Attitudes of Students, Future Educators Towards Creativity in Relation to the Development of Algorithmic Thinking Skills

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Abstract The greatest contribution of the educator in the child's life is the way he/she encourages the child in various areas of development, including creativity. Depending on the educator's self-assessment, this can have an impact on children's creative abilities, but in much more open-ended scenarios, it can also have an impact on the development of algorithmic thinking skills in children. By participating in the Algolittle project, we focused on the beginning of the professional lives of future educators, in their final year of study, to show them that encourage and development of algorithmic thinking in children from an early age contributes to the development of all other domains. The scope of the research in this paper includes the self-assessments of students, future educators toward creativity related to the development of algorithmic thinking skills, although the project itself covers a much broader area.

Keywords: creativity, algorithmic thinking skills, early childhood education, educators

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1 Introduction

The use of technology in all sectors, particularly in education, requires teachers with certain digital competencies in order to use the teaching technology and make the learning process more interesting to students. For contemporary teachers they are substantial, including educators in early childhood education institutions, as teamwork and professional learning communities in educational institutions provide a venue for research, information sharing, teamwork, connection of different findings, and application of knowledge and skills for and among children and adults. Self-assesment help students judge their own abilities and performance, and become self-regulated learners. Creativity is considered desirable in education, especially within teachers at all levels of education. In early childhood education in Croatia, it is one of the fondation values and it represents all-time skill. There is also one skill considered to be important for present and for the future, skill that helps decompose problems in smaller, solveble steps, algotithmic thinking skills. In this paper, we are presenting correlations in self-assesments of creativity and algorithmic thinking among undergraduate students of Early and Childhood Education (ECE) at University of Rijeka, as integral part of Erasmus+ project "Algorithmic thinking skills through learning through play for the programming literacy of future generations"- Algolittle.

2 Creativity

By engaging children in learning through group work, problem-based learning can create a stimulating environment for preschoolers to develop their inquiry creativity. But in a further step, one can examine creativity in these processes. Creative thinkers are active learners who are able to find and solve problems, recognize patterns, find and use information in other ways, challenge, make decisions, and search for new ideas (Healy, 2004). First of all, creativity is important in the Croatian preschool system, it is one of the six values included in the National Curriculum for Early and Preschool Education (MZO, 2014). The greatest contribution of creativity is understanding and promoting the benefits of divergent opinions.

The basic values of the National Curriculum for Early and Preschool Education derive from the commitment of the Croatian educational policy to the complete personal development of the child, to the preservation and development of the national, spiritual, material and natural heritage of the Republic of Croatia, to European coexistence and to the creation of a society of knowledge and values that enable progress and sustainable development. Creativity as a core value represents the basis for the child's development into an initiative and innovative person, capable of recognizing, initiating and shaping various creative activities and finding original approaches to solving different problems. This value relies on the acceptance of the child's natural creativity, which should be encouraged, stimulated and developed in various ways during the educational process in order to express and create. The kindergarten provides a variety of opportunities for the child to express and creatively process his or her own ideas, perceptions and experiences. Play as a teaching method not only stimulates the brain to think creatively, but also provides young children with countless opportunities to learn through constructivism (Wojciehowski & Ernst 2018). Creative thinking is necessary to develop, improve, communicate, and implement ideas as well as be open to new perspectives, express originality, understand the limitations of the real world, and see failure as a new opportunity (Greenhill, 2015). These are the basic skills on which young children learn and which should be developed from early childhood. To respond to today's challenges, educators should also be creative in developing activities that encourage children to solve problems with creative ideas. In designing the educational process, the development of the child's divergent thinking is especially valued in all types of activities, learning areas, and communication. Different cognitive-symbolic expressions of the child are understood as a tool for a better understanding of the child and as an integral part of the whole educational process in kindergarten (MZO, 2014, p.10).

3 Algorithmic thinking

Algorithmic thinking is a way of solving problems using a series of steps that lead to the goal of solving the problem. It defines an approach that can be used to develop problem-solving skills. The term algorithmic thinking was first used in the 2006 article "Computational Thinking" by Jeannette M. Wing. The author interprets that algorithmic thinking "involves solving problems, designing systems, and

understanding human behavior, relying on concepts that are fundamental to computers" (Wing, 2006, p. 33).

According to Shelton (2016), the development of algorithmic thinking in young children does not necessarily require the use of a computer, but can also be achieved with "unplugged" methods. These non-computer methods are not an alternative to computer-based problem-solving methods, but are used as an additional activity in understanding and solving problems. Educators/teachers take on the role of guiding the child in the problem-solving process to help them find a solution, as Vujičić, Jančec & Mezak (2021) describe with more details connected to algorithmic thinking. Algorithmic thinking is closely related to problems and their solutions. Each new problem expects a solution, which can be achieved by decomposing the problem and finding a logical sequence of steps to solve it.

Learning through play or Play Based Learning as a learning strategy is very useful for young children, since play are the main source of children's interest in preschool. Fun and active participation in play effectively contribute to preschoolers' learning process, but in all of this, it is important to encourage creativity and not leave it out. Resnick (2017) describes the concept of creative thinking as a new way of solving problems, especially problems related to daily life. Creative thinking understood in this way relies entirely on algorithmic thinking because it offers a different perspective on the problem-solving process.

All of these insights were incorporated into the curriculum of the elective course designed as part of the Algolittle project (Jančec and Vujičić, 2021) for the study of Early and Preschool Education. The goal of the subject curriculum was to enhance the knowledge and skills of students in their final year of undergraduate study in early and preschool education so that they could connect them to the algorithmic thinking skills they would use in their approach to teaching children trough play-based learning.

4 Methodology

The piloting process of the Algolittle course at the Faculty of Teacher Education, University of Rijeka was carried out from February 28th 2022 to June 10th 2022 in the third year of the study of Early and Preschool Education (full-time study).

Classes were organised according to the "flipped classroom" model. Students used a hybrid learning model with interactive materials and additional learning materials prepared by the professor and provided on a learning platform. Students had some additional tasks in the form of designing activity plans to integrate algorithmic thinking into different ECE development areas.

4.1 Measuring instruments and a sample of respondents

Thirty-two students of the last year of study of early and preschool education participated in the survey. All students were female. The age of the students ranged from 20 to 24. Most of them, i.e. 20 (60.6%), were 21 years old, two were 20, eight were 22 and three students were 24 years old.

Data were collected using an online pre- and post-education questionnaire to analyse differences in students' attitudes and acquired knowledge. Informed consent was obtained from students for data collection, analysis, and reporting. The questionnaire consisted of a total of 6 parts:

- Computational thinking - Problem Solving;
- Creativity;
- Teamwork;
- Algolittle questionnaire;
- Motivation to teach;
- Engagement versus disaffection with learning.

For the purposes of this article, questionnaire was used to determine students' self-assesment in creativity in relation to algorithmic thinking skills. These parts are Creativity and Algolittle questionnaire.

To measure creativity, the validated Short Scale of Creative Self - SSCS instrument (Karwowski, 2011) was used, which can be considered as two scales: measuring creative self-efficacy and creative personal identity or as a single scale with 11 items assessing personal creativity. For the purpose of this paper, the Creative Self-Concept scale was evaluated as single scale by averaging all 11 items:

(1) I think I am a creative person.

(2) My creativity is important for who I am.
(3) I know I can efficiently solve even complicated problems.
(4) I trust my creative abilities.
(5) My imagination and ingenuity distinguishes me from my friends.
(6) Many times I have proved that I can cope with difficult situations.
(7) Being a creative person is important to me.
(8) I am sure I can deal with problems requiring creative thinking.
(9) I am good at proposing original solutions to problems.
(10) Creativity is an important part of myself.
(11) Ingenuity is a characteristic that is important to me.

All items were offered with 5 responses on a Likert-type scale (1- Definitely not, 2- Somewhat not, 3- Neither yes or no, 4- Somewhat yes, 5- Definitely yes). The instrument had very good reliability, as the Cronbach's alpha value was 0,88.

To help students assess their knowledge of algorithmic thinking skills for the needs of the project, the Algolittle project partners developed a measurement tool in the form of a questionnaire containing 10 items:

(1) I can explain algorithmic thinking and its features.
(2) I know the types and characteristics of algorithmic thinking.
(3) I can give examples of algorithmic thinking in daily life.
(4) I can explain the benefits of algorithmic thinking skills in early childhood.
(5) I can develop appropriate methods and strategies to teach algorithmic thinking skills.
(6) I know what coding tools are used to develop algorithmic thinking skills in early childhood education.
(7) I know how to benefit from algorithmic thinking in different learning areas of early childhood education.
(8) I can create algorithmic thinking activities in different learning areas of early childhood education.
(9) I believe that developing algorithmic thinking skills is important for teacher candidates.
(10) I have knowledge about play-based learning.

This questionnaire also offered 5 responses on a Likert-type scale to assess knowledge by 10 statements includes (1- no knowledge, 2 – sufficient knowledge, 3 – good knowledge, 4 – very good knowledge, 5 – excellent knowledge). The instrument had excellent reliability, as the Cronbach's alpha value in final questionnaire was 0,93.

4.2 Results and discussion

SPSS Statistics was used for data analysis. First, reliability was calculated separately for each scale, followed by descriptive statistics for individual scales and correlations between scales.

Table 1: Descripive stastistic of Short Scale of Creative Self – SSCS

	N	M	SD
I think I am a creative person.	32	4,03	0,74
My creativity is important for who I am.	32	4,38	0,61
I know I can efficiently solve even complicated problems.	32	4,25	0,57
I trust my creative abilities.	32	4,09	0,73
My imagination and ingenuity distinguishes me from my friends.	32	3,47	1,08
Many times I have proved that I can cope with difficult situations.	32	4,34	0,65
Being a creative person is important to me.	32	4,28	0,81
I am sure I can deal with problems requiring creative thinking.	32	4,19	0,59
I am good at proposing original solutions to problems.	32	3,84	0,81
Creativity is an important part of myself.	32	4,06	0,88
Ingenuity is a characteristic that is important to me.	32	4,34	0,65

The overall average result of the students' self-assessment of creativity considering all statements is 4.12. The lowest average value of 3.47 was recorded for the fifth question (*My imagination and ingenuity distinguishes me from my friends*), while the highest value of 4.38 was recorded for the second question (*My creativity is important for who I am*).

The results of the students' self-assessment on knowledge of algorithmic thinking skills after the eduction show very high scores for all questions of the questionnaire. The only average response value below 4 was recorded for the sixth question (*I know what coding tools are used to develop algorithmic thinking skills in early childhood education*), which is understandable since coding was the least represented in education. The

average overall student self-assessment result for knowledge of algorithmic thinking after education is 4.33, which we are very pleased with.

Table 2: Descripive stastistic of Algolittle questionnaire

	N	M	SD
I can explain algorithmic thinking and its features.	32	4,19	0,64
I know the types and characteristics of algorithmic thinking.	32	4,25	0,67
I can give examples of algorithmic thinking in daily life.	32	4,56	0,56
I can explain the benefits of algorithmic thinking skills in early childhood.	32	4,28	0,68
I can develop appropriate methods and strategies to teach algorithmic thinking skills.	32	4,09	0,69
I know what coding tools are used to develop algorithmic thinking skills in early childhood education.	32	3,84	0,85
I know how to benefit from algorithmic thinking in different learning areas of early childhood education.	32	4,41	0,61
I can create algorithmic thinking activities in different learning areas of early childhood education.	32	4,44	0,62
I believe that developing algorithmic thinking skills is important for teacher candidates.	32	4,59	0,61
I have knowledge about play-based learning.	32	4,69	0,54

To further determine the relationship between algorithmic thinking skills and creativity, we analyzed the correlations of the individual items in these questionnaires.

Table 5 showes the results of the correlations between the individual items of the Creative Self Questionnaire and the Algorithmic Thinking Questionnaire. All items of the Algorithmic Thinking questionnaire have at least one statistically significant correlation with one of the items of the Creative Self questionnaire and the correlations are predominantly positive.

The highest correlation is seen in statement five *I can develop appropriate methods and strategies to teach algorithmic thinking skills*, with statement *Ingenuity is a characteristic that is important to me* (r=,500, p<0,01), and positively but low in statistical significance correlated with statements *I know I can efficiently solve even complicated problems* (r=,350, p<0,05), *I am sure I can deal with problems requiring creative thinking* (r=,351, p<0,05) and *Creativity is an important part of myself* (r=,363, p<0,05).

The first item *I can explain algorithmic thinking and its features* shows a strong correlation with *Creativity is an important part of myself* (r=,492, p<0,01) and positive but low in statistical significance with *Ingenuity is a characteristic that is important to me* (r=,378, p<0,05) and *I am sure I can deal with problems requiring creative thinking* (r=,412, p<0,05).

Table 4: Correlations between estimated Creativity and Algorithmic thinking skills

Algorithmic thinking skills / Creative Self - SSCS	I can explain algorithmic thinking and its features.	I know the types and characteristics of algorithmic thinking.	I can give examples of algorithmic thinking in daily life.	I can explain the benefits of algorithmic thinking skills in early childhood.	I can develop appropriate methods and strategies to teach algorithmic thinking skills	I know what coding tools are used to develop algorithmic thinking skills in ECE.	I know how to benefit from algorithmic thinking in different learning areas of ECE.	I can create algorithmic thinking activities in different learning areas of ECE.	I believe that developing algorithmic thinking skills is important for teacher candidates.	I have knowledge about play-based learning.
I think I am a creative person.	,258	,308	,111	,237	,310	,266	,326	,321	,100	,188
My creativity is important for who I am.	,308	,236	,023	,204	,298	,180	,355	,321	,075	,173
I know I can efficiently solve even complicated problems.	,220	,169	,151	,229	,350*	,017	,346	,321	,208	,159
I trust my creative abilities.	,234	,343	,102	,332	,301	,284	,342	,333	,159	,241
My imagination and ingenuity distinguish me from my friends.	-,084	-,167	-,023	-,097	-,061	,012	-,005	,021	-,044	,038
Many times, I have proved that I can cope with difficult situations.	-,081	,092	-,016	,138	,213	,275	,043	,015	,038	,225
Being a creative person is important to me.	,266	,103	,136	,202	,239	,160	,151	,196	,042	,209
I am sure I can deal with problems requiring creative thinking.	,412*	,446*	,253	,424*	,351*	,189	,316	,297	,305	,394*
I am good at proposing original solutions to problems.	,182	,253	,058	,199	,317	,293	,132	,141	,063	,182
Creativity is an important part of myself.	,492**	,520**	,252	,400*	,363*	,448**	,430*	,483**	,168	,249
Ingenuity is a characteristic that is important to me.	,378*	,386*	,421*	,427*	,500**	,392*	,364*	,414*	,359*	,502**

Item *I know the types and characteristics of algorithmic thinking* shows the same positive statisticals significant correlations with the same items of Creative Self questionnaire. Strong correlation is seen with item *Creativity is an important part of myself* (r=,520, p<0,01) and positive but low in statistical significanceone with other two statemens *Ingenuity is a characteristic that is important to me* (r=,386, p<0,05) and *I am sure I can deal with problems requiring creative thinking* (r=,446, p<0,05).

Item *I can explain the benefits of algorithmic thinking skills in early childhood* has positive but low in statistical significance correlations with items *I am sure I can deal with problems requiring creative thinking* (r=,424, p<0,05), *Creativity is an important part of myself* (r=,400, p<0,05) and *Ingenuity is a characteristic that is important to me* (r=,427, p<0,05).

Seventh statement *I know how to benefit from algorithmic thinking in different learning areas of ECE* has positive but low in statistical significance correlation *Creativity is an important part of myself* (r=,430, p<0,05) and *Ingenuity is a characteristic that is important to me* (r=,364, p<0,05).

I know what coding tools are used to develop algorithmic thinking skills in ECE is strongly statistical significant correlated with *Creativity is an important part of myself* and with *Ingenuity is a characteristic that is important to me* (r=,448, p<0,01) and positivly but low in statistical significance correlated with *Ingenuity is a characteristic that is important to me* (r=,392, p<0,05).

I can create algorithmic thinking activities in different learning areas of ECE is also statistical significant correlated with *Creativity is an important part of myself* and *Ingenuity is a characteristic that is important to me* (r=,483, p<0,01) and low in statistical significance but still positivly correlated with *Ingenuity is a characteristic that is important to me* (r=,414, p<0,05).

Item *Ingenuity is a characteristic that is important to me* is low in statistical significance but positive correlated with *I can give examples of algorithmic thinking in daily life* (r=,421, p<0,05) and *I believe that developing algorithmic thinking skills is important for teacher candidates* (r=,359, p<0,05).

There is one more item which shows statistical significance, it is low but in positive correlation, *I have knowledge about play-based learning* with next two items:

I am sure I can deal with problems requiring creative thinking (r=,394, p<0,05) and with *Ingenuity is a characteristic that is important to me* (r=,502, p<0,01).

Finally, *I have knowledge about play-based learning* has strong connection with *Ingenuity is a characteristic that is important to me* (r=,502, p<0,01) and positive but low in statistical significance with *I am sure I can deal with problems requiring creative thinking* (r=,394, p<0,05)

5 Conclusion

Future educators develop many skills and competences during their studies with the aim of a holistic approach to the education of preschool children. In their future work, they should use various methods and strategies to successfully guide children through research and cognitive, language and communication, and socio-emotional development, as well as to promote the development of practical life and motor skills and creativity. Algorithmic thinking skills, that we tried to develop in the Algolittle project through the design of an elective course and apply in our work with our students, can be integrated in all of these activities. With this research, we wanted to find out how our students experienced this, what their attitudes were after their education, and to what extent they saw the correlation between creativity and algorithmic thinking.

According to their responses, there is a strong correlation between algorithmic thinking and creativity, 24 statistically significant correlation. All items in the Algorithmic thinking questionnaire are correlated with at least one item in the SSCS creative self questionnaire. In the SSCS questionnaire, the last item, *Ingenuity is a characteristic that is important to me* is particularly noteworthy, showing a statistically significant correlation with all ten items of the Algorithmic thinking questionnaire. Items *Creativity is an important part of myself* and *I am sure I can deal with problems requiring creative thinking* of the SSCS questionnaire are also significantly related to more than half of the statements in the Algorithmic thinking questionnaire.

Several conclusions can be drawn from the research findings: our students, future educators, are aware of the importance of a holistic approach to teaching preschool children and point to the connection between creativity and algorithmic thinking skills in problem solving. They consider themselves creative and believe that developing algorithmic thinking skills is important for them. Their professional development should include topics on developing these skills for both themselves and the children they will teach.

Further research could explore the possibilities of developing a lifelong learning program and supporting educators in practice who would improve their work by developing the competencies mentioned above.

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References

Ball, D.I., Forzani, F. (2009), The work of teaching and the challenge for teacher education, Journal of Teacher Education, 60 (5), 497-511.

Clewlow, R. R. (2016). Carsharing and sustainable travel behavior: Results from the San Francisco Bay Area. *Transport Policy, 51*, 158-164. doi:10.1016/j.tranpol.2016.01.013

Cramond, B. (2002). The study of creativity in the future. In Aleinikov AG. (Ed.) *The Future of creativity*. Bensenville, IL: Scholastic Testing Service, pp. 83-89.

Greenhill, V. (2010). 21st Century Knowledge and Skills in Educator Preparation. The Partnership for 21st Century Learning. http://eric.ed.gov/?id=ED519336

Healy, J. M. (2004). Your Child's Growing Mind: Brain Development and Learning from Birth to Adolescence (3rd ed.). New York, NY: Broadway Books.

Jančec, L., & Vujičić, L. (2021). Project "Algorithmic Thinking Skills through Play-Based Learning for Future's Code Literates". In 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO) (pp. 641-644). IEEE.

Karwowski, M. (2011). Short Scale of Creative Self.

Mezak, J. (2022). Definiranje sadržaja kolegija za obrazovanje odgajatelja – integracija vještina algoritamskog razmišljanja. *Odgojno-obrazovne teme*, 5 (1), 199-224. doi.org/10.53577/oot.5.1.10

Mezak, J., Pejić Papak, P. (2019, May). Problem based learning for primary school junior grade students using digital tools. In 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO) (pp. 697-702). IEEE.

Ministarstvo znanosti, obrazovanja i sporta, MZO (2014). The National Curriculum for Early and Preschool Education. http://www.azoo.hr/images/strucni2015/Nacionalnikurikulum-za-rani-i-predskolski-odgoj-i-obrazovanje.pdf

Previšić, V. (2005), Kurikulum suvremenog odgoja i škole: Metodologija i struktura, Pedagogijska istraživanja, 2, 2, 165–175.

Resnick, M. (2017). Lifelong Kindergarten. Cultivating Creativity through Project, Passion, Peers and Play. The MIT Press.

Schelfhout, W., Dochy, F., Janssens, S., Struyven, K., Gielen, S., Sierens, E. (2006), Educating for Learning-Focused Teaching in Teacher Training: The Need to Link Learning Content with Practice Experiences within an Inductive Approach, Teaching and Teacher Education, 22, 7, 874–897.

Sekulić-Majurec, A. (2005), Kurikulum nove škole – istraživački izazov školskim pedagozima", Pedagogijska istraživanja, 2, 2., 267–279.

Shelton, C. (Spring 2016). Time to plug back in. The role of "unplugged" computing in primary schools. ITTE Newsletter.

Tsai, M.-J., Liang, J.-C., & Hsu, C.-Y. (2021). The Computational Thinking Scale for Computer Literacy Education. Journal of Educational Computing Research, 59(4), 579–602. https://doi.org/10.1177/0735633120972356

Vujičić, L., Jančec, L., & Mezak, J. (2021). Development of Algorithmic Thinking Skills in Early and Preschool Education, In: L. Gómez Chova; A. López Martínez; I. Candel Torres (Eds.).EDULEARN20 Proceedings - 13th International Conference on Education and New Learning Technologies, July 5th-6th, 2021, Valencia, Spain, (pp. 8152-8161) doi:10.21125/edulearn.2021.1650

Wing, J. M. (2006). Computational thinking. Communications of the ACM, 49(3), 33-35. http://denninginstitute.com/pjd/GP/Wing06.pdf

Wojciehowski, M., Ernst, J. (2018). Creative by Nature: Investigating the Impact of Nature Preschools on Young Children's Creative Thinking. International Journal of Early Childhood Environmental Education, 6(1), 3-20. http://files.eric.ed.gov/fulltext/EJ1193490.pdf