicosia imagined and posed relevant questions of their own creation as they tested their hypotheses.

A PBL-based approach was also used at Zhejiang University in China to help students understand microbiome with a project ranging from saliva microbiome characterization through metagenomic data analysis to broad public health applications and application of both wet-lab and computational analysis processes associated to amplicon sequencing approaches [10]. Furthermore, both the wet lab and in-silico analysis experiments were promoted using virtual simulation experiments, which was determinant in this case to adapt to the limitation of space, equipment, and reagents when laboratory classes closed during the COVID-19 pandemic. Results from this study confirm the successful use of this teaching approach corresponding to positive achievements of the learning outcomes and sparking student interest to learn more about the human microbiome, microbiology and biomedical research.

In Mexico, at the School of Engineering and Sciences, a hybrid evaluation system, involving case studies, problem-based learning, and detective role-play, combined theoretical and practical knowledge in the same exercise, facilitating the integral development of critical thinking and problem-solving competences in the field of microbiology field and reducing the stress associated to written exams for traditional assessment [11].

Corresponding with the overarching concern of assessment in higher education, PBL can be applied to the evaluation and integrative assessment of both basic sciences and clinical specializations. This approach in undergraduate medicine at the University of the West Indies was found to improve clinical reasoning in a comparison of conventional stand-alone multiple-choice questions (MCQs) and integrated clinical-scenario (case cluster) multiple-choice questions (CS-MCQs) [12].

LESSONS FROM PROJECT-BASED LEARNING (PJBL) IN MICROBIOLOGY

Researchers at the University of the Basque Country reported on their work with project-based learning [13], where student teams designed and developed a research project in medical microbiology, wrote a funding proposal, developed the experimental assays, and analyzed their results which were presented at a conference organized by their university. The scientific communication of the results required initiation in the subject, organization of the groups and of the research process. Students also learned to scrutinize the viability of an idea, identify the steps required to develop a project, searched for related project calls, wrote a project proposal, and carried out the experiments. Their results were analyzed and presented in conference posters and talks for the experience of real scientific communication. Over the period of three academic years working with this approach, a total of 44 separate projects confirmed PjBL as a source of high levels of motivation, more commitment to learning the subject, and a greater capacity to interpret the results following the scientific method.

Undergraduate pharmacy student competence in literature review, experimental design, independent operation, and comprehensive application of their knowledge in microbiology is also promoted by a project and module-based teaching method at the China Pharmaceutical University, Nanjing [14]. A program with four sessions of experiments centered on pharmacological microrganisms was designed, using basic knowledge and microbiology laboratory skills applied to determine antibacterial activity and in vitro antibacterial tests of drugs. These activities provided opportunities for students to acquire and expand not only their scientific knowledge but also their operational and exploratory ability connected with practice, improving the learning outcomes of this microbiology course.

A research team from George Washington University, Woodgrove High School, and the Universidade do Porto [15] studied how PjBL could improve both undergraduate and graduate student learning outcomes in analyzing genomic data. The project involved the characterization of their

students' own skin microbiome through targeted amplicon sequencing (metataxonomy) to improve the research experience through the use and selection of bioinformatics and statistical tools as well as the critical analysis of results and to enhance communicative competences. Participation in this real genomics research experience gave students a better understanding of the complexity and the multiple steps of a genomic project, ranging from lab work to public health applications, with better results in formative assessments and an overall stronger learning experience through the incorporation of PjBL. Also using the microbiome to explore microbiology knowledge and research skills, researchers at the PGRI Ronggolawe University (Unirow) Tuban in Indonesia [16] implemented a mini-research-project methodology applied to the microbiology course in a Biology Education study program during the COVID-19 pandemic. Despite the limitations, this work confirmed that learning by developing research skills can improve research skills and academic success, the ability to compile ideas and support information providing a critical data analysis, and the capacity to formulate problems in microbiology. Moreover, the results revealed that microbiology student attitudes tend to be positive and responsible for high learning achievements and outcomes when engaging in mini-research-based learning methodology.

Also from other universities in Indonesia, researchers used qualitative classroom action research (CAR) in a PjBL approach [17] to foster learning about environmental microbiology through test questions on conceptual knowledge, learning observation sheets, and questionnaires. Although the 25 students participating in this study responded positively to the implementation of PjBL and registered an increase in their conceptual knowledge, some difficulties were revealed during the learning process. For example, difficulties were found in (i) assisting all groups at all times by implementing team teaching in learning; (ii) mastering learning material with completion measures through peer tutors; and (iii) monitoring plans that students had made by asking students to document their work.

Another study from Zayed University, Dubai, on the impact of PjBL in microbiology [18], for example, integrates a composting project into a university-wide initiative for food security and improvement of knowledge and environmentally sustainable practice by relying on

natural decomposition of organic material by microorganisms within the introductory microbiology curriculum. A composting project allowed students to observe the implication of microbes transforming the recycled ingredients over time as a realistic example of the impact of microbiology in daily activities, as well as revealing the potential of PjBL for initiating pro-environmental practices and promoting research and communication skills.

These issues of collaborative autonomy, where team teaching and peer tutoring play a central role in learner development, and creating mechanisms for keeping individual progress records necessarily impact the design and development of further initiatives and studies in other fields and groups.

Transformative learning can occur from the perspectives of both learning and teaching. For example, a researcher at Whitworth University in Spokane, Washington [19], studied his open-ended, inquiry-based learning approach in environmental microbiology with groups of four students to determine not only that they all achieved significant personal improvement as students but also that he had completed almost all of his proposed objectives for the course.

Within the pandemic challenges for emergency remote teaching (ERT) and learning in higher education, further research from the Universitas PGRI Ronggolawe Tuban in Indonesia [20] proposed a PjBL assignment where an online mini-research project on sterilization improved critical thinking skills in microbiology. Results confirmed the improvement of students' creative and critical thinking skills, namely the abilities to identify, cause problems, analyze, evaluate, and link concepts.

In this brief collection of studies, problem- and project-based forms of inquiry-based learning have resulted in satisfactory results for the researchers, operating primarily through qualitative classroom action research. By extracting the teaching parameters that can be derived from these lessons, we might better develop lessons that will inspire students to engage in creative thinking. Note that the positive impact on professional practice is the most important challenge and aim of innovative

methodologies. Although few studies report follow-up studies, or lifelong impact of these methodologies on professional practice, further studies and research programs should effectively measure the real impact and benefits of these innovative methodologies.

STRENGTHS, RESOURCES, AND POTENTIAL

Borrowing a theme from the Call for Papers of CREATIONS 2018: Creating Conditions for Deeper Learning in Science in Athens, creativity, one of our most important traits, is described as "the ability to use our minds to generate new ideas, new possibilities and new inventions based on originality in its production" [21]. The event celebrated the endpoint of the CREATIONS project (http://creations-project.eu/, 2015-2018), funded by the European Union's HORIZON 2020-SEAC-2014-1 Program (Grant 665917) and by the "Qualitätsoffen-sive Lehrerbildung" Program funded by the German Federal Ministry of Education and Research (BMBF; Grant: 01JA160) at the heart of the project reported by the researchers at the Universität Bayreuth, Germany [3].

In this Quality campaign for teacher education (our translation), 16 partners from ten European countries created a roadmap for implementing outreach and innovative educational activities for science with the eponymous goal of Developing and Engaging Science Classrooms. The project results posted by the Universität Bayreuth [22] point out that essential community infrastructures must support the potential dynamic and that innovative activities must be monitored for impact to regularly ascertain the effective nature of integrated approaches.

Another concern is the extent of creative thinking associated with science classrooms. The quantitative three-criterion definition of creativity, identified by the U.S. Patent Office is "novelty, utility, and surprise… quantitative and multiplicative rather than qualitative or additive" [23]. In the classroom, any new approach to learning can be novel and surprising to the students but the utility of an approach to learning will be determined by the teacher, whose creative lesson planning can impact the results. The case for a small 'c' creativity framework [24] is very important here, where development of the learners' individual creative thinking is the focus, which is based on an inquiry-based learning that favors a blend of open-ended assignments, collaborative activities, presentations of novel concepts, encouragement of interdisciplinary exploration, and granting students autonomy in selecting tasks and managing their time.

An Erasmus+ project currently with the Universität Bayreuth is DiSTARS – Students as Digital Storytellers: A STEAM Approach to Space Exploration (https://www.distars.eu/outcomes/, 2020-2023) – which supports creative thinking "as a generic element in the processional and communicative aspects of the pedagogy by integrating arts (virtual arts, performing arts, design, music)".

STEAM approaches – involving the sciences, technology, engineering, arts (and letter and humanities), and math – can strengthen the integration of creativity in science classes. For the purposes of the CT.uni project, for which the present review is written, we are considering a broader range of creative thinking activities. With community building and assessment in mind, the potential of the (inter)active use of resources – from scientific instruments, applications, and databases to ICT tools and research facilities – requires attention (figure 14.2).

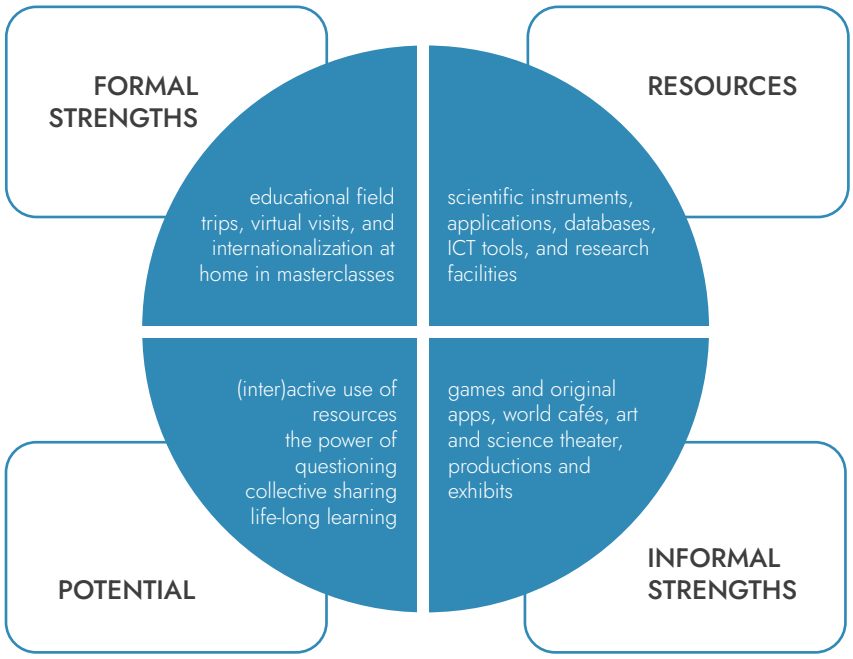

Figure 14.2.
A proposed composite of resources and strengths for integrating creative thinking in the classroom
Source: Created for CT.uni by María del Carmen Arau Ribeiro

When shared collectively, in games and original apps, world cafés, art and science theater productions, and exhibits, students who are empowered to think and question can become life-long learners. To complement these informal strengths, educational field trips, even virtual visits and internationalization at home in masterclasses are examples of formal structures that can support creative approaches to learning and teaching.

>> REFERENCES

[1] Beatrix Fahnert, "Keeping education fresh—not just in microbiology", FEMS Microbiology Letters 364(21), p. 209, 2017. https://doi.org/10.1093/FEMSLE/FNX209

[2] Beatrix Fahnert, "Absence makes the mind grow stronger-Educating in a pandemic and beyond. FEMS Microbiology Letters 368, p. 129, 2021. https://doi.org/10.1093/femsle/fnab129

[3] Julia Mierdel and Franz X. Bogner, "Simply InGEN(E)ious! How creative DNA Modeling can enrich classic hands-on experimentation", Journal of Microbiology and Biology Education 21(2), 21.2.45, May 29, 2020, https://doi.org/10.1128/jmbe.v21i2.1923

(4) Sara Segar, From Boring Lessons to Engaged Learners: How project-based and problem-based learning can transform your teaching. https://spacesedu.com/en/project-based-learning-vs-problem-based-learning/

[5] Bruno J. Bromke, Stacie E. Byers, and Walter S. Ceglowski, "Video Case Programs for PBL: Integration of Microbiology and Medicine", Teaching and Learning in Medicine 9(3), pp. 233-237, 1997. https://doi.org/10.1080/10401339709539847

[6] Keri Maree Jones, "The application of problem-based learning to the teaching of microbiology for pharmacy students", Pharmacy Education 5(1), pp. 13-18, 2005. https://research.monash.edu/en/publications/the-application-of-problem-based-learning-to-the-teaching-of-micr

[7] V. Lifschitz, A. Bobadilla, P. Esquivel, G. Giusiano, and L. Merino, "Aplicación del aprendizaje basado en problemas para la enseñanza de la microbiología en estudiantes de medicina [Application of the problem-based learning for the microbiology teaching among medicine students]", Educación Medica 13(2), pp. 107-111, 2010. https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1575-18132010000200008

[8] Khalid M. Bindayna, Ahmed Qareeballa, Ronni M. Joji, Ali A. Mahmeed, Hicham Ezzat, Abdulrahman Y. Ismaeel, and Khaled S. Tabbara, "Student perception of microbiology laboratory skills learning through a problem-based learning curriculum: Arabian gulf university experience", Advances in Medical Education and Practice 11, pp. 963-968, 2020. https://doi.org/10.2147/AMEP.S276221

[9] Vicky Nicolaidou, Persoulla Nicolaou, and Stella A. Nicolaou, "Transforming a cookbook undergraduate microbiology laboratory to inquiry based using a semester-long PBL case study", Advances in Physiology Education 43(1), pp. 82—92, 2019. https://doi.org/10.1152/advan.00167.2018

[10] Hao Sun, Pinmei Wang, and Yudong Li, "An integrated microbiome project for charactering microbial diversity in classroom based on virtual simulation experiments", Biochemistry and Molecular Biology Education, 2023. https://doi.org/10.1002/BMB.21706

[11] Josefina C. Reyna, Carmen D. G. Barriga, and Ana E. N. Ochoa, "Role-playing and its Association with Problem-based Learning in Microbiology Education", ACM International Conference Proceeding Series, pp. 188-192, 2021. https://doi.org/10.1145/3460238.3460267

[12] Sehlule Vuma and Bidyadhar Sa, "A comparison of clinical-scenario (case cluster) versus stand-alone multiple-choice questions in a problem-based learning environment in undergraduate medicine", Journal of Taibah University Medical Sciences 12(1), pp. 14-26, 2017. https://doi.org/10.1016/J.JTUMED.2016.08.014

[13] Estibaliz Mateo and Elena Sevillano, "Project-based learning methodology in the area of microbiology applied to undergraduate medical research", FEMS Microbiology Letters 365(13), 2018. https://doi.org/10.1093/femsle/fny129

[14] Weihua Chu, "Exploration of Project and Module-based Teaching Method in Pharmaceutical Microbiology Laboratory Courses for Undergraduate Pharmacy Students", Indian Journal of Pharmaceutical Education and Research 57(1), pp. 28-32, 2023. https://doi.org/10.5530/001954641319

[15] Marco Pérez-Losada, Kelly M. Crandall, and Keith A. Crandall, "Testing the 'Grandma Hypothesis': Characterizing skin microbiome diversity as a project-based learning approach to genomics", Journal of Microbiology and Biology Education 21(1), 2020. https://doi.org/10.1128/JMBE.V21I1.2019

[16] Ali Mustofa and Supian Dian Nurtjahyani, "Analysis of students' research skills and affective character in microbiology class through mini research-based learning during the Covid-19 pandemic", AIP Conference Proceedings 2468(1), 030001, 2022. https://doi.org/10.1063/5.0103506

[17] F. I. Taharu, L. Aba, M. Iksan, Nurwahida Kusrini, J. Gazalin, and Duriani, & T. Ibrahim, "Project-based learning to improve the conceptual knowledge of students in environmental microbiology topics", IOP Conference Series: Earth and Environmental Science, 343(1), 2019. https://doi.org/10.1088/1755-1315/343/1/012120

[18] Carole Ayoub Moubareck, "The effectiveness of project-based learning on Emirati undergraduate students in a microbiology course", Learning and Teaching in Higher Education: Gulf Perspectives 18(2), pp. 95-106, 2022. https://www.emerald.com/insight/content/doi/10.1108/LTHE-06-2021-0047/full/html

[19] Frank Caccavo Jr. "An open-ended, inquiry-based approach to environmental microbiology", American Biology Teacher 73(9), pp. 521-525, 2011. https://doi.org/10.1525/abt.2011.73.9.4

[20] Nurtjahyani, S. D., Pratiwi, L. D., & Sukisno. (2021). Analysis of critical thinking skills in microbiology learning through mini project assignments during the Covid-19 pandemic. Journal of Physics: Conference Series, 1806(1). https://doi.org/10.1088/1742-6596/1806/1/012130

[21] http://creations2018.ea.gr/conference-themes/

[22] Project results, Creations2018, Universität Bayreuth, https://www.bayceer.uni-bayreuth.de/didaktik-bio/en/forschung/proj/detail.php?id_obj=133354

[23] Dean Keith Simonton, "Taking the U.S. Patent Office criteria seriously: A quantitative three-criterion creativity definition and its implications", Creativity Research Journal, 24(2-3), pp. 97-106, 2012. https://doi.org/10.1080/10400419.2012.676974

[24] Dorothea Lasky and Susan Yoon, "A creative classroom for everyone: An introduction to a small 'c' creativity framework", Thinking Skills and Creativity 36, Jun 2020. https://www.sciencedirect.com/science/article/pii/S1871187119301968.

>> ANNOTATED FURTHER READING SUGGESTIONS ON DEEP AND DEEPER LEARNING FOR PBL

https://www.ascd.org/blogs/what-is-deep-learning-who-are-the-deep-learning-teachers This link provides a nice narrative from the Association for Supervision and Curriculum Development on the shoulders of giants…

https://www.nationalacademies.org/news/2012/07/transferable-knowledge-and-skills-key-to-success-in-education-and-work-report-calls-for-efforts-to-incorporate-deeper-learning-into-curriculum This 2012 report on deeper learning recommends working on cognitive, interpersonal, and interpersonal competences. Consider how this relates to creative approaches.

https://www.air.org/project/study-deeper-learning-opportunities-and-outcomes# These briefs and reports follow high school students to university to understand the lasting effects of deep learning in an earlier project by AIR.

https://www.courier-journal.com/story/opinion/contributors/2014/11/15/putting-students-politics-deeper-learning-can-unite-us/19032497/ This article took us to those reports.

https://www.opencolleges.edu.au/informed/features/deep-learning/ The view from 2015, where deep learning is described as "combining in-depth academic knowledge and skills with the belief that students must also master communication skills, learn to collaborate effectively, and manage their own learning".

https://www.air.org/project/study-deeper-learning-opportunities-and-outcomes# These briefs and reports follow high school students to university to understand the lasting effects of deep learning in an earlier project by AIR.

https://www.courier-journal.com/story/opinion/contributors/2014/11/15/putting-students-politics-deeper-learning-can-unite-us/19032497/ This article took us to those reports.

https://www.opencolleges.edu.au/informed/features/deep-learning/ The view from 2015, where deep learning is described as "combining in-depth academic knowledge and skills with the belief that students must also master communication skills, learn to collaborate effectively, and manage their own learning".

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PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER FIFTEEN

DIFFERENT TEACHING APPROACHES AND USE OF ACTIVE LEARNING STRATEGIES AS TOOLS FOR INTER- AND TRANSDISCIPLINARY EDUCATION

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ABSTRACT

The article reviews the ways in which education and research can help solve today's complex problems by exploring teaching and learning strategies beyond traditional methods. It examines different teaching approaches and their connection to uni-, pluri-, multi-, inter-, and transdisciplinary attitudes, and how educational professionals view teaching. Experienced teachers are found to adopt inter- and transdisciplinary approaches more often compared to younger teachers, who use more uni- or pluridisciplinary strategies. A project-based learning strategy was used to teach a group of engineering students to solve problems on campus, with evidence of student motivation and engagement. The approach promoted active learning, inter- and transdisciplinary collaboration, and developed 21st century education skills, particularly teamwork and problem-solving.

Keywords: teaching approaches, active learning strategies, inter- and transdisciplinarity

INTRODUCTION

According to Moreira dos Santos et al. (2020) [1], the creation of specialized knowledge areas and college programs in the 20th century was based on the idea of breaking down knowledge into smaller parts for easier learning. This team of researchers comprised of Carlos Alberto Moreira dos Santos, Marco António Carvalho Pereira, Mariana Aranha de Souza, João Paulo Machado Dias, Felipe Souza Oliveira, from the Universidade de São Paulo and the Universidade de Taubaté. One of the reasons they cite for the creation of knowledge areas, different disciplines, and college programs was based on the fact that it was thought that the organization of knowledge in smaller fractions would lead to the development of more specialized knowledge in one area, and consequently would facilitate learning. However, this uni-, pluri-, and multidisciplinary approach does not account for the complexity of today's problems and needs a more inter- and transdisciplinary approach to teaching and learning. It requires knowledge that goes beyond the unidisciplinary field. To better equip students for the job market, teachers need to have inter- or transdisciplinary attitudes.

This review of "Different Teaching Approaches and Use of Active Learning Strategies as Tools for Inter- and Transdisciplinary Education" [1] illustrates an innovative approach to active learning by integrating project-based learning strategies with a novel teaching methodology.

DEVELOPING SOFT SKILLS AND INTER- AND TRANSDISCIPLINARY ATTITUDES

Active learning strategies, such as project-based learning, problem-based learning, team-based learning, and design thinking are crucial in developing soft skills and inter- and transdisciplinary attitudes in students. The article describes a case study where students were divided into five teams of five members each, decided by lot, to elaborate and execute the projects. The teams had a multidisciplinary group of faculty members, experienced undergraduate and graduate students, technicians from different backgrounds, capable of supporting the development of conceptual contents and assisting the technical procedures necessary for the execution of the projects.

All the projects were required to be low cost and related to university campus issues. The team of students had to elaborate a sketch of the project, source and purchase the items required to build the system, and demonstrate how the system could work to address a problem. Students' motivation and engagement were assessed using their comments and satisfaction during the conduct of the projects.

Project-Based Learning is an active learning strategy in which students' teams work on projects based on real problems, aimed at developing students' technical and soft skills. It is a strategy in which students find themselves facing tangible problems that ought to be solved using technical knowledge. The four professionals in figure 1 [1] are a cartoonist (upper left panel), an engineer (upper right panel), a business administrator (lower left panel), and a writer (lower right panel).

All of them work in the book creation, production and distribution chain. Based on their professional fields, Table 15.1 [1] shows that each one has different thoughts on the same object of work.

Professional	Unidisciplinary thoughts
Cartoonist	Make drawings to illustrate books
Engineer	Work at the book production line
Business administrator	Manage book production and distribution
Writer	Write texts in order to report the subject in books

Table 15.1.
Disciplinary fields, different teachers' perceptions, and different teaching approaches [1]

Experienced teachers tend to adopt inter- and transdisciplinary approaches more often compared to younger teachers who use more uni- or pluridisciplinary strategies. In this review, Project-Based Learning was used to teach engineering students to solve campus problems and was found to promote active learning to provide education skills, particularly teamwork and problem-solving skills.

Figure 15.1.
Representation of different thoughts of four profesionals about a boof [1]

TOWARDS A TRANSDISCIPLINARY APPROACH

Based on the reflections on interdisciplinary thoughts, it is possible to summarize how teaching strategies vary based on the teacher's disciplinary field, experience, and approach. Table 15.2 shows that less experienced teachers tend to have a uni- or pluridisciplinary attitude, which is influenced by their college education.

Disciplinary field	How teachers see the object of teaching	Teaching approach
Unidisciplinary	Has specific knowledge about the subject matter	Teaches as if only one field of knowledge existed
Pluridisciplinary	Recognizes the existence of other fields of knowledge that involve the object of teaching	Teaches the content in a unidisciplinary way, but knows the existence of other fields of knowledge
Multidisciplinary	Looks at the object of teaching in a unidisciplinary way, but is able to make students interact with other fields of knowledge	Teaches the content of your knowledge, but cares about the student learning on other subjects
Interdisciplinary	Deals with the object of teaching in broader way because is routinely interacting with professionals from other fields of knowledge	Teaches the content of his/her subject as well as others by appropriating knowledge from other areas through collaboration with different professionals
Transdisciplinary	Looks at the object of teaching in very broad way, considering aspects in all fields of knowledge that involve the existence of the object	Teachers concerned with all updated aspects of knowledge in the areas of Exact, Biological, and Human Sciences

Table 15.2.
Disciplinary fields, different teachers' perceptions, and different teaching approaches [1]

Over time, mid-career teachers develop a more multidisciplinary attitude and move towards inter- and transdisciplinary approaches, leading to a more complete education for students. This process of continuous development is important for teachers and should be facilitated through reflective opportunities and broad formative experiences.

>> REFERENCE

[1] Carlos Alberto Moreira dos Santos, Marco Antonio Carvalho Pereira, Mariana Aranha de Souza, João Paulo Machado Dias, Felipe Souza Oliveira, "Different Teaching Approaches and Use of Active Learning Strategies as Tools for Inter- and Transdisciplinary Education", International Journal of Social Science Studies 8(2), pp. 15-23, March 2020. https://redfame.com/journal/index.php/ijsss/article/view/4693/4882

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PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER SIXTEEN

ESRA KANLI ON THE ASSESSMENT OF CREATIVITY

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ABSTRACT

Our review is based on the article by Esra Kanli "Assessment of Creativity: Theories and Methods", and on the other sources related to assessment of creativity in the form of free online tests and online tools to increase creativity skills. Creativity can be improved through training and working on the mindset of people. The aim of our review is to inform our readers about possible ways for assessment of creativity. The history of creativity assessment is very old and many authors seek the best definition of creativity and the best tools to assess it. They are looking for the factors that influence creativity — mental processes, personality traits, and external forces. Next question is, how can we decide which product or solution is creative? Esra Kanli brings the overview on assessment of creativity from the psychometric perspective and informs about different instruments used in this area.

Keywords: creativity, assessment of creativity, creativity test, psychometric perspective, creativity skills

INTRODUCTION

Creativity is one of the most important soft skills demanded by employers; it cannot be replaced by technology, as it is one of human skills that move human society forward. Creativity helps to improve the present and to create new products, new technologies, new approaches, and to find solutions to challenges we face now and in the future. Our aim as teachers is to prepare the next generation to be able to adapt to new situations and challenges that we cannot identify now. And we want to make this process attractive and effective. This is why we need to know what creativity is and how it can be assessed and developed. The present review is based on the article by Esra Kanli, "Assessment of Creativity: Theories and Methods" [1], which offers an overview of the assessment of creativity from a psychometric perspective and presents different instruments used in this area, as well as other sources related to the assessment of creativity in the form of free online tests and online tools to increase creativity skills.

Let us begin with Esra Kanli's favorite definition of creativity, written by Plucker et al. [2], understood as "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context". Kanli claims that "in the educational context, assessment of creativity is mostly about recognizing creativity and creating ideal conditions to nurture it, not about categorizing the students as "creative" or "not creative".

She summarizes possible purposes of creativity assessment – to "guide individuals to recognize own strengths and support them in nourishing them; to develop a better understanding about human abilities like intelligence and creativity; to restructure curriculum and learning experiences in accordance with the needs of students"; and to choose the most effective approaches. She points out that the "utilization of standard measures will provide a common language for professionals to discuss various aspects of creativity" [1] (p. 2). She points to references that offer more than 100 creativity definitions and more than 70 different creativity assessments. The psychometric perspective in creativity research perceives creativity as a "combination of cognitive, conative and emotional factors which interact

with the environment dynamically" (p. 4). She adopts the 4P framework as categorization in psychometric study – process (mental processes), person (personality traits), product, and press (environment, external forces) – each of which are considered in this review.

ASSESSING THE CREATIVE PROCESS

The assessment of creative process with the use of psychometric measures "involve[s] cognitive factors that lead to creative production like finding and solving problems, selective encoding (i.e. selecting info that is relevant to problem and ignoring distractions), evaluation of ideas, associative thinking, flexibility and divergent thinking" (p. 4). She states that in the past they "mostly relied on divergent thinking in the creativity assessment tests" (p. 4) and as an example she gives Guilford's Structure of Intellect Model (SOI). The SOI model "was mainly about defining and analyzing the factors constituting intelligence and he proposed 24 distinct types of DT… His model covers 180 (6x5x5) intellectual abilities organized along three dimensions namely; operations (evaluation, convergent production, divergent production, memory, cognition), contents (visual, auditory, symbolic, semantic, behavioral) and products (units, classes, relations, systems, transformation, implications)" (p. 5).

The most popular creativity assessment tests are Torrance Tests of Creative Thinking (TTCT) that consist of two different tests – verbal and nonverbal – and both have two parallel forms, so they can "be used as pre-posttest in experimental settings" (p. 6). Their scores were expressed by the factors of fluency, originality, flexibility and elaboration. In post-tests, "figural tests scored for resistance to premature closure and abstractness of titles in addition to originality, fluency and elaboration" (p. 6).

Mednick created the Remote Associates Test (p. 6) with a different perspective of inclusion of convergent thinking into creativity assessment. This test consisted of 30 items and each one "included three stimulus words and the participant was required to find a fourth word that links them all" (p. 7).

The Test for Creative Thinking – Drawing Production (TCT-DP) was developed by Jellen and Urban and was designed to "mirror a more holistic concept of creativity… aimed to consider "not only divergent thinking but also aspects like content, gestalt, composition, elaboration, mental risk taking, breaking of boundaries, unconventionality and humor" (p. 7).

Evaluation of Potential Creativity (EPoC) is similar to the TCT-DP test but it involves a multivariate approach, "which is, the combination of the cognitive, conative-affective and environmental factors influences creative capacity". Evaluation criteria for this test are included in the table of the reviewed article (p. 8).

Kanli discusses issues of reliability and validity in creativity assessment and concludes that "the debate on the predictive validity of divergent thinking tests is still ongoing" and there are methodological issues. She cites Kaufman et al. (p. 10), pointing out that "scores may be susceptible to intervention effects, administration procedures can affect the originality and fluency scores, statistical procedures may be inadequate, score distributions often violate the statistical assumption of normal distribution and creative achievement in adulthood may be domain specific and the DT tests used are almost always domain general".

ASSESSING THE CREATIVE PERSON

Assessment of a creative person usually deals with character traits as for example: "autonomous, self-confident, open to new experiences, independent and original" (p. 10) [1]. We can measure characteristics of a creative person on the basis of "self-reports, or external ratings of past behavior or personality traits" (p. 10). Kanli reports on several approaches and instruments to assess the personality correlates of creative behavior as "the Khatena-Torrance Creative Perception Inventory, Group Inventory for Finding Talent, Creativity Achievement Questionnaire or Runco Ideational Behavior Scale" (p. 11). She points out that self-reported creativity tests are fast and easy to score, but respondents may not be telling the truth, so they "are not useful in any type of high-stakes assessment" (p. 12).

ASSESSING THE CREATIVE PRODUCT

Kanli points to the importance of measuring the creativity of a product as "the most important aspect of creativity assessment" (p. 12) [1]. She explains three instruments for assessing the creative products — Creative Product Semantic Scale, Student Product Assessment Form, and Consensual Assessment Technique, the most popular assessment tool.

ASSESSING THE CREATIVE PRESS

Creative potential is influenced by a number of environmental factors, such as parental practices, culture, birth order, teaching practices, place of living, etc. These factors are assessed with instruments like the Classroom Activities Questionnaire (CAQ) – for assessing classroom and learning environment and KEYS: Assessing the Climate for Creativity, designed for assessment of perceptions and influence of those perceptions on the creativity of the work of individuals.

Kanli concludes with a brief overview of creativity assessment in table 5 [1] that shows types of assessment, examples, and their advantages and disadvantages. For a further overview of creativity assessment tools, it might be interesting to look at the work of Bonnie Cramond [3], where several creativity assessment tests are described and explained. There are also several sources [4], [5] (mentioned in the section on *Material and Approaches*) to help teachers improve their creativity skills to create a better learning environment and to help their students to develop their own creativity skills.

On the basis of Kanli's 4Ps, creativity is very important and needed in the educational process. Creative teachers make the teaching process more interesting and effective. Creative students are demanded by employers because they bring new ideas and solutions to wicked problems. Note that, while creativity can be tested, test results are valid locally; their relevance depends on truthfulness of answers in tests, on environments, and on lecturers. Testing students may help to discover most talented

creative students with the aim to support their talent individually. Creativity can be improved through training and working on the mindset. For me it was interesting and inspiring to try several free online creativity tests to assess my own creativity skills and my personality traits related to creativity.

MATERIALS AND APPROACHES

The following list of free online creativity tests and web pages offer support for teachers in the area of creativity:

1. Planning for and evaluating creativity. Planning for and evaluating creativity | Self-evaluation | National Improvement Hub (education.gov.scot)
2. Mind Tools - Creativity Test (with several links to improvement of creativity and further topics) How Creative Are You? - Learning From Csikszentmihalyi's Creativity Model (mindtools.com)
3. Creativity Portal. Fun Creativity Tools for Teachers, Educators, Homeschoolers. Creativity-Portal.com
4. Creativity test - How can you tell how creative you are? | World Economic Forum (weforum.org)
5. Test of creative skills The Ultimate Creativity Test: Do You Have the Skills You Need To Be Creative? (mycreativityskills.com)
6. Test of creativity type: Creative Types by Adobe Create (mycreativetype.com)
7. Free online creativity test Free online creativity test - TestMyCreativity
8. 3 Examples — Torrance Tests of Creative Thinking (TTCT) torrance-creativity-test.pdf (innovators-guide.ch)
9. Creativity test: 10 Best Ways to test Creative Intelligence (with links how to train creativity) Creativity Test: 10 Best Ways To Test Creative Intelligence (lifehack.org)
10. 3-18 Creativity Skills: Progression Framework. cre23-creativity-progressionframework.pdf (education.gov.scot)

RELATING THE MATERIAL AND APPROACHES TO REALITY

On the basis of the reviewed article and other sources, we can assume that tests of creativity are often based on Torrance Tests of Creative Thinking. The relevance of creativity tests relies on truthfulness and recent condition/mood of the tested person, on environmental conditions during testing, and on the lecturer's explanation and evaluation, so results are indicative. Tests are good for finding creative talents among students, for self-understanding and future self-improvement of creativity skills. For me it was an interesting experience to try several tests and to discover my opportunities for self-improvement of creative skills.

In my teaching process, I use a design thinking approach, mostly project/problem-based learning with the aim to support the development of the soft skills of my students – e.g. teamwork, divergent thinking, critical thinking, etc., creativity included. My students in courses of Commercial Business and Business in Practice work on projects where they create business plans and solutions to challenges in management of retail and tourism businesses. I appreciate learning more about assessment of

creativity, which may help to better support my students in developing their creativity potential.

I consider this review to be the starting point for the next deeper study of sources given in this text. The first reviewed article gives a theoretical basis; the second brings deeper explanation of several assessment tools; and further sources are practical and easy to use in assessment of creativity and in training of creativity skills.

>> REFERENCES

[1] Esra Kanlı, "Assessment of Creativity: Theories and Methods", Pooja Jain (Ed.) (2021). Creativity - A Force to Innovation, IntechOpen, 2021. http://dx.doi.org/10.5772/intechopen.93971

[2] Jonathon A. Plucker, Ronald A. Beghetto, and Gayle T. Dow, "Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research", Educational Psychologist 39(2), pp. 83-96, 2004. https://doi.org/10.1207/s15326985ep3902_1

[3] Bonnie Cramond, "Appendix. Assessing Creativity: A palette of possibilities. Choosing a creativity assessment that is fit for purpose", 2021. https://cms.learningthroughplay.com/media/ynrbfpi4/appendix_assessingcreativity_pdf.pdf

[4] National Improvement Hub, "Planning for and evaluating creativity", 2023. https://education.gov.scot/resources/planning-for-and-evaluating-creativity/

[5] Test my Creativity, "Free online creativity test", 2023. http://www.testmycreativity.com/

>> FURTHER READING SUGGESTIONS

Planning for and evaluating creativity. Planning for and evaluating creativity | Self-evaluation | National Improvement Hub (education.gov.scot)

Christopher Brandt, "Measuring Student Success Skills: A Review of the Literature on Creativity", 2021. Center for Assessment. https://files.eric.ed.gov/fulltext/ED617833.pdf

Mind Tools - Creativity Test (with several links to improvement of creativity and further topics) How Creative Are You? - Learning From Csikszentmihalyi's Creativity Model (mindtools.com)

Creativity Portal. Fun Creativity Tools for Teachers, Educators, Homeschoolers. Fun Creativity Tools for Teachers, Educators, Homeschoolers · Creativity-Portal.com

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PROMOTING CREATIVE THINKING SKILLS THROUGH STEAM APPROACHES

CHAPTER SEVENTEEN

FUTURE(S) THINKING FOR CREATIVITY

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ABSTRACT

This paper explores the concept of futures thinking in education, a proactive approach designed to prepare learners for the dynamic challenges of an evolving world. Through the exploration of potential future scenarios, educators aim to equip students with the requisite skills, knowledge, and mindset to navigate uncertainty effectively. Beginning with an examination of terminology surrounding future thinking and its integration into creativity and education, the paper proceeds to contextualize futures thinking within higher education. It offers practical insights into key strategies and examples for integrating futures thinking into educational practices. The final consideration is for learner awareness of a tool like the Futures Consciousness Scale (FCS) as guidance as they plan their educational trajectories and prepare for the future. Through this exploration, the paper seeks to provide educators with valuable insights and tools to foster a forward-thinking mindset among learners and promote their readiness for an ever-changing world.

Keywords: futures thinking, creativity, design thinking, strategies, education

INTRODUCTION

Futures thinking in education is a forward-looking approach that aims to prepare learners for a rapidly evolving world. By creating conditions for considering potential future scenarios, educators can better equip these learners with the skills, knowledge, and mindset needed to thrive in an uncertain future. In this literature review, we explore the terminology future thinking and futures thinking to better understand how thinking about the future has fit into the landscape of creativity and education. Then we contextualize futures thinking in higher education before examining the key strategies and providing practical examples for integrating futures thinking into educational practices. We conclude by highlighting aspects of the Futures Consciousness Scale (FCS), which can help to clarify and position learners as they plan for their own learning.

THINKING FOR THE FUTURE(S)

The area of scenario methodology follows a definition of scenarios as "internally consistent and coherent descriptions of hypothetical futures, reflecting specific perspectives on past, present, and future developments" (OECD, Part I, p. 11) [1]. The word "hypothetical" is critical – they are not intended to be totally realistic but to help clarify the directions in which we are going and how we might influence that pathway.

Factors like desired professions, educational choices, and potential opportunities would be considered for students' future thinking when planning their career path. Here, they are imagining what might happen based on current trends, plans, or expectations for career paths through the cognitive process of considering and envisioning future possibilities or scenarios. For example, from the National Defense University in Taipei, Fa-Chung Chiu explored how student groups engaged in future thinking [2] correlated with results from present-day thinking and their respective results on a creative test and a time perception test. The 160 participants in this study were, on average, 20 year-old students in business administration at Fu-Jen Catholic University in Taiwan in 2012.

The first of the tests in question, the Creative Imagery Task by Ronald Finke in 1990 at Texas A&M University offers the choice of three out of 15 objects to assemble imaginary objects [3]. The second, a time perception test, is a future-orientation subscale developed by Phil Zimbardo and John Boyd in 1999 as the Zimbardo Time Perspective Inventory (ZTPI) [4]. Now at the Center for Compassion and Altruism Research and Education at Stanford Medicine, Zimbardo used 56 items in the ZTPI to measure five assessments of time perspective, described as past positive, past negative, present fatalistic, present hedonistic, and future.

Chiu's results [2] show that the factors of originality and thinking beyond reality were highest for the group that imagined their future at the farthest point but that practicality equally improved over present-day thinking for those engaged in future thinking, whether five or 50 years into the future. These results, and the tests themselves, provide a benchmark for future thinking in education so that we can explore and contrast the implications of futures thinking.

In contrast to future thinking, governments, think tanks, and organizations might engage in *futures* thinking when conducting scenario planning exercises to anticipate and prepare for potential geopolitical, socioeconomic, or environmental changes. These examples demonstrate a broader, more systematic approach to considering multiple potential future scenarios and their implications through a process that involves exploring various future possibilities, even those that may diverge from current expectations or trends.

Where future thinking represents a more immediate, personalized process of considering future outcomes based on present circumstances, futures thinking proposes an approach that can be more comprehensive and structured. Wendy Schulz from the University of Hawai'i and Infinite Futures reviewed five ages or waves (she uses the terms interchangeably) of futures thinking throughout history [5], ranging first from an oral tradition to the early written age through Sīmǎ Qiān of the Han Dynasty, Ibn Khaldun the prominent 14th century social scientist, Nostradamus in the early 16th century, and Robert Boyle, the 17th century father of modern

chemistry. She characterizes the third wave, with the terms *extraction* and *enlightenment*, as "embedded in the idea of progress through science, technology and rationalism" (p. 4), where science fiction literature was also transformed on screen, as in the first sci-fi movie, Georges Méliès' *A Trip to the Moon* (1902) inspired by Jules Verne and H.G. Wells.

Schulz refers to the fourth wave as one of systems and cybernetics, where industry, like the Rand Corporation and Shell, had a significant impact on the growth of futures thinking.

A clash of futures thinking arose from debate between Herman Kahn's Hudson Institute, which harnessed technological optimism in foreseeing a 200-year transition to global wealth, in stark contrast with the 1972 prediction of global system collapse in The Club of Rome's commissioned work, *The Limits to Growth* (LTG) [6]. A team of 17 researchers worked on LTG with Jay Forrester – computer engineer, management theorist, and systems scientist at Massachusetts Institute of Technology (MIT). The LTG team, led by Dennis and Donella Meadows, Jørgen Randers, and William Behrens, explored three scenarios combining five factors – population, food production, consumption of nonrenewable natural resources, industrialization, and pollution – using World3, a computer simulation model. In two of the scenarios, the resources are not enough but a third scenario reaches a stabilized world, as verified independently in 2008 by Australia's Graham M. Turner of CSIRO Sustainable Ecosystems [7].

The fifth wave is termed one of *emergence and complexity*, where futurists can interact, their skills validated by the Association of Professional Futurists (APF, https://www.apf.org/), founded in 2002. Jane McGonigal, the Director of Game Research and Development at the Institute for the Future (IFTF, https://www.iftf.org/), game designer, and TED speaker, for example, has developed an approach to present action through the global games SuperStruct and Evoke to bring together a diversity of cultures in the quest to devise solutions.

The codification of futures thinking occurred primarily in three academic texts from the 1990s. As the backbone for most graduate courses, Jib Fowles' *Handbook of Futures Research* (1978) [8], Richard Slaughter's *Knowledge Base of Futures Studies* (1996) [9], [10], and Wendell Bell's

Foundations of Futures Studies (1997) [11], [12], which covers scenario planning and trend analysis so that students can tailor their approaches to their specific contexts.

The joint publication by the Organization for Economic Cooperation and Development (OECD) and the Center for Education Research and Innovation (CERI) recognizes the contribution of the private sector in developing these tools based on scenario methodology [1]. Although the five parts of the online publication offer considerable material to integrate futures thinking into education (OECD), we particularly recommend parts 4 and 5 for tools, practices, and lessons learnt.

1. Getting started: Futures thinking in education
2. What is shaping the future of schooling? – Trends and their implication in education
3. What might schooling look like in the future? Scenarios for further reflection
4. How to go about it? – Some tools to shape the future
5. Futures thinking in action: Some practices and lessons learnt

Practitioners will best remember futures thinking in action rather than remembering what they have read about it, which is the case of the authors of the present article, who have participated in futures thinking with peers and students. The focus on a wide range of societal, technological, economic, and environmental factors means that futures thinkers are better prepared for a range of potential future contexts. An extended timeframe means that scenarios that may unfold over decades, or even centuries, and the complex and interrelated dynamics involved could potentially shape the future. The systematic exploration of a wide range of potential future scenarios, covering what is *possible*, *probable*, and *preferable*, descriptors that together can serve as a prompt to uncover each of these scenarios with their associated implications for society, organizations, and individuals. As a strategic tool, we have used these 3 Ps to navigate uncertainty more confidently and prepare for a range of possible futures.

MATERIALS AND APPROACHES

The systematic approach to futures thinking (FsT) is reminiscent of design thinking (DT) and systems thinking (ST) in their aim to embrace a multiplicity of possibilities through a blend of divergent and convergent thinking. Nevertheless, where DT focuses on the problem space and user-oriented solutions for people, businesses, and technology, FsT – much like ST – broadens the search to include social, economic, political, and environmental considerations and impacts [13].

Futures Thinking means asking questions. As a scenario methodology involving the 3Ps — defined as what is possible, probable, and preferable – engaging in FsT requires the identification of the existing situation, the trends, and the drivers involved by asking at least the following questions in Table 17.1.

Possible futures	What might happen when (something specific) happens? What might happen in the future?
Probable futures	What is most likely to happen in the future? Which future scenario makes the most sense? Which trends and drivers are likely to persist?
Preferable futures	What do you want to happen in the future? Why? Who benefits and who loses?
Situations	What is happening now? What happened before? What are the roots of this activity? Who benefits from the current state and who loses?
Trends	How do you describe the comparison between the past and the current situation? What are the patterns that can be identified in these changes?
Drivers	What are the roots of this activity? How are specific community perceptions, beliefs, values, and/or attitudes causing the changes? What are the ripple effects from policy changes or from changes in demographics, the environment, or developments in science and technology?

Table 17.1.
Sample questions for futures thinking

FUTURES THINKING IN HIGHER EDUCATION: STRATEGIES AND APPLICATION

Futures thinking can cultivate a forward-looking mindset, a valuable professional and personal skill. Although the OECD/CERI Schools for Tomorrow Project aimed at K-12, CT.uni aims to reinforce the place of creative thinking in higher education. This section will bring the strategies and application to life for futures thinking with explanations and examples for transdisciplinary learning.

We examine three primary strategies for futures thinking – scenario analysis and planning, backcasting, and (mega-)trend analysis — and look at how each can be integrated into diverse courses in higher education. More importantly, for each suggested course application, the transformative possibilities of interdisciplinary work offer further outcomes that can take learners far beyond their expected results. Consider the expertise of mechanical engineering students in a futures thinking project with future educators or logistics students with future marketing managers. When learners engage with skill set(s) outside of their specific areas, the diversity of "form, function, meaning or context [...] serves very clearly to reinforce the sense of community in a Community of Practice, one in which everyone learns" [14]. Collaborative workshops can open learners to the potential of working together to create and explore future scenarios.

Beginning with a scan of the horizon, examining an area or areas to identify future challenges and opportunities, *Scenario Analysis and Planning* involves envisioning, creating, and using different future scenarios with internally consistent images and developing strategies to navigate these scenarios. The exercise of scenario planning carries benefits for informed decision-making, especially in simulations of strategic planning, investment decisions, and product development. In terms of risk mitigation, scenario planning identifies vulnerabilities; these challenges can be met when contingency plans have been developed

in advance. Innovation strategies can also arise from scenario planning, which can motivate new research and design based on alignment with the result of futures thinking.

- In science courses, for example, students could explore scenarios related to climate change, considering potential impacts on ecosystems and human societies and then devise mitigation and adaptation strategies.
- A robotics course might explore scenarios related to the integration of artificial intelligence in various industries. The robots they design could address potential challenges and opportunities in those future scenarios.
- Scenarios for a tech future, in yet another example, might range from descriptions of an "Innovation Explosion" to "Steady Evolution", or rather a "Regulatory Renaissance" or even an "Innovation Oasis".

These scenarios would be developed into detailed narratives covering the key events, technological breakthroughs, regulatory changes, and their impact on (their organization's) operations, markets, and the competition.

Backcasting starts with a vision of a desired future state and works backward to identify the steps needed to achieve it. The three main steps for backcasting involve identifying the major milestones in the intervening years, decades, or centuries (depending on the timespan), defining the actions and policy changes over time, and revealing the monitoring and adjusting required to accompany these alterations.

- Teachers of business studies courses, for example, could ask their students to first envision a sustainable and inclusive global economy then work backward to identify policies, innovations, and practices necessary to reach that goal.
- In a civics class, learners could envision a future where equitable access to education is a reality worldwide. They would then research and propose policies, technologies, and international collaborations needed to achieve this vision.

The benefits of backcasting can symbolize learning about leadership and innovation as well as how to make an impact on climate change, economic growth, or even the quality of life.

(Mega-)Trend analysis involves examining current trends and projecting how they might evolve in the future. As a trend is projected into the future, learners will define the trend in as much detail as possible, analyze its impact, then attribute the best action to take in the trends analyzed.

- In this case, a history course could study demographic shifts, technological advancements, and geopolitical trends to then analyze and predict how these trends may shape future societies.
- An art course could analyze current design trends and project how they might evolve in the future. The art pieces they create would then reflect these projected trends.

Some trends that may recur include, for example, sustainability, e-commerce, and consumer behavior (see Appendix A). For each trend defined, and keeping in mind that these have been developed by university students, the potential action, impact, and related policy could be hypothesized to build competitive edge(s), relevance, and user satisfaction.

Integrating futures thinking in education empowers learners to think critically, anticipate change, and proactively shape their future. By employing strategies, like scenario planning, backcasting, trend analysis, and scenario building workshops, educators prepare learners for the challenges and opportunities of tomorrow.

THE FUTURES CONSCIOUSNESS SCALE

The University of Turku has spearheaded a Futures Consciousness Scale (FCS), establishing a five-dimensional model for this quantitative tool to analyze *Time perspective, Agency beliefs, Openness to alternatives, Systems perception*, and *Concern for others*, drawn from other scales like the Big Five Inventory and Mindful Attention Awareness Scale. The researchers confirm the validity of their scale [15] and we look forward to a version in open educational resources (for now pricing information is available at https://futuresconsciousness.utu.fi/). Without the funds, we have encouraged our students to reflect on the expansion of the FCS's interrelated subdimensions in figure 17.1.

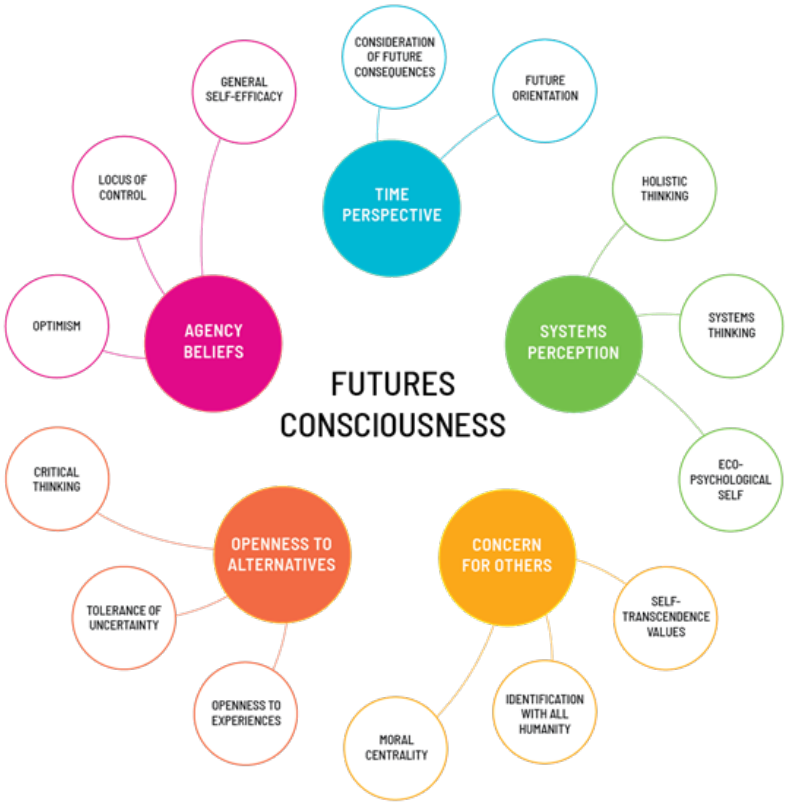

Figure 17.1.
Understanding the FCS five-dimensional model [16]

Aspects of the Futures Consciousness Scale can clarify and position learners as they plan for their own learning, thus appropriate reflection time is recommended for full-student engagement in any futures thinking activity. We can highlight some potential difficulties based on our experience, especially with systems thinking, where the non-linear relationships and dynamic interactions are sometimes difficult to navigate for sequential thinkers. Note that, for students imbued in an analytical approach, the holistic approach of looking at "the big picture" may be unfamiliar. A final concern, although by no means the last, is that an interdisciplinary perspective may still be a challenge for students in many universities that have not yet adopted this approach. We would also like to point out that, unless the high school system has been adjusted to promote self-efficacy in their students, the transition to university may represent a significant challenge for university students whose perceived control is quite low.

DISCUSSION AND CONCLUDING REMARKS

By expanding on the ways that problems can be explored through design thinking, learners can grow their toolkit beyond linear problem-solving. Teachers may feel that they need more support, which is what we have tried to provide here. Encounter Edu [17] is another site that blends expertise in education, communications, and multi-media production to provide ready-made lessons that include a component of futures thinking.

At the U4 Innovation Lab at CMI - Chr. Michelsen Institute, an independent social science research institute in Norway [18], futures thinking is applied, for example, following their guided spiral inquiry to challenge assumptions, assess recommendations, synthesize ideas, reconsider methodologies, and test hypotheses in their Anti-Corruption efforts in figure 17.2 [18].

The international foundation Creativity, Culture, and Education (CCE) [19], working with schools, communities, agencies, governments, and NGO partners at local, regional, and national levels across the world, led the initiative Creative Partnerships (2002-2011), which has provoked more recent interest in cultivating creativity in schools and has simultaneously supported researchers in higher education.

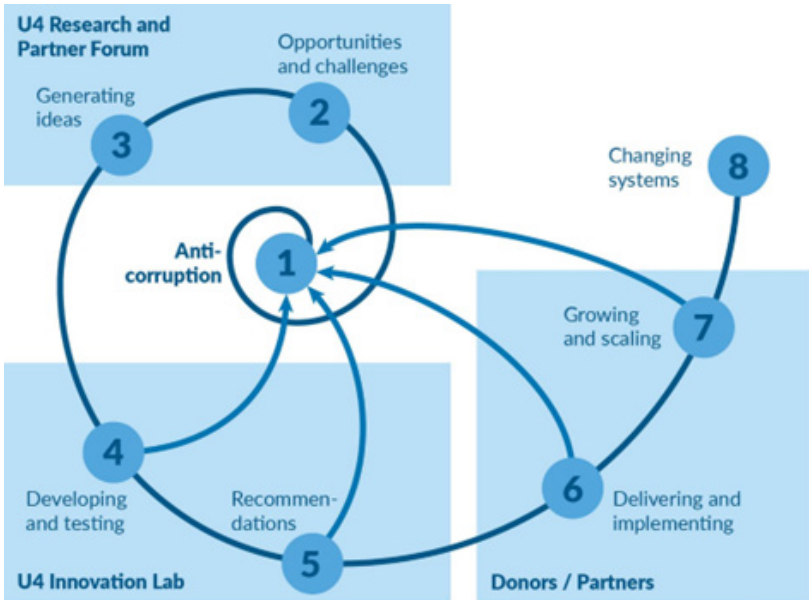

Figure 17.2.
Spiral Inquiry pattern for anti-corruption [18]

Bringing design and futures studies together are the two research teams representing higher education in four different corners of the world– Finland, London, Mexico, and Australia: Ceschin and Gaziulusoy (2016) [20] from Brunel University London and University of Melbourne's School of Design Victorian Eco-innovation Lab, respectively; and five years later, Garduño Garcia and Gaziulusoy (2021) with Gaziulusoy, this time affiliated with the Universidad Nacional Autonoma de México, teaming up with Garduño Garcia at Aalto University School of Art, Design, and Architecture [21].

Joining strategies for futures thinking with innovation is possible with many tools that are becoming more prevalent in higher education, from Digital Greenhouse Guernsey's *Innovation Toolkit 2.0* [22] to Stanford University's *d.school* [23] and projects like *CT.uni: Creative Thinking – Taking an Innovative and STEAM Approach for a Transdisciplinary University* [24] and *DT.uni - Design thinking approach for an interdisciplinary university* [25], where the "3i Approach to Design Thinking" refers to the interdisciplinary teams engage in innovation through (re)iteration.

Futures thinking offers training for navigating ambiguous problems through re-framing so that your students might find solutions that bridge the present and the future.

>> REFERENCES

[1] OECD - Organization for Economic Cooperation and Development, Schooling for Tomorrow - The Starterpack: Futures Thinking in Action. https://www.oecd.org/education/school/schoolingfortomorrow-thestarterpackfuturesthinkinginaction.htm

Part I: Getting started: Futures thinking in education https://www.oecd.org/education/school/38988392.pdf

Part II: What is shaping the future of schooling?: Trends and their implication in education https://www.oecd.org/education/school/38988417.pdf

Part III: What might schooling look like in the future? Scenarios for further reflection https://www.oecd.org/education/school/38988449.pdf

Part IV: How to go about it?: Some tools to shape the future https://www.oecd.org/education/school/38988573.pdf

Part V: Futures thinking in action: Some practices and lessons learnt https://www.oecd.org/education/school/38988825.pdf

[2] Fa-Chung Chiu, "Fit between future thinking and future orientation on creative imagination", Thinking Skills and Creativity 7(10), 234-244, 2012. https://doi.org/10.1016/j.tsc.2012.05.002

[3] Ronald A. Finke, Creative imagery: Discoveries and inventions in visualization. Lawrence Erlbaum Associates, Inc., 1990. https://psycnet.apa.org/record/1990-98533-000

[4] Philip G. Zimbardo and John N. Boyd, "Putting time in perspective: A valid, reliable individual-differences metric", Journal of Personality and Social Psychology 77(6), pp. 1271-1288, 1999. https://doi.org/10.1037/0022-3514.77.6.127

[5] Wendy Schulz, "A Brief History of Futures", World Futures Review 7(4), pp. 324-331. https://doi.org/10.1177/1946756715627646 Full text available online at https://www.researchgate.net/publication/315586338_A_Brief_History_of_Futures

[6] Donella H. Meadows, Jørgen Randers, and Dennis L. Meadows, "The Limits to Growth (1972)", Libby Robin, Sverker Sörlin, and Paul Warde (Eds.), The Future of Nature: Documents of Global Change. New Haven: Yale University Press, 2013, pp. 101-116. https://doi.org/10.12987/9780300188479-012

[7] Graham M. Turner, "A comparison of The Limits to Growth with 30 years of reality", Global Environmental Change 18(3), pp. 397-411, August 2008. https://doi.org/10.1016/j.gloenvcha.2008.05.001

[8] Jib Fowles (Ed.), Handbook of Futures Research, Westport, CT: Greenwood Press, 1978. https://archive.org/details/handbookoffuture0000unse

[9] Richard Slaughter, Knowledge Base of Futures Studies – Volume 1: Foundations, Melbourne, Australia: Futures Study Centre, 1996.

[10] Richard Slaughter, Knowledge Base of Futures Studies – Volume 2: Organizations, Practices, Products, Victoria, Australia: DDM Media Group, 1996. https://archive.org/details/knowledgebaseoff0000unse

[11] Wendell Bell, Foundations of Futures Studies – Volume 1: History, Purposes, and Knowledge (Human Science for a New Era Series). New Brunswick, NJ: Transaction Publishers, 1997.

[12] Wendell Bell, Foundations of Futures Studies – Volume 2: Values, Objectivity, and the Good Society (Human Science for a New Era Series). New Brunswick, NJ: Transaction Publishers, 1997. https://archive.org/details/foundationsoffut0002bell

[13] Anna Roumiantseva (in collaboration with Dave Weissburg at Fidelity Lab), The Fourth Way: Design Thinking Meets Futures Thinking, October 19, 2016. https://medium.com/@anna.roumiantseva/the-fourth-way-design-thinking-meets-futures-thinking-85793ae3aa1e

[14] María del Carmen Arau Ribeiro, "Crossing Disciplines: Interdisciplinary Practice in Higher Education", CASALC Review, Psychological and creative approaches to language teaching 5(1), 2015 [online]. https://www.journals.muni.cz/casalc-review/article/view/20565

[15] Fanny Lalot, Sanna Ahvenharju, Matti Minkkinen, and Enrico Wensing, "Aware of the future? Development and validation of the Futures Consciousness Scale", European Journal of Psychological Assessment 36(5), 2019. https://doi.org/10.1027/1015-5759/a000565

[16] Sanna Ahvenharju, Fanny Lalot, Manni Minkkinen, and Alan Quiamzade, "Individual futures consciousness: Psychology behind the five-dimensional Futures Consciousness scale", Futures 128, p. 102708, 2021. https://doi.org/10.1016/j.futures.2021.102708

[17] Encounter Edu — A World of Live Learning: Making education relevant, fun, and important. https://encounteredu.com/

[18] CMI - Chr. Michelsen Institute, U4 Innovation Lab for Anti-Corruption in Development, https://www.cmi.no/news/1821-u4-innovation-lab

[19] Creativity Culture & Education, https://www.creativityculture education.org/

[20] Fabrizio Ceschin and Idil Gaziulusoy, "Evolution of design for sustainability: From product design to design for system innovations and transitions", Design Studies 47, pp. 118-163, 2016. https://api.semanticscholar.org/CorpusID:76651048

[21] Claudia Garduño García and Idil Gaziulusoy, "Designing future experiences of the everyday: Pointers for methodical expansion of sustainability transitions research", Futures 127, p. 102702, 2021. https://doi.org/10.1016/j.futures.2021.102702

[22] Digital Greenhouse Guernsey, Introduction to the Innovation Toolkit 2.0, https://digitalgreenhouse.gg/innovation-hub/innovation-resources/introduction-to-the-innovation-toolkit-2-0/

[23] Stanford d.school, Tools for taking action, https://dschool.stanford.edu/resources

[24] CT.uni: Creative Thinking – Taking an Innovative and STEAM Approach for a Transdisciplinary University, https://sites.google.com/view/ct-uni/home

[25] DT.Uni - Design thinking approach for an interdisciplinary university, http://portal.ipg.pt/DTtasks/

>> FURTHER LISTENING, VIEWING, AND READING SUGGESTIONS

Bill Lucas, "A Five-Dimensional Model of Creativity and its Assessment in Schools", Applied Measurement in Education 29, 2016. https://doi.org/10.1080/08957347.2016.1209206

Bill Lucas, Guy Claxton, and Ellen Spencer, A Framework of Personal, Learning, and Thinking Skills, 2013. https://webarchive.nationalarchives.gov.uk/ukgwa/20110223175304/http:/curriculum.qcda.gov.uk/uploads/PLTS_framework_tcm8-1811.pdf

Kim Kastens, "The story behind 'Last Call'", Earth and Mind: The Blog – Reflections on thinking and learning about the Earth, 2015. https://serc.carleton.edu/earthandmind/posts/last_call.html

The Time Paradox | Philip Zimbardo & John Boyd | Talks at Google, https://www.youtube.com/watch?v=1LDwdyIxRy0&ab_channel=TalksatGoogle

Appendix A

TRENDS	PROPOSED DESCRIPTIONS
Augmented Reality (AR) and Virtual Reality (VR)	Leveraging AR and VR technologies for interactive and immersive brand experiences
Wearable Technology	Enhancing productivity and accuracy with wearables for tasks like order picking, inventory management, and training.
Evolution in Influencer Marketing	Moving towards micro and nano influencers for more authentic and niche-specific audience reach
Purpose-Driven Marketing	Aligning marketing efforts with social or environmental causes to resonate with conscious consumers
Niche and Micro-Markets	Targeting specialized segments or micro-communities for more tailored messaging
Subscription-Based Models	Interactive Content Offering subscription services or memberships for exclusive access and recurring revenue streams
Content Personalization	Tailoring content to individual preferences and behaviors for a more personalized user experience
User-Generated Content (UGC)	Encouraging customers to create content related to the brand, building authenticity and trust
	Engaging formats like quizzes, polls, and interactive infographics for increased user engagement
Chatbots and Conversational Marketing	Utilizing AI-powered chatbots for real-time customer interactions and lead generation
Voice Search Optimization	Optimizing content for voice-activated search on devices like smart speakers and virtual assistants
Local SEO and Geotargeting	Optimizing content and advertising for local searches to attract nearby customers
Search Engine Optimization (SEO) and Core Web Vitals	Prioritizing user experience factors like page load speed, mobile-friendliness, and safe browsing
Webinars and Virtual Events	Hosting online events to educate, engage, and connect with a broader audience
Video Marketing	Increased use of video content across platforms, including live streams, stories, and short-form videos
Storytelling and Brand Narratives	Creating compelling narratives to connect emotionally with consumers and build brand identity
Ephemeral Content	Temporary content formats, like stories on platforms
Social Commerce	Integrating e-commerce features directly into social media platforms for seamless shopping experiences
Data Analytics	Leveraging Big Data and analytics tools to find insight on decision-making, process optimization, and performance evaluation
AI and Machine Learning	Leveraging AI for data analysis, personalization, and automating marketing tasks for efficiency
AI-powered Content Creation	Using AI tools to assist in generating content, from automated copywriting to design
Cybersecurity, Privacy Compliance and Data Protection	Adapting to evolving privacy regulations and ensuring transparent data handling practices
	Identifying and safeguarding sensitive logistics data and customer relationship management data and results
Geopolitical shifts and trade agreements	Navigating complex global trade regulations, tariffs, and compliance standards
Supply Chain Digitization and Visibility	Integration of digital technologies (IoT, blockchain, RFID) for real-time tracking, tracing, and visibility across the entire supply chain

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