

What Do We Know (So Far) About COVID-19 in CS Education?

A Literature Map of the First 2 Years of the Pandemic

Brian Harrington, Aditya Kulkarni, Zixiao Ren, Conroy Trinh, Raha Gharadaghi, Thezyrie Amarouche, Ansh Aneel, Anand Karki, Seemin Syed, David Yue



Introduction

In this work, we systematically search, categorize, and map all research papers relating to COVID-19 from the first 2 post-pandemic years of conferences sponsored by the ACM Special Interest Group on Computer Science Education (SIGCSE) following the methodologies set out for literature mappings in [1, 2, 3].

Literature Map

The query: `COVID' OR `CORONAVIRUS' OR `PANDEMIC' was run on the ACM Digital Library on May 18, 2022, limiting the scope to events sponsored by the ACM SIGCSE, returning 263 total publications. After filtering for relevant papers, a total of 42 papers were mapped on 3 dimensions.

Activity

Remote Teaching: Movement to remote and/or asynchronous teaching modalities, including lectures, tutorials, and office hours

Remote Assessment: Evaluating and assessing student work without physical proximity, including issues of academic integrity and transition from traditional invigilation

Remote Work: Students working with other students or instructors in a remote environment, including online labs and practical sessions

Virtual Event: Individual events held online, not directly related to specific course teaching or assessment, including workshops, seminars, and conferences

Pandemic (general): Assessment of the impact of the pandemic generally on students, independent of its impact on the course environment

Measurement

Grades: Any assessment directly evaluating progress in a course, both formative and summative

Performance (other): Any assessment not directly evaluating progress in a specific course, such as non-course performance tests, comprehension tests, and evaluations related directly to a specific study

Attendance/Retention: Any evaluation of the number of students participating a course including attendance, enrolment, and drop-fail-withdrawal rates

Affective/Perceptions: Any evaluation of feelings towards or perceptions of a course or the field of computer science in general, usually in the form of surveys or open ended feedback

Mental Health: Any evaluation of the mental health, stress level, or psychological well-being

Population

K-12 students
University/College students
Educators

First year students or students in CS0/CS1/Introductory courses
Gender
Race

Findings

In the first 2 years of published research, interesting trends are already appearing both in terms of the research findings themselves, and in terms of what areas are being studied.

Some areas of the map (e.g., perceptions of remote teaching for university/college students) have good coverage in a wide array of papers, while other areas (e.g., mental health of educators) have no publications at all. This shows that there are some areas that would benefit from a more constrained analysis and others that are open areas in need of research and investigation.

This mapping project produced a framework for future literature review, and a mapping of current research that will be of benefit to both researchers and practitioners.

Literature Mappings

Activity vs Measurement					
	Remote Teaching	Remote Assessment	Remote Work	Virtual Event	Pandemic (general)
Grades	[13]	[11] [18] [25] [30] [31] [42]	[13]	[24]	
Performance (Other)		[11]		[14] [24]	[40]
Attendance/Retention	[13] [32]	[30] [32]	[13] [32]	[23]	[19]
Affective/Perceptions	[1] [2] [3] [4] [5] [6] [10] [12] [15] [17] [21] [27] [28] [29] [35] [36] [37]	[2] [18] [21] [31] [34] [36]	[1] [3] [7] [8] [9] [21] [27] [29] [33] [36] [37]	[20] [23] [24] [39]	[6] [19] [26] [33] [36]
Mental Health		[34]	[41]		[19] [38]

Activity vs Population					
	Remote Teaching	Remote Assessment	Remote Work	Virtual Event	Pandemic (general)
K-12	[5] [13] [15] [21] [22] [28] [37]	[21]	[8] [13] [21] [37]	[14] [20] [23] [24]	
University/College	[1] [3] [4] [6] [10] [12] [13] [17] [27] [29] [32] [35] [36]	[11] [18] [25] [30] [31] [32] [34] [42]	[1] [3] [7] [9] [13] [27] [29] [32] [33] [41]	[6] [19] [26] [38]	[33] [40]
Educators	[4] [6]			[6] [14]	[39]
CS0/CS1/First Year	[10] [16] [17] [29]	[11] [18] [25] [30] [34] [36]	[1] [7] [27] [29] [36] [41]	[19] [36]	[40]
Gender	[5] [15]		[33] [41]	[23] [26]	[33]
Race	[5] [15]		[33]	[20] [26] [38]	[33]

Measurement vs Population					
	Grades	Performance (Other)	Attendance/Retention	Affective/Perceptions	Mental Health
K-12	[24]	[14] [24]	[23]	[3] [5] [8] [20] [21] [23] [24] [28] [37] [39]	
University/College	[11] [13] [18] [25] [30] [31] [42]	[11]	[13] [19] [30] [32]	[1] [4] [7] [9] [10] [12] [15] [17] [18] [19] [26] [27] [29] [31] [33] [34] [35] [36]	[19] [34] [38] [41]
Educators		[14]		[4] [18] [39]	
CS0/CS1/First Year	[11] [18] [25] [30]	[11] [40]	[19] [30]	[7] [10] [15] [17] [18] [19] [29] [34]	[19] [34] [41]
Gender			[23]	[5] [15] [23] [26] [33]	[41]
Race				[5] [15] [20] [26] [33]	[38]

Mapping References

- [1] C. O. Alm, R. Bailey, and H. Miller. Remote early research experiences for undergraduate students in computing. SIGCSE 2022.
- [2] Y. Bao and H. Hosseini. Computational thinking, perception, and confidence in distance learning. SIGCSE 2021.
- [3] D. Basu and N. Gopalkrishna. Evaluation of course strategies: Face-to-face vs. online. ICER 2020.
- [4] D. Bosk and R. Glassey. When flying blind, bring a co-pilot: Informal peer observation and cooperative teaching during remote teaching. ITICSE 2021.
- [5] K. M. Braswell, J. Johnson, B. Brown, and J. Payton. Pivoting during a pandemic: Designing a virtual summer camp to increase confidence of black and latina girls. SIGCSE 2021.
- [6] A. Brooks, C. Hardin, J. Scianna, M. Berland, and L. H. Legault. Approaches to transitioning computer science classes from offline to online. ITICSE 2021.
- [7] J. K. Estell, S. Coffman-Wolph, J. Sieg, and M. Musser. Supporting pharmaceutical healthcare outreach: A culminating first-year programming experience. SIGCSE 2021.
- [8] A. C. Galdo, M. Celepkolu, N. Lytle, and K. E. Boyer. Pair programming in a pandemic: Understanding middle school students' remote collaboration experiences. SIGCSE 2022.
- [9] K. Gama, C. Zimmerle, and P. Rossi. Online hackathons as an engaging tool to promote group work in emergency remote learning. ITICSE 2021.
- [10] Z. Gao, S. Heckman, and C. Lynch. Who uses office hours? a comparison of in-person and virtual office hours utilization. SIGCSE 2022.
- [11] M. Hassan and C. Zilles. Exploring 'reverse-tracing' questions as a means of assessing the tracing skill on computer-based cs 1 exams. ICER 2021.
- [12] S. Hofstätter, S. Althammer, M. Sertkan, and A. Hanbury. A time-optimized content creation workflow for remote teaching. SIGCSE 2022.
- [13] L. J. Barker, A. Volda, and V. Nagy. Service interruption: Managing commitment to community partners during a crisis. ICER 2021.
- [14] R. Jocius, D. Joshi, J. Albert, T. Barnes, R. Robinson, V. Cateté, Y. Dong, M. Blanton, I. O'Byrne, and A. Andrews. The virtual pivot: Transitioning computational thinking pd for middle and high school content area teachers. SIGCSE 2021.
- [15] D. Kwak, P. Morreale, S. T. Hug, Y. Kumar, J. Chu, C.-Y. Huang, J. J. Li, and P. Wang. Evaluation of the use of growth mindset in the cs classroom. SIGCSE 2022.
- [16] C. Latulipe. A cs1 team-based learning space in gather.town. SIGCSE 2021.
- [17] C. Latulipe and A. De Jaeger. Comparing student experiences of collaborative learning in synchronous cs1 classes in gather.town vs. zoom. SIGCSE 2022.
- [18] N. T. S. Lee, O. Kurniawan, and K. T. W. Choo. Assessing programming skills and knowledge during the covid-19 pandemic: An experience report. ITICSE 2021.
- [19] M. Lewis, Z. Deng, S. Krause-Levy, A. Salguero, W. G. Griswold, L. Porter, and C. Alvarado. Exploring student experiences in early computing courses during emergency remote teaching. ITICSE 2021.
- [20] D. Lusa Krug, E. Bowman, T. Barnett, L. Pollock, and D. Shepherd. Code beats: A virtual camp for middle schoolers coding hip hop. SIGCSE 2021.
- [21] Y. Ma, J. Martinez Ruiz, T. D. Brown, K.-A. Diaz, A. M. Gaweda, M. Celepkolu, K. E. Boyer, C. F. Lynch, and E. Wiebe. It's challenging but doable: Lessons learned from a remote collaborative coding camp for elementary students. SIGCSE 2022.
- [22] F. Mardi, K. Miller, and P. Balcerzak. Novice - expert pair coaching: Teaching python in a pandemic. SIGCSE 2021.
- [23] A. McDonald and L. K. Dillon. Virtual outreach: Lessons from a coding club's response to covid-19. SIGCSE 2021.
- [24] M. M. McGill, S. B. Lee, L. Lineberry, J. Sands, and L. A. DeLysler. Piloting the air force jrotc cyber academy for high school students. SIGCSE 2021.
- [25] C. McMahon, B. Yao, J. Yokota, and D. Garcia. Lessons learned from asynchronous online assessment formats in cs0 and cs3. SIGCSE 2022.
- [26] C. Mooney and B. A. Becker. Investigating the impact of the covid-19 pandemic on computing students' sense of belonging. SIGCSE 2021.
- [27] N. Najjar, A. Stubler, H. Ramaprasad, H. Lipford, and D. Wilson. Evaluating students' perceptions of online learning with 2-d virtual spaces. SIGCSE 2022.
- [28] R. Perlman, H. Cohen, and O. Hazzan. The cs-orona initiative: Fulfilling the organizational needs of israeli high school computer science teachers during the corona pandemic. SIGCSE 2021.
- [29] C. Piech, A. Malik, K. Jue, and M. Sahami. Code in place: Online section leading for scalable human-centered learning. SIGCSE 2021.
- [30] S. Podlipnig. A four-year study of a placement exam for an introductory programming course. SIGCSE 2022.
- [31] K. Quille, K. Nolan, B. A. Becker, and S. McHugh. Developing an open-book online exam for final year students. ITICSE 2021.
- [32] S. Rampure, A. Shen, and J. Hug. Experiences teaching a large upper-division data science course remotely. SIGCSE 2021.
- [33] M. Ross, E. Litzler, and J. Lopez. Meeting students where they are: A virtual computer science education research (cser) experience for undergraduates (reu). SIGCSE 2021.
- [34] M. Sabin, K. H. Jin, and A. Smith. Oral exams in shift to remote learning. SIGCSE 2021.
- [35] S. Sharmin and L. Y. Zhang. Experience report on the use of breakout rooms in a large online course. SIGCSE 2022.
- [36] A. A. Siegel, M. Zarb, B. Alshaigy, J. Blanchard, T. Crick, R. Glassey, J. R. Hott, C. Latulipe, C. Riedesel, M. Senapathi, Simon, and D. Williams. Teaching through a global pandemic: Educational landscapes before, during and after covid-19. ITICSE-WGR 2021.
- [37] E. Skuratowicz, M. Vanderberg, E. E. Hung, G. Krause, D. Bradley, and J. P. Wilson. I felt like we were actually going somewhere: Adapting summer professional development for elementary teachers to a virtual experience during covid-19. SIGCSE 2021.
- [38] H. Thiry and S. T. Hug. Sustaining student engagement and equity in computing departments during the covid-19 pandemic. SIGCSE 2021.
- [39] J. Tsan, M. Coenraad, Z. Crenshaw, J. Palmer, D. Eathing, K. Beck, D. Weintrop, and D. Franklin. Reimagining professional development for k-8 cs teachers: Evaluating a virtual, diffuse model. SIGCSE 2022.
- [40] I. YeckehZaare, G. Grot, I. Dimovski, K. Pollock, and E. Fox. Another victim of covid-19: Computer science education. SIGCSE 2022.
- [41] K. M. Ying, G. A. Katuka, and K. E. Boyer. Using dialogue analysis to predict women's stress during remote collaborative learning in computer science. ITICSE 2021.
- [42] L. Y. Zhang, A. K. Petersen, M. Liut, B. Simion, and F. Alaca. A multi-course report on the experience of unplanned online exams. SIGCSE 2021.

Methodology References

- [Paper1] B. Kitchenham and S. M. Charters. Guidelines for performing systematic literature reviews in software engineering. Technical report, Technical report, ver. 2.3 ebse technical report. ebse, 2007.
- [Paper2] B. Kitchenham, R. Pretorius, D. Budgen, O. P. Brereton, M. Turner, M. Niazi, and S. Linkman. Systematic literature reviews in software engineering—a tertiary study. *Information and software technology*, 52(8):792–805, 2010.
- [Paper3] A. Zavaleta Bernuy and B. Harrington. What are we asking our students? a literature map of student surveys in computer science education. In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*, ITICSE '20, page 418–424, New York, NY, USA, 2020. Association for Computing Machinery.