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LEARNING TO MAKE, MAKING TO LEARN: STEAM MEETS MAKER MOVEMENT

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Abstract: In this paper, we examine the potential advantages of integrating principles and methods from STEAM education and the maker movement into the teaching and learning process. The transition of the maker movement from informal to formal education, such as schools and colleges, is encouraged by STEM, and even more so by STEAM education. The maker movement, characterized as a community fostering creation based on science, technology, art, and craft, along with STEAM education, is rooted in the tradition of learning by doing and has experienced significant growth in recent years, even within Serbian schools (13 makerspaces were opened last year). Why is this collaboration between makers and education so fruitful? It aims to cultivate creativity, problem-solving skills, communication, social, and other competencies that schools typically struggle to develop. Our main goal is to address the lack of theoretical discussions regarding the connections between the nature of learning and the nature of a making process. Thus, we explore how learning emerges from STEAM education and the maker movement from the perspectives of socio-constructivist theory, progressivism, and critical pedagogy. This analysis led us to propose seven principles of learning by making that, if employed, can serve as a foundation for bridging STEAM, makers, and everyday teaching practice. They are as follows: tinkering – active thought, transdisciplinarity, real-life problems and project-based learning, community of learners, playfulness, metacognition and a hacking mindset, and mistakes-based learning. Finally, we outline both potential pitfalls and resources for implementing the maker movement in Serbian schools.

Keywords: STEAM, teaching/learning, maker movement, makerspace, makers

INTRODUCTION: WHY IS IT IMPORTANT TO UNITE THE MAKER MOVEMENT AND STEAM?

The maker movement, as a community that fosters creation based on science, technology, art, craft, do-it-yourself home improvement, and similar endeavors,

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emerged within informal education at the beginning of this century but soon found a path into the formal learning environment (e.g., Martin, 2015). Besides recognizing the importance of making as an essential part of human evolution and a basic human need, other core principles of the movement, particularly from the perspective of formal education, include (Hatch, 2014): share, learn, tool up, play, and participate. People need to share what they make with others, and another aspect of sharing is sharing knowledge about the process of making (i.e., know-how). Making is inseparable from learning because we have to learn to be able to make, but making also brings about a natural interest in learning. Tools, both high- and low-tech tools, are an essential part of making. Play brings a positive mood, makes our cognitive processes more flexible (this is also the effect of a positive mood alone, as noted by Reeve, 2009), and ultimately increases productivity. The idea is to be playful with ideas and with what we are making. Finally, it is expected to participate in a community of makers/learners by working directly together, holding classes, attending makers' events, or in some other ways.

Although it has been constituted in recent times, the maker movement has long-standing theoretical roots—it has been an educational "revolution in waiting for 100 years" (Blikstein, 2018: 420). The movement is grounded in sound educational perspectives and a history of ideas about learning, including progressivism, socio-constructivism, and critical pedagogy (e.g., Blikstein, 2018; Libow Martinez & Stager, 2013). More than a century ago, Dewey wrote, "Only the already experienced can be symbolized" (Dewey, 1910: 166). He made a paradigm shift by proclaiming the maxim of *learning by doing*. Dewey not only framed learning as the product of practical activities within the context of authentic inquiry and experimentation but also emphasized that learning in school needs to be connected to the real world, to children's activities outside of school, thus gaining full meaning for learners (e.g. Pešikan, 2020). The fact that knowledge and understanding must be actively constructed (and not transmitted) links constructivism and socio-constructivism. However, the latter adds social interaction (i.e. co-construction) and cultural tools as the main means for shaping individual cognitive development. Critical pedagogy brings to the fore the importance of empowering learners against oppressive social structures maintained by the traditional school system and highlights the need to support students in perceiving themselves as agents of change.

STEAM, which stands for Science, Technology, Engineering, Arts, and Mathematics, is an educational approach that as many authors suggest offers a path toward significant educational improvements, particularly in developing competencies needed for the 21st century (Dryder & Vos, 1994; Trilling & Fadel, 2009; OECD, 2013). The STEAM approach is widely discussed and described as encompassing principles such as interdisciplinarity, collaboration, hands-on and inquiry-based learning, critical thinking, problem-solving, project-based learning, real-world applications, and technology integration (Henriksen, 2014). Additionally, it incorporates principles like transdisciplinarity, embodiment, and a critical approach (Sengupta, Shanahan, & Kim, 2019). Recent authors highlight the transformative potential of the STEAM approach in educational contexts (Williams, 2023). In this paper, we argue that the combined impact of the STEAM and makers approaches in educational settings is far more powerful than the changes they can bring individually.

METHODOLOGY

The main research question is what the potential advantages of integrating principles and methods from STEAM education and the maker movement into the teaching and learning process are. The paper aims to map concordances between STEAM tradition and maker movement tradition in an educational context by defining principles that can support teaching and learning processes into being more engaging and relevant for students.

Building upon five years of experience in STEAM and makers practices at the Center for the Promotion of Science in Belgrade, where one of the authors was involved in designing, coordinating, implementing, and evaluating 15 children's science camps, three maker labs, and numerous maker workshops, this paper explores reflections on these programs and their theoretical foundations. It examines the connections between socio-constructivist theory, critical pedagogy, and the practice of STEAM and makers programs in Serbia. Thus, the paper has two core foundations: practical work with children and theories of learning and teaching. The concept of bridging STEAM and maker approaches predates the popularization and formal naming of these categories in educational settings. Although these approaches have more similarities than differences, they have developed as relatively separate traditions, particularly in formal education in Serbia. Therefore, this paper aims to map the intersections of these approaches and ground them in educational sciences. This can help educators understand the role of maker tools, approaches, and principles in everyday teaching practice better, particularly in project-based learning, STEAM, and thematic teaching, all of which are becoming part of the official curricula.

The methodology of this paper involves a reflective practice approach, where practical experiences are critically examined through theoretical lenses to develop new principles. Practical experiences from STEAM and makers practices are revisited and reread by using established theoretical frameworks dominant in educational contexts in European and Western traditions today.

RESULTS: PRINCIPLES OF LEARNING BY MAKING

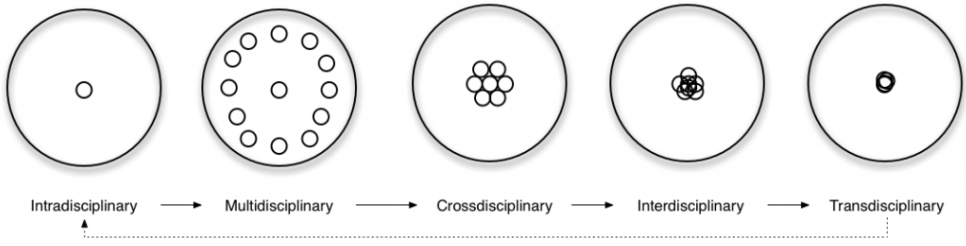
Tinkering – Active Thought

Tinkering is a term often used within the maker movement to designate a way to approach and solve problems in a creative and improvisational manner (like in a children's game) as well as a form of learning where both hands and mind are active (e.g. Bevan et al., 2015; Libow Martinez & Stager, 2013). It is a concept closely related to Piaget's constructivist theory and its notion of an active learner. It is also similar to the term *mentipulation* coined by Ivić and associates (Ivić, Pešikan, & Antić, 2003) to describe the mental processing of information about reality. Tinkering could be defined as "the generative process of developing a personally meaningful idea, becoming stuck in some aspects of physically realizing the idea, persisting through the process, and experiencing breakthroughs as one finds solutions to problems" (Bevan et al., 2015). As such, it is an iterative process (e.g. Bevan et al., 2015; Libow Martinez & Stager, 2013) during which learners set goals, develop strategies, try to overcome problems, feel frustration, seek social scaffolding, strive to understand, experience turn-taking, and feel joy (Bevan et al., 2015). Furthermore, it is the process of interdisciplinary inquiry, as seen in play and complex scientific investigation. In STEAM education, this is achieved by using a wide palette of concepts, tools, and procedures.

Transdisciplinarity

If you look outside your window and see a road with some vehicles on it, what would you think about this phenomenon? Can we classify traffic as an engineering issue? Or would you think about the noise and pollution and consider it an ecological issue? Perhaps you would see it as a sociological issue because some vehicles are more expensive than others, indicating the different social statuses of their drivers. Or would you think of all of these aspects? Traffic, like any other phenomenon, cannot be confined to any single discipline. Disciplines are merely human interpretative frameworks trying to grasp the phenomena that surround us. In STEAM and the maker movement, engineers, artists, craftspersons, and scientists from diverse backgrounds collaborate. This fosters the development of new methodologies and approaches, rooted in their own disciplines but expanding into new territories where their fields intertwine. As Jensenius (2012) wrote, transdisciplinarity is a new point of departure, where borderless and discipline-free phenomena are addressed through joint efforts and different, but equally valuable, contributions. (*Figure 1*).

Figure 1. Continuum of disciplinarities (Jensenius, 2012; based on an original drawing by Zeigler, 1990)



This approach brings more justice to everyone involved and to the phenomenon in question as well. This kind of teaching and learning transcends subject divisions and embraces a collaborative, multidimensional approach, opening students' mindsets to more complex ways of approaching the world.

Real-Life Problems and Project-Based Learning

Advocating for schoolwork to be focused on real-life problems or some versions of problems professionals encounter is a common theme in a number of educational approaches, including progressivism and constructivism. This is also advised from the perspective of neuroscience findings, i.e. brain-based education (e.g. Woolfolk, 2021). Working on problems with real-life relevance provides an authentic context for learning (Libow Martinez & Stager, 2013) and increases intrinsic motivation (a well-documented effect in handbooks of educational psychology, e.g. Vizek-Vidović et al., 2005 and Woolfolk, 2021).

A natural context for solving real-life problems is project-based learning, as they share a multiperspective approach (and build multiperspective understanding), collaboration, and interdisciplinarity, among other qualities. There are no disciplinary bounds in life or professional work—at the very least, we have to cooperate with other professionals. Not surprisingly, one of the outcomes of project-based learning is the transfer of knowledge and skills between subjects (e.g. Šefer, 2005). The unity of real-life problems and project-based learning is highly valued in the maker movement; therefore, guidelines for project ideas and how projects should evolve are provided (Gabrielson, 2015; Libow Martinez & Stager, 2013): is the project personally meaningful? Does it prompt intrigue? Is it challenging but doable? Is sufficient time provided? Will the product be shareable?

Community of Learners

Building on the foundation of socio-constructivism, Barbara Rogoff is probably the best-known proponent of the idea of a community of learners "where everyone plays active and often asymmetrical roles in sociocultural activities" (Rogoff, 1994: 209). The maker movement (as a type of community) emphasizes the importance of creating within a community through principles of sharing and participation. Makers form communities of practice within makerspaces, where they jointly "develop, negotiate, and share" their conceptual understandings (Sheridan & Konopasky, 2016). Community improves learning in various ways. On a group level, it provides gains in resources when people share knowledge and skills, offer new perspectives, and enable collaborative problem-solving. On an individual level, it provides important feedback in the form of encouragement, creative suggestions, or constructive corrections. The formative role of social interaction does not end with the development of higher-order mental processes nor in the realm of cognition (although this was a focus of Vygotsky and his successors). By learning in a community, children develop social and communicational competencies—skills that are essential to workplace success regardless of the profession. Moreover, making and learning in a community may unfold online (even through asynchronous communication), but current insights support the coexistence of physical and online communities (e.g. Litts et al., 2016).

Playfulness

The principle of playfulness is central to both STEAM education and the maker movement. Makerspaces look a lot like playgrounds. Makerspaces are a sort of playground for the body and the mind (Myers-Spencer & Huss, 2013). To draw a parallel, in deprived environments, children usually learn to make their toys and reconstruct their living spaces into playgrounds. Their play is riskier, deeper, and even more creative than the play of children from more advantaged backgrounds and in more structured environments (Brown & Patte, 2013). If we compare this with classrooms, play should become a necessary principle of didactical choices for children of all ages, from toddlers to adolescents. Yes, it will look and sound messy and might seem hard to manage (Crawford-Berniskis, 2014), but play always has a purpose for a child, even if at times it may appear purposeless to teachers (Smidt, 2011). Playful (Marten, 2015) and provocative, unstructured spaces that encourage self-expression are invaluable learning resources and are exactly what makerspaces provide (Rosefeld, Halverson, & Sheridan, 2014). They could also be called spaces of creation (Plemmons, 2014). Flexibility is perhaps the most important quality of these spaces (Helfrich, 2014). This implies that teachers should be able to work and remain comfortable in chaotic situations (Crawford-Berniskis, 2014). Curiosity is nurtured, promoted, and invited in these spaces which motivate more questions than answers (Kurti et al. a, 2014: 9).

Metacognition and a hacking mindset

Makerspaces are sometimes called hackerspaces and are often funded as cooperatives of programmers and hackers (Crawford-Berniskis, 2014). But, in the maker movement hacking[1] is less of a tool or programming practice and more of a mindset (Martin, 2015) that could be applied to understanding learning, education, and society. Technology and specifically coding are very important aspects of the maker movement. Coding became one of the literacies of a new age. BBC, in a project "Make it digital"[2], equipped every child of age 7 across the UK with a pocket-sized codable computer with motion detection, a built-in compass. and Bluetooth technology. With children's programs for coding (Scratch, Codeable, etc.), and the gadgets like Little bits, Arduinos, and Raspberry pies making the craziest things is rather easy. What kind of learning is this? First, coding itself is a very *metacognitive action* and it requires a clear division of the steps of a process, the organization of an algorithm of wanted action, and many adjustments of these steps along the way (Weizenbaum, 1976). Second, it is a *holistic process of solving a problem,* from the discovery of what is needed to the discovery of how it can be resolved, it is a path of inventing (Piaget, 1973). The same logic is applied in steps described in STEAM: identify the problem, identify criteria and constraints, brainstorm possible solutions, generate ideas, explore possibilities, select and approach, build a model or prototype, refine the design or for less formal learning environments it is, and ask-imagine-plan-create-improve (Myers-Spencer & Huss, 2013:43).

Mistakes-Based Learning

Mistakes are extremely unwanted elements in the teaching/learning process; the entire education is based on avoiding mistakes and prescribing punishments for mistakes. This practice is unfortunately rooted in many theoretical insights from traditional psychology in which mistakes were considered an aspect of learning that corrupted knowledge and should be avoided (Ausubel, 1968; Bandura, 1986; Skinner, 1953). However, there is an important aspect of making mistakes that can lead a learning process towards more flexibility,

[1] Hacking: a usually creatively improvised solution to a computer hardware or programming problem or limitation; a clever tip or technique for doing or improving something (Merriam Webster online dictionary)

[2] http://www.bbc.co.uk/programmes/articles/4hVG2Br1W1LKCmw8nSm9WnQ/the-bbc-micro-bit

risk-taking, and depth. Mistakes are probably the very boundary stone (Serbian: *međa*) between knowing and not knowing. They act as indicators of what is not learned or is supposed to be learned in a school context. This is how teaching transforms into a hunt for mistakes, and teachers constantly tend to create a mistake-free environment. This environment has clear authorities, i.e. those who can point out the mistakes made by students—knowledge holders. These authorities are teachers, scientists, textbooks, and other instructional materials, and they rule classrooms, making the story about mistakes a story about power relations as well. What is considered a mistake, who defines those criteria, and who is allowed to make mistakes? These questions bring us to the dominant ideologies in the curricula and the consequent social control (Apple, 2004). On the other hand, the entire history of science is also a history of mistakes, as Popper points out (1962: 25):

> The history of science, like the history of all human ideas, is a history of irresponsible dreams, of obstinacy, and of error. But science is one of the very few human activities—perhaps the only one—in which errors are systematically criticized and fairly often, in time, corrected. This is why we can say that, in science, we often learn from our mistakes, and why we can speak clearly and sensibly about making progress there.

Based on mistakes, theories are proven or rejected, paradigms are shifted, and society transforms. Therefore, what if mistakes, and our way of dealing with them, are instead treated as a lack of knowledge (Prodanović & Krstić 2021) treated as proof of knowledge, flexible mindset, and creativity? Moreover, substantial research evidence shows that mistakes play a role in building confidence, critical thinking, and a flexible, risk-taking mindset (Dweck, 2008; Keith & Frese, 2008; Metcalfe, 2017). As making is what makes us human (Hatch, 2014), so are mistakes; their quality distinguishes us from machines, and the status they hold in a classroom is a very good indicator of classroom freedom. The Makers movement and STEAM are spheres where mistakes are unavoidable. In tinkering and making "failure is something that you just figure out how to work with" (Crawford-Berniskis, 2014: 13) and you will refer to it many times since it is a process *of learning by mistaking* (Martin, 2015). This principle suggests that one does not create and learn *against* mistakes but *with*, *on*, *around*, and *from* mistakes. It shows openness toward the uncertainty about where your learning is taking you. Let us promote learning as a slow and patient (Biesta, 2012), mistake-embracing, iterative journey that is concurrently open-ended and uncertain (Biesta, 2013; Todd, 2016).

CONCLUSIONS AND IMPLICATIONS

More than 13 makerspaces are built mostly in schools in Serbia[3] opening opportunities for bridging STEAM curricula and project-based learning with the Makers movement. These schools are tooled. However, how to make a makerspace a learning space? First, we have to understand our learners, connect the existing curricula and STEAM projects with the community, consider global trends and best practices, develop themes, and order equipment and materials (Kurti et al. b, 2014). Educational makerspaces are based on student ownership of their learning, and it is not necessary to be a technical expert to start a makerspace in your school or library (Kurti et al. a, 2014: 11). The only thing necessary is our orientation toward collaboration, sharing, problem-solving, learning by mistaking, playing, and being capable of seeing everything in a classroom as potential material.

Every educational reform, as a change of familiar routines, faces some similar obstacles. Here, we will outline risks and potential pitfalls that are relatively specific to the transition of the maker movement into formal education, i.e., schools and faculties. By explicating the nature and importance of learning that takes place in the process of creating, this paper aims to overcome one of the challenges for the implementation of the maker movement – the traditional divide between hands-on activities and "mental" educational activities, where the former are regarded as inferior. However, there is still a risk of pure tooling-up (or a risk of a "tool-centric" approach, see Martin, 2015) if teachers lack the competencies to manage the process, the sensitivity to utilize unplanned/unexpected learning opportunities, the skills to support learning in a group/community, the courage to explore something new and unstructured, and the integrity to reflect on the process and identify the needs for improvement. Furthermore, the purchase of high-tech devices should not be considered sufficient or necessary, thus preventing the misinterpretation of the maker movement as appropriate only for schools in wealthy societies. There is also a risk of distributing tools and opportunities for making (and learning) unevenly among students: for example, giving more to excellent students or delegating tasks and activities in line with gender biases. Finally, making and tinkering – similarly to project-based learning – are inconsistent with regular school schedules and might deteriorate in quality when traditional grading is applied (Libow Martinez & Stager, 2013). Although there are some solutions and recommendations (e.g., Libow Martinez & Stager, 2013; Šefer et al., 2012), this could be the point of the biggest transformation of the educational system.

[3] https://mejkerslab.rs/otvoreni-mejkers-labovi/

REFERENCES

Apple, M. W. (2004). *Ideology and Curriculum (3rd ed.)*, New York: Routledge. Available at: https://doi.org/10.4324/9780203487563

Ausubel D. P. (1968). *Educational Psychology: A Cognitive View.* New York: Holt, Rinehart & Winston.

Bandura A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bevan, B., Gutwill, J. P., Petrich, M., & Wilkinson, K. (2015). Learning through STEM-rich tinkering: Findings from a jointly negotiated research project taken up in practice, *Science Education*, 99(1), 98–120. Available at: https://doi.org/10.1002/sce.21151

Biesta, G. (2012) The Educational Significance of the Experience of Resistance: Schooling and the Dialogue between Child and World. *Other Education: The Journal of Educational Alternatives*, 62(1), 92–103.

Biesta, G. (2013). *The Beautiful Risk of Education*, New York: Routledge.

Blikstein, P. (2018). Maker Movement in Education: History and Prospects. In: de Vries, M. J. (ed.), *Handbook of Technology Education*, Cham: Springer International Publishing, 419–437. DOI: I 10.1007/978-3-319-44687-5_33.

Brown, F. & Patte, M. (2013). *Rethinking Children's Play,* Bloomsbury Publishing.

Crawford Barniskis, S. (2014). Makerspaces and Teaching Artistis. *Teaching Artist Journal.* 12 (1), 6-14.

Dewey, J. (1910). *How we think.* D.C. Heath & Co. Publishers.

Dryder, G., Vos, J. (1994). *Learning revolution*. Aylesbury: Accelerated Learning System Ltd.

Dweck, C. S. (2008). *Mindset.* Ballantine Books.

Gabrielson, C. (2015). *Tinkering: Kids learn by making stuff* (2nd ed.). Maker Media, Inc.

Henriksen, D. (2014). *Full STEAM ahead: Creativity in excellent STEM teaching practices*. The STEAM Journal, 1(2), Article 15. https://doi.org/10.5642/steam.20140102.15

Hatch, M. (2014). *The Maker Movement Manifesto: Rules for Innovation in the New World of Crafters, Hackers, and Tinkerers.* McGraw-Hill Education.

Helfrich, J. (2014). Creative Spaces: Flexibile Environments for the 21st- Century Learner. *Knowledge Quest.* 42 (5), 76–78

Ivić, I., Pešikan, A., & Antić, S. (2003). *Aktivno učenje 2*, Beograd: Institut za psihologiju, Filozofski fakultet.

Jensenius, A. R. (2012). *Disciplines: intra, cross, multi, inter, trans*. Available at: http://www.arj.no/2012/03/12/disciplinarities-2/

Keith, N., & Frese, M. (2008). Effectiveness of error management training: a meta-analysis. *Journal of applied psychology*, 93(1), 59.

Kurti, R. S., Kurti, D. L., & Fleming, L. a. (2014). The Philosophy of Educational Makerspaces. *Teacher Librarian: The Journal for School Library Professionals,* 41(5), 8–11.

Kurti, R. S., Kurti, D. L., & Fleming, L. b. (2014). Practical implementation of an educational Makerspace. *Teacher Librarian: The Journal for School Library Professionals,* 42 (2), 20–24.

Libow Martinez, S. & Stager, G. (2013). *Invent To Learn: Making, Tinkering, and Engineering in the Classroom*. Constructing Modern Knowledge Press.

Litts, B. K., Rosenfeld Halverson, E. & Bakker, M. (2016). The role of online communication in a maker community. In: Peppler, K., Rosenfeld Halverson, E., & Kafai, Y. B. (eds), *Makeology: Makerspaces as learning environments*, 1, New York: Taylor & Francis, 190–204.

Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research*, 5(1), 30–39. Available at: https://doi.org/10.7771/2157-9288.1099

McLaren, P. & Farahmandpur, R. (2005). *Teaching Against Global Capitalism and the New Imperialism. A Critical Pedagogy*, Lanham: Rowman & Littlefiel Publishers.

Metcalfe, J. (2017). Learning from Errors. *Annual Review Of Psychology*, 68: 465–489. Available at: https://doi.org/10.1146/annurev-psych-010416-044022

Myers-Spencer, R. & Huss, J. (2013). Playgrounds for the Mind. *Children and Libraries: The Journal of the Association for Library Service to children,* 11(3), 41–46.

OECD (2013), *Trends Shaping Education,* Paris: OECD Publishing. Available at: http://dx.doi.org/10.1787/trends_edu-2013-en

Pešikan, A. (2020). *Učenje u obrazovnom kontekstu*, Beograd: Službeni glasnik.

Piaget, J. (1973). *To understand is to invent: The future of education*, New York: Grossman Publishers.

Plemmons, A. (2014). Building a Culture of Creation. *Teacher Librarian: The Journal for School Library Professionals,* 41 (5), 12–16.

Popper, K. R. (1962). *Conjectures and Refutations: The Growth of Scientific Knowledge*, London, England: Routledge.

Prodanović, S. & Krstić, P. (2021). *O čemu govorimo kada govorimo o neznanju: pohvala* grešci, Beograd: Institut za filozofiju i društvenu teoriju.

Reeve, J. (2009). *Understanding motivation and emotion* (5^{th} ed.), Hoboken, USA: John Willey & Sons.

Rogoff, B. (1994). Developing understanding of the idea of communities of learners. *Mind, Culture, and Activity*, 1(4), 209–229.

Rosenfeld Halverson, E., Sheridan, K. M. (2014). The Maker Movement in Education. *Harvard Education Review*, 84(4), 495–504.

Sengupta, P., Shanahan, M.-C., & Kim, B. (eds.). (2019). *Advances in STEM education: Critical, transdisciplinary, and embodied approaches in STEM education*, New York and London: Springer International Publishing. Available at: https://doi.org/10.1007/978-3-030-29489-2

Smidt, S. (2011). *Playing to Learn: The Role of Play in the Early Years*, New York: Routledge.

Sheridan, K. M., & Konopasky, A. (2016). Designing for resourcefulness in a community-based makerspace. In: Peppler, K., Rosenfeld Halverson, E., & Kafai, Y. B. (eds.), *Makeology: Makerspaces as learning environments*, 1, New York: Taylor & Francis: 223–236.

Skinner B. F. (1953). *Science and Human Behavior,* New York: MacMillan.

Šefer, J. (2005). *Kreativne aktivnosti u tematskoj nastavi*, Beograd: Institut za pedagoška istraživanja.

Šefer, J., Angelovski, N., & Milošević, Z. (2012). *Kreativna nastava u praksi: Igra i* istraživanje, Beograd: Institut za pedagoška istraživanja.

Triling, B., & Fadel, C. (2009). *21st Century Skills Learning for life in our times,* San Francisco: Jossey-Bass.

Todd, S. (2016). Facing uncertainty in education: Beyond the harmonies of Eurovision education. *European Educational Research Journal*, 5(6), 619–627.

Vizek Vidović, V., Vlahović-Štetić, V., Rijavec, M., & Miljković, D. (2014). *Psihologija obrazovanja* (srpsko izdanje), Beograd: Klet.

Weizenbaum, J. (1976). *Computer Power and Human Reason: From Judgment to Calculation*, San Francisco: W. H. Freeman.

Williams, J. M. (2023). *Making changes in STEM education: The change maker's toolkit*. CRC Press. https://doi.org/10.1201/9781003319912

Woolfolk, A. (2021). *Educational psychology* (14th ed.), Needham Heights: Pearson Education Limited.