Evaluating Playful Creative Problem Solving in Kyiv and Ukrainian Refugees in France

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Abstract: Creativity in playful creative problem-solving (CPS) is influenced by the emotional state of the learner-player. In this study, we evaluated how stressful situations (such as conditions of war) can impact divergent thinking (DT) in CPS. To evaluate divergent thinking, the main components of which are fluency, flexibility, and originality, creativity researchers have developed the Alternative Uses Test (AUT), where participants are asked to write about different uses of familiar objects in a limited amount of time. In educational robotics, DT has been operationalized with the same components of fluency, flexibility, and originality based on the diverse configurations made by the learner-players. In the present research, we engaged participants in a playful activity with modular robotics to evaluate divergent thinking. Participants engaged in the CreaCube task are Ukrainians. We recruited two groups of participants: Ukrainian refugees living in France and participants staying in Kyiv (Ukraine). These participants are experiencing a stressful situation due to the daily war events in Kyiv during the development of this study (missile attacks, power and heating restrictions, air sirens, and limited communication with partners on the frontlines). By comparing these two groups of learner-players in the CreaCube task, we aim to identify how stressful situations affect divergent thinking. The preliminary results showed that flexibility and originality as DT components of the participants from Kyiv in the first experiment are significantly higher than those of the refugee participants based in France. This may indicate that the participants from Kyiv, having been in stressful situations (war conditions) for almost a year, have developed more original ideas (originality component) and different ideas (flexibility component), which could be explained by the daily problem-solving activity under war constraints. Playful situations under war conditions permitted the Kyiv participants to distract themselves from the current situation and show originality in thinking better than participants playing in France who were not in stressful situations. This may indicate that wartime constraints have engaged the participants in better strategies for generating novel ideas, but it also indicates that the interest in game activities has a positive effect on DT even in stressful situations for the participants.

Keywords: Divergent thinking, Creativity, Fluency, Flexibility, Originality, Wartime

1. Playful Educational Robotics

1.1 Educational Robotics in the Classroom

The current stage of the development of science and technology is characterised by the growing popularity of robotics and the expansion of the scope of robots (Akcaoglu *et al.*, 2017; Buchem and Bäcker, 2022; Chevalier *et al.*, 2022). Teaching youth to design, program, and use robots and robotic systems relates to the requirements of today, namely the emergence of new professions in the field of robotics and, as a result, the need for relevant specialists. In the present world, increased attention is paid to robotics as an applied science, including its educational and developmental potential. *Educational robotics* is a cross-disciplinary area of students' learning. Its process integrates the knowledge of STEM subjects (physics, technology, mathematics), cybernetics, mechatronics, informatics, and digital technology. Teaching educational robotics corresponds to the idea of advanced training (learning the technologies that will be needed in the future) and allows students of all ages to be involved in the process of innovation, scientific and technical creativity (Morze, Strutynska and Umryk, 2018a).

Educational robotics classes ensure the implementation of interdisciplinary links with STEAM subjects, as well as the practical application of theoretical knowledge. According to Morze, Strutynska and Umryk (2018b), such classes include the following components:

1. The idea of creating a specific robot and the corresponding technical task.
2. Modelling of the robot.
3. Design of the robot.
4. Build a robot algorithm and program the robot in accordance with the technical task.
5. Testing the robot.

One of the most effective ways to do this is to propose learning research projects for students, such as:

- *Plant Pollination project* (creating a robot for plant pollination - modelling the relationship between a pollinating insect and a flower at the stage of reproduction) - integration of biology, robotics, and programming.
- *Flood Protection project* (designing an automatic gateway to control water levels in accordance with different rainfall patterns) - integration of technology, robotics, and programming.
- *Ocean Cleanup Project* (designing a prototype robot to remove plastic debris from the ocean) - integration of ecology, technology, robotics, and programming.
- *Project "Space Exploration"* (design of a prototype robot all-terrain vehicle for exploration of distant planets) - integration of technologies, robotics, and programming.

The implementation of such projects contributes to the development of the key competencies for the 21st century, such as the #5c21 framework, which includes collaboration, problem solving, critical and creative thinking, but also computational thinking, and research skills (Morze, Strutynska and Umryk, 2018b).

Incorporating basic knowledge of the fundamentals of robotics into school education will enable the training of specialists for future jobs related to industries that do not exist today. It is important to remember that the use of educational robotics makes it possible at an early stage to identify the technical inclinations of students and develop their technical creativity (Morze, Strutynska and Umryk, 2018a).

1.2 Playful Activities Engaging Children in Creative Problem Solving in Educational Robotics

The positive impact of the game approach on the development of critical thinking, collective creativity, and problem-solving skills was considered by Tang, Vezzani, and Eriksson (2020). Learning to be imaginative and creative requires open and flexible environments rich in materials and role models that reflect the cultural life of their communities, e.g., songs, crafts, languages, and artefacts. Language mediation within semantic tasks, as in the *Alternative Uses Test* (Guilford, 1967; Beaty *et al.*, 2022) but also musical instruments in the case of musical creativity and STEM artefacts (robots, electronic components, etc.) in the context of creative problem solving (CPS) with technologies (Charisi, Liem and Gómez, 2018). CPS can be supported with visuospatial constructive play objects (VCPO) or artefacts such as modular robotics (Ness and Farenga, 2016). In the CPS tasks with modular robotics, creativity can be observed not only by the analysis of the configurations but also by the behavioral learning analytics, including the gestures and actions of the participant engaged with the mediating artefacts.

2. Creativity: From Divergent Thinking to Convergent Thinking

Creativity is a complex human process that can be observed in a high diversity of learning, professional, and personal tasks. Despite being considered a transversal competency by most of the 21st century skills frameworks (Burkhardt *et al.*, 2003; Care, Griffin and McGaw, 2012; P21, 2019), creativity needs to be considered in the specific context of an academic domain and task. Moreover, the results on the assessment of creativity show how the same subjects can have different divergent thinking (DT) scores depending on the task and the materiality of the artefacts engaged in the task (Leroy, Romero and Cassone, 2021; Romero and Barma, 2022). Guilford (1967) underlined the potential benefits of creativity, which could have a positive influence on society in light of issues like maintaining peace, providing for a rising global population, and improving the educational level in general (Guilford, 1967; Lubart, 2017). The 7 C's framework for conceptualising work on creativity proposed by Lubart (2017) shows that creativity can cover many different aspects and be expressed in different forms of activity, from the creation and context of ideas and productions to their consumption.

In this study, we focus on CPS tasks in which the learner is engaged both in DT (ideation) and convergent thinking (idea selection) processes in different cycles of iterative improvement. DT is the process of creating multiple, unique ideas or solutions to a problem that an individual is trying to solve. Through spontaneous, free-flowing thinking, DT requires coming up with many different answers or routes forward, which is an important aspect of CPS (Runco, 2011, 2014). In CPS, DT corresponds to idea creation, while convergent thinking corresponds to idea selection.

DT is a cognitive process that leads to the creation of various ideas and their advancement in different directions in a problem-solving situation. Some of these ideas are conventional, and some are original. The three main components of DT are *fluency*, *flexibility*, and *originality*, as defined by Guilford (1967). DT components permit us to differentiate between the *fluency* of ideas, even if they are not original, the *flexibility* of ideas showing a certain difference with prior ideas, and *originality*, which are the ideas appearing to be rare within a certain group of references. DT allows an individual to identify the fullest range of alternatives and possibilities. DT is not linear and does not lead in only one direction but instead branches out so the individual has more freedom, latitude, and a very full set of options (Runco, 2022).

DT has been thoroughly studied and is considered an important process in creativity research. Originality, as one of the DT components, is an extremely important characteristic because it is a prerequisite for creativity (Acar *et al.*, 2019). DT tests are very often used in creativity studies and as measures of creative potential (Runco and Acar, 2012; Runco *et al.*, 2016). By no means is DT synonymous with creativity, but results from DT tests have proven to be informative about the potential for CPS. DT tests offer information about originality, one part of the standard definition of creativity, as well as flexibility and fluency with ideas (Runco, 2022).

To test DT generally, the Alternative Uses Test (AUT) is used, which asks participants to describe or write several uses for known items to tell lots of different ways how the spoon, wheel, toothbrush, etc. can be used (Wallach and Kogan, 1965), or other ideation tasks that are not only semantic but also can engage the learners' in drawing or other DT activities (Torrance, 1972; Abdulla Alabbasi *et al.*, 2021; Acar *et al.*, 2021; Runco, 2022).

In the present study, we focus on the creators' DT and the actual creation (configuration) made with a set of modular robotic cubes. In our study, we aimed to evaluate the three DT components (fluency, flexibility, and originality) through an educational modular robotics task that engaged the Ukrainian participants in building their ideas during stressful situations (war conditions).

3. How Stress can Impact Creativity

It is believed that creativity requires a positive emotional setting to be supported. For instance, Stinkeste, Napala, and Romero (2021) show that, both in individual and collective settings, a positive climate is very important to support CPS. In STEAM activities, team climate has been observed to support the creative process in relation to co-creativity. Other researchers studying the impact of stress on creativity indicate that their relationship is controversial and much disputed because stress can affect creativity either positively or negatively.

Anderson, De Dreu, and Nijstad (2004) claim that stress may boost creative thinking in organizations. According to their findings, stress is a source of extrinsic motivation and raises arousal levels. As a result, when people are under stress, they may utilize a concentrated problem-solving method that promotes creativity. Other studies show that stress can reduce creativity. Thus, according to the meta-analysis in psychology studies developed by Byron, stress tends to reduce creativity by putting a strain on cognitive abilities, leading to the employment of straightforward cognitive techniques that are likely to decrease originality (Byron, Khazanchi, and Nazarian, 2010).

The study by Kassymova *et al.* (2019) investigated the extent to which stress affects students' academic success and health. Investigating the following dependencies, they also found that stress and creativity interact in an ambiguous way. On the one hand, stress suppresses creativity, like all other intellectual abilities. On the other hand, stress encourages people to search for new forms of response, i.e., to be creative. The nature of creativity in a stressful situation is largely related to the *type of stress*. The more stressful a person is, the higher and more extensive their creative achievements are. On the third hand, a person's creative abilities help him or her to easily endure stress, sometimes without noticing it. Fourthly, a person's creative abilities can lead them to specific stressful situations related to the need for their realisation (Kassymova *et al.*, 2019). Thus, a person's creative abilities can be an important source of stress resistance. Based on these different studies, we need to consider the relationship between the domain and the tasks in which creativity is studied in relation to stress.

3.1 Play under Conditions of war

Safety is an important human need for all citizens. During wartime, children and adults suffer from different types of chronic stress, which can have a long-term impact. The literature review of Elbedour, ten Bensel, and Bastien (1993) has identified the wartime effects on the child's psychological development, especially if their adults' figures of reference have not developed coping strategies. The child's adjustment is also affected by their community stability and social services, which require them to consider the importance of the school's educational activities in supporting the well-being of the children. Moreover, when free play outdoors is diminished, this can also be an aggravating factor for mental distress (Gray, Lancy and Bjorklund, 2023). As educators and researchers, we do not have the possibility to stop the war, but we can imagine different ways to support Ukrainian educators, researchers, and, most importantly, Ukrainian children through playful activities.

When the war in Ukraine started, we wanted to know how we could help Ukrainian colleagues in the learning sciences and support their educational efforts during wartime. The research and societal values of the MSc *SmartEdTech* of Université Côte d'Azur are to develop learning activities that can support the sustainable development goals (SGDs) with a special focus on quality education (SGD4) “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”? We organised our first activity in 2021, inviting female researchers in STEM education from Ukraine for a special webinar on Women's Day of 2021. Afterwards, we had the opportunity to support Prof. Oksana Strutynska, full professor at Kyiv, in joining the *Let's STEAM!* and *ANR CreaMaker* projects in the LINE research lab. We then organised two workshops in Nice including supporting unplugged computer sciences activities developed within the Unplugged Quest project in 2022. In January 2023, Prof. Strutynska flew back to Kyiv for Christmas and after the holidays, she also ran different individual and collective playful sessions at the Faculty of Mathematics, Informatics, and Physics at the Dragomanov Ukrainian State University.

4. Methodology

4.1 Participants

The experiment involved 33 Ukrainian participants, who were divided into two groups: Ukrainian refugees in France and participants from Kyiv (who were in stressful situations - conditions of war). The participants were presented with a playful activity with modular robotics to evaluate divergent thinking, the CreaCube task.

In the workshops developed in Nice in 2022, we engaged Ukrainian families among the refugee community in Nice. Most of the children are well-integrated in primary and middle schools but have different levels of French proficiency, which made the translation of some terms necessary, and different levels of prior knowledge in computer sciences. The participants were invited to the LINE lab in Nice, and after the activities, we shared some snacks to support team building and the opportunity to debrief not only about the Unplugged Quest activities but also in relation to their daily challenges. We involved 17 participants in a playful activity in Nice.

We organised the workshops in Nice on a non-school day to allow the parents to come with their children. We shared with the parents the Unplugged Quest activities. They appreciated the diversity of languages in the activities that support their children's language learning. On the Nice team, we are amazed at the courage of the volunteers who were joining these activities.

In Kyiv, Prof. Strutynska proposed the participants join the Faculty of Mathematics, Informatics, and Physics at the Dragomanov Ukrainian State University (Ukraine), according to the safety measures during wartime. Participants reported enjoying the playful activities. We involved 16 participants in the experiment. During the workshop, we took all the necessary measures to ensure the safety of the participants. During air raid sirens, we went down to the shelter. After the danger was over, we returned to the game activities.

4.2 Evaluation of Divergent Thinking

To evaluate divergent thinking, learner-players are asked to solve the CPS CreaCube playful task. The resolution of the CreaCube activity involves the manipulation and assembly of cubes. In order to complete the game's objective, the player must investigate unknown cubes and make an autonomous vehicle that can move from the starting point to the final destination (Romero, DeBlois and Pavel, 2018). In this way, we can analyze the process of CPS to evaluate the DT components for every participant.

Participants are required to build an autonomous vehicle that can move from the starting point to the destination using Cubelets modular robotics. Participants build different options for vehicles (*fluency component*), including different ideas (*flexibility component*) and original ideas (*originality component*). Based on the operationalization of the AUT by Guilford (1967), we evaluate DT in the CreaCube task using the three DT components. *Fluency* corresponds to the total number of distinct ideas; *flexibility* corresponds to the number of distinct categories; and *originality* is the rarest response, corresponding to those provided by fewer than 5% of all participants within the same age category. Participants are invited to play again after their first success in the CreaCube game. The goal of the second attempt is to determine whether the player has learned and considered the cubes' characteristics from the first attempt, as well as whether they have tried to solve the problem by creating a new solution or trying to duplicate the first solution exactly. These next actions also prove to evaluate the DT of participants.

5. Results

During the experiments, all learner-players had two attempts at the CreaCube activity (A1 and A2). In each attempt, we obtained results for three DT components: fluency, flexibility, and originality. After experiments, we analyzed the participants' activity from videos by using specially developed software in which the figure configurations are pre-set (Figure 1).

Figure 1: Ad hoc developed software for analysis DT components

Once the video is uploaded to the CreaMaker research platform, it is analysed by integrating the corresponding coding schemas (Figure 2).

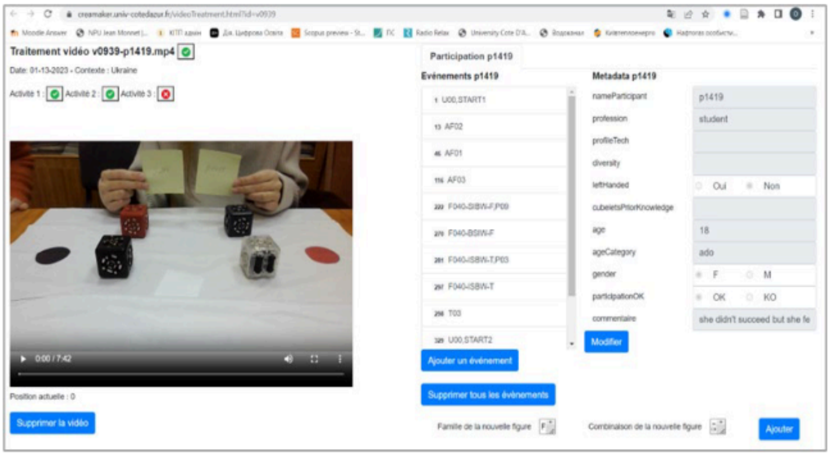

Figure 2: Video analysis using the figures coding schema to calculate the DT scores

We processed the videos using this specially developed software, based on which the DT components are analysed based on the video analysis through the CreaMaker platform. The results analysed with JASP (0.17.1 release) are shown in Table 1.

Table 1: DT components' scores for Kyiv and Nice participants

	A1_Fluidity		A1_Flexibility		A1_Originality		A1_Time		A2_Fluidity		A2_Flexibility		A2_Originality		A2_Time	
	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice	Kyiv	Nice
Valid	16	15	16	15	16	15	16	15	14	15	14	15	14	15	14	15
Missing	0	0	0	0	0	0	0	0	2	0	2	0	2	0	2	0
Mean	4.938	4.933	2.188	1.600	1.188	0.133	206.063	223.800	2.857	2.600	1.214	1.200	0.286	0.333	71.000	87.800
Std. Deviation	5.234	8.996	1.974	0.632	1.471	0.352	148.486	227.507	2.381	3.757	0.802	1.265	0.611	0.816	36.574	93.253
Minimum	0.000	1.000	0.000	1.000	0.000	0.000	68.000	64.000	0.000	0.000	0.000	0.000	0.000	0.000	21.000	19.000
Maximum	19.000	37.000	7.000	3.000	5.000	1.000	539.000	655.000	9.000	15.000	3.000	5.000	2.000	3.000	140.000	307.000

We can observe in Table 1 a higher level of flexibility (m=2.18; sd=1.97) and originality (m=1.19; sd=1.47) in the first instance (A1) of the CreaCube task among the participants in Kyiv than those in Nice.

The next figures focus on the DT components with the highest differences between the Nice and Kyiv participants. Firstly, figure 3 shows the difference in the first instance of the CreaCube activity (A1) on the originality DT component. We can observe that Kyiv participants are more original (m=1.18; sd=1.47) than those in Nice (m=0.13; sd=0.35). The Welch's t-test (t(16.821) = 2.784, p = 0.013) suggest that there is a significant disparity in originality scores between the Kyiv and Nice groups.

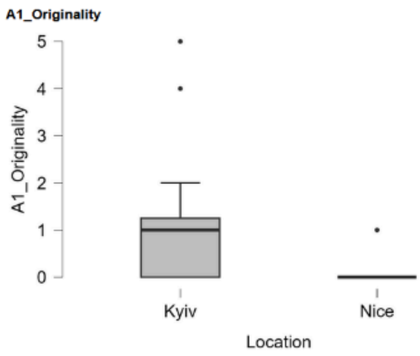

Figure 3: Originality in A1 among Kyiv and Nice participants

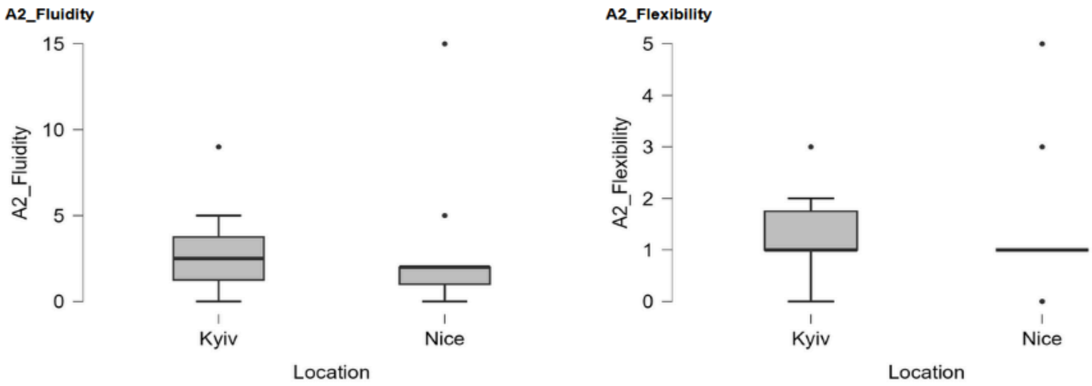

Figure 4: Fluency and Flexibility in A2 among Kyiv and Nice participants

We can observe that despite a similar average, the distribution of the DT scores of fluency and flexibility in A2 are more diverse among Kyiv participants than those in Nice. There was no significant difference in fluidity scores between the Kyiv and Nice groups in A2, $t(27) = 0.218$, $p = 0.829$, neither in flexibility, $t(27) = 0.036$, $p = 0.972$.

6. Discussion

The analysis of the Nice and Kyiv participants shows some differences, especially in relation to originality in A1. The second activity (A2) shows a lower level on each of the DT components, which is a normal observation due to the prior experience acquired when solving the first instance of the task.

The higher rate average value of the originality component (A1, see Figure 3) of the Kyiv group compared to the Nice group can be explained by the fact that learner-players from the Kyiv group daily face the need to solve various problems due to the wartime stress: lack of electricity, heat, and sometimes water; difficulty in cooking in the absence of electricity; closed shops; household appliances do not work; ATMs do not work; need to interrupt studies, work, and moving around the city during air raids; constant stress due to the war, etc.

Therefore, their readiness to solve problems in the novelty situation of A1 is higher among the Kyiv participants than that of the participants from the Nice group. In addition, in such difficult war conditions, the opportunity to attend a playful activity with modular robotics CreaCube also brought participants from the Kyiv group positive emotions and distracted them from the current situation in the country. This allowed them to relax, which can also serve as an additional factor in a higher level of CPS.

Despite a limited sample size, this study is an opportunity to consider playful interventions to help Ukrainians engage in creative activities and value the DT capacities developed under the stressful situation of war. Both the experimenters and participants in France and Ukraine reported a highly positive playful experience that, beyond the DT indicators, is a positive intervention to support Ukrainians through game-based learning activities.

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References

Abdulla Alabbasi, A.M. *et al.* (2021) 'Problem Finding, Divergent Thinking, and Evaluative Thinking Among Gifted and Nongifted Students', *Journal for the Education of the Gifted*, 44(4), pp. 398–413. Available at: https://doi.org/10.1177/01623532211044539.

Acar, S. *et al.* (2019) 'Latency as a predictor of originality in divergent thinking', *Thinking Skills and Creativity*, 33, p. 100574. Available at: https://doi.org/10.1016/j.tsc.2019.100574.

Acar, S. *et al.* (2021) 'Applying Automated Originality Scoring to the Verbal Form of Torrance Tests of Creative Thinking', *Gifted Child Quarterly*, p. 001698622110618. Available at: https://doi.org/10.1177/00169862211061874.

Akcaoglu, M. *et al.* (2017) 'Game design as a complex problem solving process', in *Handbook of research on serious games for educational applications*. IGI Global, pp. 217–233.

Anderson, N., De Dreu, C.K.W. and Nijstad, B.A. (2004) 'The routinization of innovation research: a constructively critical review of the state-of-the-science', *Journal of Organizational Behavior*, 25(2), pp. 147–173. Available at: https://doi.org/10.1002/job.236.

Beaty, R.E. *et al.* (2022) 'Semantic Distance and the Alternate Uses Task: Recommendations for Reliable Automated Assessment of Originality', *Creativity Research Journal*, 34(3), pp. 245–260. Available at: https://doi.org/10.1080/10400419.2022.2025720.

Buchem, I. and Bäcker, N. (2022) 'NAO Robot as Scrum Master: Results From a Scenario-Based Study on Building Rapport With a Humanoid Robot in Hybrid Higher Education Settings', *Advances in Human Factors in Training, Education, and Learning Sciences*, 59, p. 65.

Burkhardt, G. *et al.* (2003) *enGauge 21st Century Skills: Literacy in the Digital Age*. North Central Regional Education Laboratory and the Metiri group, p. 88. Available at: http://www4.unescobkk.org/ict/elearning/pdf/enGauge21st_Century_Skills_Literacy_in_the_Digital_Age.pdf.

Byron, K., Khazanchi, S. and Nazarian, D. (2010) 'The relationship between stressors and creativity: A meta-analysis examining competing theoretical models.', *Journal of Applied Psychology*, 95(1), p. 201.

Care, E., Griffin, P. and McGaw, B. (2012) *Assessment and teaching of 21st century skills*. Springer.

Charisi, V., Liem, C. and Gómez, E. (2018) 'Novelty-based cognitive processes in unstructured music-making play settings in early childhood', in *Proceedings of 8th Joint IEEE International Conference of Development and Learning and Epigenetic Robotics ICDL-EpiRob2018*, pp. 218–223.

Chevalier, M. *et al.* (2022) 'The role of feedback and guidance as intervention methods to foster computational thinking in educational robotics learning activities for primary school', *Computers & Education*, 180, p. 104431. Available at: https://doi.org/10.1016/j.compedu.2022.104431.

Elbedour, S., ten Bensel, R. and Bastien, D.T. (1993) 'Ecological integrated model of children of war: Individual and social psychology', *Child Abuse & Neglect*, 17(6), pp. 805–819. Available at: https://doi.org/10.1016/S0145-2134(08)80011-7.

Gray, P., Lancy, D.F. and Bjorklund, D.F. (2023) 'Decline in Independent Activity as a Cause of Decline in Children's Mental Wellbeing: Summary of the Evidence', *The Journal of Pediatrics*, 0(0). Available at: https://doi.org/10.1016/j.jpeds.2023.02.004.

Guilford, J. (1967) 'Creativity: Yesterday, today and tomorrow', *The Journal of Creative Behavior*, 1, pp. 3–14.

Kassymova, G. *et al.* (2019) 'Impact of stress on creative human resources and psychological counseling in crises', 13, pp. 26–32.

Leroy, A., Romero, M. and Cassone, L. (2021) 'Interactivity and materiality matter in creativity: educational robotics for the assessment of divergent thinking', *Interactive Learning Environments*, pp. 1–12. Available at: https://doi.org/10.1080/10494820.2021.1875005.

Lubart, T. (2017) 'The 7 C's of Creativity', *The Journal of Creative Behavior*, 51(4), pp. 293–296. Available at: https://doi.org/10.1002/jocb.190.

Morze, N., Strutynska, O. and Umryk, M. (2018a) 'Implementation of Robotics as a Modern Trend in STEM Education', *International Journal of Research in E-learning*, 4(2). Available at: https://doi.org/10.31261/IJREL.2018.4.2.02.

Morze, N., Strutynska, O. and Umryk, M. (2018b) 'ОСВІТНЯ РОБОТОТЕХНІКА ЯК ПЕРСПЕКТИВНИЙ НАПРЯМ РОЗВИТКУ STEM-ОСВІТИ', *Електронне наукове фахове видання "ВІДКРИТЕ ОСВІТНЄ Е-СЕРЕДОВИЩЕ СУЧАСНОГО УНІВЕРСИТЕТУ"*, (5), pp. 178–187. Available at: https://doi.org/10.28925/2414-0325.2018.5.178187.

Ness, D. and Farenga, S.J. (2016) 'Blocks, Bricks, and Planks: Relationships between Affordance and Visuo-Spatial Constructive Play Objects', *American Journal of Play*, 8(2), pp. 201–227.

P21 (2019) *Framework for 21st century learning*. Available at: https://static.battelleforkids.org/documents/p21/P21_Framework_Brief.pdf.

Romero, M. and Barma, S. (2022) 'Analysing an Interactive Problem-Solving Task Through the Lens of Double Stimulation', *Canadian Journal of Learning and Technology*, 48(1). Available at: https://doi.org/10.21432/cjlt28170.

Romero, M., DeBlois, L. and Pavel, A. (2018) 'Créacube, comparaison de la résolution créative de problèmes, chez des enfants et des adultes, par le biais d'une tâche de robotique modulaire', *MathémaTICE* [Preprint], (61). Available at: http://revue.sesamath.net/spip.php?article1104.

Runco, M. A. (2011) 'Divergent Thinking', in Mark A. Runco and S.R. Pritzker (eds) *Encyclopedia of Creativity (Second Edition)*. San Diego: Academic Press, pp. 400–403. Available at: https://doi.org/10.1016/B978-0-12-375038-9.00077-7.

Runco, M.A. (2014) '"Big C, Little c" Creativity as a False Dichotomy: Reality is not Categorical', *Creativity Research Journal*, 26(1), pp. 131–132. Available at: https://doi.org/10.1080/10400419.2014.873676.

Runco, M.A. *et al.* (2016) 'Which test of divergent thinking is best?', *Creativity. Theories–Research-Applications*, 3(1), pp. 4–18.

Runco, M.A. (2022) 'Positive Creativity and the Intentions, Discretion, Problem Finding, and Divergent Thinking That Support It Can Be Encouraged in the Classroom', *Education Sciences*, 12(5), p. 340. Available at: https://doi.org/10.3390/educsci12050340.

Runco, M.A. and Acar, S. (2012) 'Divergent thinking as an indicator of creative potential', *Creativity Research Journal*, 24(1), pp. 66–75.

Stinkeste, C., Napala, A. and Romero, M. (2021) 'Impact of Team Climate on Co-Creativity in STEAM Education in Primary Education', *Creative Education*, 12(8), pp. 1977–1994.

Tang, T., Vezzani, V. and Eriksson, V. (2020) 'Developing critical thinking, collective creativity skills and problem solving through playful design jams', *Thinking Skills and Creativity*, 37, p. 100696. Available at: https://doi.org/10.1016/j.tsc.2020.100696.

Torrance, E. (1972) 'Predictive validity of the Torrance tests of creative thinking', *The Journal of Creative Behavior*, 6(4), pp. 236–262.

Wallach, M.A. and Kogan, N. (1965) *Modes of thinking in young children.* Holt, Rinehart and Winston: New York (Modes of thinking in young children).