

S/N	Authors	Article Title	Source Title	Publication Year	Explicitness (Conceptual, Operational)	Written or Inferred (Conceptual, Operational)	Conceptual Nature	Operational Nature	Operational Level
1	Allsop Y.	Assessing computational thinking process using a multiple evaluation approach	International Journal of Child-Computer	2019	Implicit	Inferred		none	program
2	Altanis, I; Retalis, S; Petropoulou, O	Systematic Design and Rapid Development of Motion-Based Touchless Games for Enhancing Students' Thinking Skills	EDUCATION SCIENCES	2018	Implicit	Inferred		none	program
3	Angeli C., Xerou E., Nicolaou M.	Investigating K-2 students' computational thinking skills during a problem-solving activity about the water cycle using educational robotics	16th International Conference on Cognition and Exploratory Learning	2019	Implicit	written	decomposition		
4	Angeli, C; Valanides, N	Developing young children's computational thinking with educational robotics: An interaction effect between gender and scaffolding strategy	COMPUTERS IN HUMAN BEHAVIOR	2020	Implicit	written	decomposition		
5	Asbell-Clarke, J; Rowe, E; Almeda, V; Edwards, T; Bardar, E; Gasca, S; Baker, RS; Scruggs, R	The development of students' computational thinking practices in elementary- and middle-school classes using the learning game, Zoombinis	COMPUTERS IN HUMAN BEHAVIOR	2021	Explicit, Explicit	written, written	both	not clear	problem
6	Ata, R; Cevik, M	Understanding predictor effects of computational thinking skills and media and technology use and attitudes of pre-service teachers for STEM awareness	KEDI JOURNAL OF EDUCATIONAL POLICY	2020	Implicit	written	decomposition		
7	Atmatzidou, S; Demetriadis, S	Advancing students' computational thinking skills through educational robotics: A study on age and gender relevant differences	ROBOTICS AND AUTONOMOUS SYSTEMS	2016	Implicit, implicit	Written, inferred	decomposition	generalization	program
8	Avcu, Yunus Emre; Er, Kemal Oguz	Developing an Instructional Design for the Field of ICT and Software for Gifted and Talented Students	International Journal of Educational	2020	Implicit	Inferred		decomposition	none
9	Baek, Youngkyun; Wang, Sasha; Yang, Dazhi; Ching, Yu-Hui; Swanson, Steve;	Revisiting Second Graders' Robotics with an Understand/Use-Modify-Create (U <sup>2</sup> MC) Strategy	European Journal of STEM Education	2019	Implicit, implicit	Written, inferred	decomposition	both	problem
10	Basu S., McElhaney K.W., Grover S., Harris C.J., Biswas G.	A principled approach to designing assessments that integrate science and computational thinking	Proceedings of International Conference of the Learning	2018	Implicit	Inferred	generalization		
11	Basu, S; Rutstein, DW; Xu, YN; Wang, HW; Shear, L	A principled approach to designing computational thinking concepts and practices assessments for upper elementary grades	COMPUTER SCIENCE EDUCATION	2021	Implicit, implicit	Written, inferred	both	decomposition	problem
12	Beason K., Fenwick J.B., Norris C.	Introducing middle school students to computational thinking with the CS first curriculum	ACMSE 2020 - Proceedings of the 2020	2020	Implicit	Inferred		none	program
13	Cachero, C; Barra, P; Melia, S; Lopez, O	Impact of Programming Exposure on the Development of Computational Thinking Capabilities: An Empirical Study	IEEE ACCESS	2020	Implicit	Written	generalization		
14	Calderon, AC; Skillicorn, D; Watt, A; Perham, N	A double dissociative study into the effectiveness of computational thinking	EDUCATION AND INFORMATION	2020	Implicit, implicit	Inferred, inferred	both	both	problem
15	Chen, KZ; Chi, HH	Novice young board-game players' experience about computational thinking	INTERACTIVE LEARNING		Implicit	Written	decomposition		

16	Chiazzese, G; Arrigo, M; Chifari, A; Lonati, V; Tosto, C	Exploring the Effect of a Robotics Laboratory on Computational Thinking Skills in Primary School Children Using the Bebras Tasks	SIXTH INTERNATIONAL CONFERENCE ON TECHNOLOGICAL INFORMATICS-BASEL	2018	Implicit	Inferred		both	problem
17	Chiazzese, G; Arrigo, M; Chifari, A; Lonati, V; Tosto, C	Educational Robotics in Primary School: Measuring the Development of Computational Thinking Skills with the Bebras Tasks		2019	Implicit	Inferred		both	problem
18	Choi, J; Lee, Y; Lee, E	Puzzle Based Algorithm Learning for Cultivating Computational Thinking	WIRELESS PERSONAL COMMUNICATIONS	2017	Explicit	written	none	not assessed	not assessed
19	Çınar M., Tüzün H.	Comparison of object-oriented and robot programming activities: The effects of programming modality on student achievement, abstraction, problem solving, and motivation	Journal of Computer Assisted Learning	2020	Implicit, implicit	Written, inferred	both	both	none
20	Citta, G; Gentile, M; Allegra, M; Arrigo, M; Conti, D; Ottaviano, S; Reale, F; Sciortino, M	The effects of mental rotation on computational thinking	COMPUTERS & EDUCATION	2019	Explicit, implicit	Written, inferred	decomposition	not clear	problem
21	Corral L., Fronza I.	A strategy for assessing the acquisition of computational thinking competences: A software engineering approach	CEUR Workshop Proceedings	2019	Implicit, implicit	Written, inferred	decomposition	none	program
22	del Olmo-Munoz, J; Cozar-Gutierrez, R; Gonzalez-Calero, JA	Computational thinking through unplugged activities in early years of Primary Education	COMPUTERS & EDUCATION	2020	Implicit	Inferred		both	problem
23	del Rey, YAR; Cambinda, INC; Deco, C; Bender, C; Avello-Martinez, R; Villalba-Delal, H; Oner, D	Developing computational thinking with a module of solved problems	COMPUTER APPLICATIONS IN ENGINEERING EDUCATION		Explicit, implicit	Written, inferred	<i>decomposition</i>	not clear	not clear
24	Delal, H; Oner, D	Developing Middle School Students' Computational Thinking Skills Using Unplugged Computing Activities	INFORMATICS IN EDUCATION	2020	Implicit	Inferred		both	problem
25	Deng, WB; Pi, ZL; Lei, WN; Zhou, QG; Zhang,	Pencil Code improves learners' computational thinking and computer learning attitude	COMPUTER APPLICATIONS IN	2020	Explicit	written	none	not assessed	not assessed
26	Dolgopolas, V; Jevsikova, T; Dagiene, V; Savulioniene, L	Exploration of Computational Thinking of Software Engineering Novice Students Based on Solving Computer Science Tasks	INTERNATIONAL JOURNAL OF ENGINEERING	2016	Implicit	Inferred		both	problem
27	Febrian A., Lawanto O., Peterson-Rucker K., Melvin A., Guymon S.E.	Does everyone use computational thinking?: A case study of art and computer science majors	ASEE Annual Conference and Exposition, Conference	2018	Implicit, implicit	Written, inferred	decomposition	none	problem
28	Fronza, I; El Ioini, N; Corral, L	Teaching Computational Thinking Using Agile Software Engineering Methods: A Framework for Middle Schools	ACM TRANSACTIONS ON COMPUTING	2017	Implicit	Inferred		none	program
29	Garneli, V; Chorianopoulos, K	Programming video games and simulations in science education: exploring computational thinking through code analysis	INTERACTIVE LEARNING ENVIRONMENTS	2018	Implicit	Inferred		none	program
30	Garneli, V; Chorianopoulos, K	The effects of video game making within science content on student computational thinking skills and performance	INTERACTIVE TECHNOLOGY AND	2019	Implicit	Inferred		none	program

31	Gillott, Lauren; Joyce-Gibbons, Andrew; Hidson, Elizabeth	Exploring and Comparing Computational Thinking Skills in Students Who Take GCSE Computer Science and Those Who Do Not	International Journal of Computer Science Education in Schools	2020	Implicit	Inferred		none	program
32	Grover, S; Pea, R; Cooper, S	Designing for deeper learning in a blended computer science course for middle school students	COMPUTER SCIENCE EDUCATION	2015	Implicit	Inferred	none		
33	Guggemos J., Seufert S., Román-González M.	Measuring computational thinking - Adapting a performance test and a self-assessment instrument for German-speaking countries	16th International Conference on Cognition and Exploratory Learning	2019	Implicit	written	generalization		
34	Hava, K; Unlu, ZK	Investigation of the Relationship Between Middle School Students' Computational Thinking Skills and their STEM Career Interest and Attitudes Toward Inquiry	JOURNAL OF SCIENCE EDUCATION AND TECHNOLOGY	2021	Implicit	Written	generalization		
35	Hsiao H.-S., Lin Y.-W., Lin K.-Y., Lin C.-Y., Chen J.-H., Chen J.-C.	Using robot-based practices to develop an activity that incorporated the 6E model to improve elementary school students' learning performances	Interactive Learning Environments	2019	Implicit	Inferred		both	problem
36	Hutchins, NM; Zhang, NY; Biswas, G	The Role Gender Differences in Computational Thinking Confidence Levels Plays in STEM Applications	INTERNATIONAL CONFERENCE ON COMPUTATIONAL	2017	Explicit	written	decomposition	not assessed	not assessed
37	Izu, C; Mirolo, C; Settle, A; Mannila, L;	Exploring Bebras Tasks Content and Performance: A Multinational Study	INFORMATICS IN EDUCATION	2017	Implicit, implicit	Written, inferred	both	both	problem
38	Jaipal-Jamani, K; Angeli, C	Effect of Robotics on Elementary Preservice Teachers' Self-Efficacy, Science Learning, and Computational Thinking	JOURNAL OF SCIENCE EDUCATION AND	2017	Implicit	Written	decomposition		
39	Jeon I., Song K.-S.	The effect of learning analytics system towards learner's computational thinking capabilities	ACM International Conference Proceeding	2019	Explicit, implicit	Written, inferred	decomposition	both	problem
40	Jeong Y.-S., Sung Y.-H.	The effect of network-based PUMA teaching-learning model on information literacy, computational thinking, and communication skills	Universal Journal of Educational Research	2019	Explicit	written	generalization	not assessed	not assessed
41	Juskeviciene, A; Stupuriene, G;	Computational thinking development through physical computing activities in STEAM education	COMPUTER APPLICATIONS IN	2021	Explicit	written	none	not assessed	not assessed
42	Kalliopi K., Michail K.	Assessing computational thinking skills at first stages of schooling	ACM International Conference Proceeding	2019	Implicit, implicit	Written, inferred	both	generalization	problem
43	Kert, SB; Erkoc, MF; Yeni, S	The effect of robotics on six graders ' academic achievement, computational thinking skills and conceptual knowledge levels	THINKING SKILLS AND CREATIVITY	2020	Explicit	written	decomposition	not assessed	not assessed
44	Kong, SC; Lao, ACC	Assessing In-service Teachers' Development of Computational Thinking Practices in Teacher Development Courses	SIGCSE '19: PROCEEDINGS OF THE 50TH ACM TECHNICAL	2019	Implicit, implicit	Written, inferred	decomposition	both	problem
45	Kukul, V; Karatas, S	Computational Thinking Self-Efficacy Scale: Development, Validity and Reliability	INFORMATICS IN EDUCATION	2019	Explicit	na, written		not clear	not clear
46	Lapawi, N; Husnin, H	Investigating Students' Computational Thinking Skills on Matter Module	INTERNATIONAL JOURNAL OF ADVANCED	2020	Implicit	Inferred		both	problem
47	Lee T.Y., Mauriello M.L., Ahn J., Bederson B.B.	CTArcade: Computational thinking with games in school age children	International Journal of Child-Computer	2014	Explicit	na, written		generalization	problem

48	Leonard, AE; Daily, SB; Jorg, S; Babu, SV	Coding moves: Design and research of teaching computational thinking through dance choreography and virtual interactions	JOURNAL OF RESEARCH ON TECHNOLOGY IN		Implicit	written	decomposition		
49	Leonard, J; Buss, A; Gamboa, R; Mitchell, M; Fashola, OS; Hubert, T; Almughyirah, S	Using Robotics and Game Design to Enhance Children's Self-Efficacy, STEM Attitudes, and Computational Thinking Skills	JOURNAL OF SCIENCE EDUCATION AND TECHNOLOGY	2016	Implicit	Inferred	none		program
50	Liu Z., Luo H., Chai X.	A New Evaluation Metrics for Block-based Python Code	2019 IEEE International Conference on Consumer Electronics -	2019	Implicit	Inferred	none		program
51	Looi, CK; How, ML; Wu, LK; Seow, P; Liu, L	Analysis of linkages between an unplugged activity and the development of computational thinking	COMPUTER SCIENCE EDUCATION	2018	Implicit	Written	none		
52	Marcelino, MJ; Pessoa, T; Vieira, C; Salvador, T; Mendes, AJ	Learning Computational Thinking and scratch at distance	COMPUTERS IN HUMAN BEHAVIOR	2018	Implicit	Written	decomposition		
53	Mendoza Diaz N.V., Meier R., Trytten D.A.,	Computational Thinking Growth during a First-Year Engineering Course	Proceedings - Frontiers in Education	2020	Explicit	written	decomposition	not assessed	not assessed
54	Moreno-Leon, J; Robles, G; Roman-Gonzalez, M	Dr. Scratch: Automatic Analysis of Scratch Projects to Assess and Foster Computational Thinking	RED-REVISTA DE EDUCACION A	2015	Implicit	Inferred	none		program
55	Moreno-Leon, J; Robles, G; Roman-Gonzalez, M	Towards Data-Driven Learning Paths to Develop Computational Thinking with Scratch	IEEE TRANSACTIONS ON EMERGING	2020	Implicit	Inferred	none		program
56	Munoz, R; Barcelos, TS; Villarroel, R; Silveira, IF	Game Design Workshop to Develop Computational Thinking Skills in teenagers with Autism Spectrum Disorders	2016 11TH IBERIAN CONFERENCE ON INFORMATION	2016	Implicit	Inferred	none		program
57	Munoz, R; Villarroel, R; Barcelos, TS; Riquelme, F; Quezada, A; Bustos-Valenzuela, P	Developing Computational Thinking Skills in Adolescents With Autism Spectrum Disorder Through Digital Game Programming	IEEE ACCESS	2018	Implicit	Inferred	none		program
58	Newton, KJ; Leonard, J; Buss, A; Wright, CG; Barnes-Johnson, J	Informal STEM: learning with robotics and game design in an urban context	JOURNAL OF RESEARCH ON TECHNOLOGY IN	2020	Implicit, implicit	Written, inferred	none	none	program
59	Noh, J; Lee, J	Effects of robotics programming on the computational thinking and creativity of elementary school students	ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND	2020	Implicit, implicit	Written, inferred	decomposition	both	problem
60	Nunez N.A., Cornejo-Meza G., Sanchez S.A.	Comparing computational thinking skills of engineering students in urban and rural areas of Peru	2020 IEEE ANDESCON, ANDESCON 2020	2020	Implicit	Inferred		both	problem
61	Palts T., Pedaste M.	Tasks for Assessing Computational Thinking Skills at Secondary School Level	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial	2019	Implicit	Inferred		both	problem
62	Panskyi, T; Rowinska, Z; Biedron, S	Out-of-school assistance in the teaching of visual creative programming in the game-based environment - Case study: Poland	THINKING SKILLS AND CREATIVITY	2019	Implicit	Inferred		none	program

63	Park, Y; Shin, Y	Comparing the Effectiveness of Scratch and App Inventor with Regard to Learning Computational Thinking Concepts	ELECTRONICS	2019	Implicit	Inferred		none	program
64	Peel, A; Fulton, J; Pontelli, E	DISSECT: An Experiment in Infusing Computational Thinking in a Sixth Grade Classroom	FRONTIERS IN EDUCATION	2015	Explicit	written	decomposition	not assessed	not assessed
65	Price, CB; Price-Mohr, RM	An Evaluation of Primary School Children Coding Using a Text-Based Language (Java)	COMPUTERS IN THE SCHOOLS	2018	Implicit	Inferred	decomposition		
66	Psycharis S., Kotzampasaki E.	The impact of a stem inquiry game learning scenario on computational thinking and computer self-confidence	Eurasia Journal of Mathematics, Science	2019	Implicit, implicit	Inferred, inferred	decomposition	both	problem
67	Rahman M.M., Sharker M.H., Paudel R.	An Effective Approach to Teach an Introductory Computer Science Course with Computational Thinking and Flow-Chart Based Visual Programming	Proceedings - Frontiers in Education Conference, FIE	2020	Explicit	written	generalization	not assessed	not assessed
68	Rijke, WJ; Bollen, L; Eysink, THS; Tolboom,	Computational Thinking in Primary School: An Examination of Abstraction and Decomposition in Different Age Groups	INFORMATICS IN EDUCATION	2018	Implicit	Inferred		decomposition	problem
69	Rodrigues, RS; Andrade, WL; Campos, LMRS	Can Computational Thinking help me? A quantitative study of its effects on education	2016 IEEE FRONTIERS IN EDUCATION	2016	Explicit	written	decomposition	not assessed	not assessed
70	Rodriguez B., Rader C., Camp T.	Using student performance to assess CS unplugged activities in a classroom environment	Annual Conference on Innovation and Technology in Computer	2016	Explicit	written	generalization	not assessed	not assessed
71	Romero, M; Lepage, A; Lille, B	Computational thinking development through creative programming in higher education	INTERNATIONAL JOURNAL OF EDUCATIONAL	2017	Implicit, implicit	Written, inferred	none	none	program
72	Rowe E., Almeda M.V., Asbell-Clarke J., Scruggs R., Baker R., Bardar E., Gasca S.	Assessing implicit computational thinking in Zoombinis puzzle gameplay	Computers in Human Behavior	2021	Explicit, Explicit	written, written	generalization	not clear	problem
73	Sondakh D.E., Osman K., Zainudin S.	Holistic assessment of computational thinking for undergraduate: Reliability and convergent validity	ACM International Conference Proceeding	2019	Implicit	Inferred		both	problem
74	Sondakh, DE; Osman, K; Zainudin, S	A Pilot Study of an Instrument to Assess Undergraduates' Computational thinking Proficiency	INTERNATIONAL JOURNAL OF ADVANCED	2020	Implicit	Inferred		both	problem
75	Song J.B.	The effectiveness of an unplugged coding education system that enables coding education without computers	Universal Journal of Educational Research	2019	Implicit	Inferred		both	problem
76	Souza, IML; Andrade, WL; Sampaio, LMR	Analyzing the Effect of Computational Thinking on Mathematics through Educational Robotics	2019 IEEE FRONTIERS IN EDUCATION CONFERENCE (FIE	2019	Implicit	Inferred		both	problem
77	Srisangngam P., Dechsura C.	STEM education activities development to promote computational thinking's students	2020 5th International STEM Education Conference, iSTEM-Ed	2020	Implicit	Inferred		both	problem
78	Sulistiyo M.A.S., Wijaya A.	The effectiveness of inquiry-based learning on computational thinking skills and self-efficacy of high school students	Journal of Physics: Conference Series	2020	Implicit	Inferred	none		
79	Sun, LH; Hu, LL; Yang, WP; Zhou, DH; Wang,	STEM learning attitude predicts computational thinking skills among primary school students	JOURNAL OF COMPUTER ASSISTED	2020	Implicit	Inferred		both	problem

80	Sunendar A., Santika S., Supratman, Nurkamilah	The Analysis of Mathematics Students' Computational Thinking Ability at Universitas Siliwangi	Journal of Physics: Conference Series	2020	Explicit	written	both		
81	Troiano G.M., Chen Q., Alba Á.V., Robles G., Smith G., Cassidy M., Tucker-Raymond E.,	Exploring How Game Genre in Student-Designed Games Influences Computational Thinking Development	Conference on Human Factors in Computing Systems - Proceedings	2020	Implicit, implicit	Written, inferred	generalization	none	program
82	Troiano G.M., Snodgrass S., Argimak E., Robles G., Smith G., Cassidy M., Tucker-Raymond E., Puttick G.,	Is My game ok Dr. scratch?: Exploring programming and computational thinking development via metrics in student-designed serious games for STEM	Proceedings of the 18th ACM International Conference on Interaction Design and Children, IDC 2019	2019	Implicit	Inferred		none	program
83	Tsai, MJ; Liang, JC; Hsu, CY	The Computational Thinking Scale for Computer Literacy Education	JOURNAL OF EDUCATIONAL	2020	Implicit	written	decomposition		
84	Uzumcu, O; Bay, E	The effect of computational thinking skill program design developed according to interest driven creator theory on prospective teachers	EDUCATION AND INFORMATION TECHNOLOGIES	2021	Implicit	Written	generalization		
85	Wang, DL; Wang, TT; Liu, Z	A Tangible Programming Tool for Children to Cultivate Computational Thinking	SCIENTIFIC WORLD JOURNAL	2014	Implicit	Written	decomposition		
86	Wei, XF; Lin, L; Meng, NX; Tan, W; Kong, SC; Kinshuk	The effectiveness of partial pair programming on elementary school students' Computational Thinking skills and self-efficacy	COMPUTERS & EDUCATION	2021	Implicit	Inferred		none	program
87	Wiebe, E; London, J; Aksit, O; Mott, BW; Boyer, KE; Lester, JC	Development of a Lean Computational Thinking Abilities Assessment for Middle Grades Students	SIGCSE '19: PROCEEDINGS OF THE 50TH ACM TECHNICAL	2019	Implicit	Inferred		both	problem
88	Witherspoon, EB; Higashi, RM; Schunn, CD; Baehr, EC; Shoop,	Developing Computational Thinking through a Virtual Robotics Programming Curriculum	ACM TRANSACTIONS ON COMPUTING EDUCATION	2017	Implicit	Inferred		none	problem
89	Wu, B; Hu, YL; Ruis, AR; Wang, MH	Analysing computational thinking in collaborative programming: A quantitative ethnography approach	JOURNAL OF COMPUTER ASSISTED	2019	Implicit	Written	generalization		
90	Wu, SY; Su, YS	Visual Programming Environments and Computational Thinking Performance of Fifth- and Sixth-Grade Students	JOURNAL OF EDUCATIONAL	2021	Explicit, implicit	Written, inferred	decomposition	generalization	problem
91	Xu, L; Tong, MW; Li, B; Meng, J; Fan, CY	Application of Concept Map in the Study of Computational Thinking Training	14TH INTERNATIONAL CONFERENCE ON COMPUTER SCIENCE AND EDUCATION	2019	Implicit	Inferred		none	program
92	Yadav, A; Mayfield, C; Zhou, NE; Hambrusch,	Computational Thinking in Elementary and Secondary Teacher Education	ACM TRANSACTIONS ON COMPUTING	2014	Implicit	Written	decomposition		
93	Yang D., Baek Y., Swanson S.	Developing Computational Thinking through Project-Based Airplane Design Activities	Proceedings - Frontiers in Education	2020	Implicit, implicit	Written, inferred	both	both	problem
94	Yin, Y; Hadad, R; Tang, XD; Lin, Q	Improving and Assessing Computational Thinking in Maker Activities: the Integration with Physics and Engineering Learning	JOURNAL OF SCIENCE EDUCATION AND TECHNOLOGY	2020	Implicit	Inferred		both	problem

95	Yusoff K.M., Ashaari N.S., Wook T.S.M.T., Ali N.M.	Validation of the Components and Elements of Computational Thinking for Teaching and Learning Programming using the Fuzzy Delphi Method	International Journal of Advanced Computer Science and	2021	Explicit	written	decomposition	not assessed	not assessed
96	Zhao, WN; Shute, VJ	Can playing a video game foster computational thinking skills?	COMPUTERS & EDUCATION	2019	Implicit	Written	both		