A Longitudinal Analysis of K12 Computing Education Research in the U.S.: Implications and Recommendations for Change

Bishakha Upadhyaya
Knox College

Dr. Monica McGill
Knox College & CSEdResearch.org

Dr. Adrienne Decker
University at Buffalo

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Introduction

- What we know:
  - That K-12 CS Education is in its infancy
  - So, K-12 CS Education Research is also still in its infancy
  - The U.S. has a decentralized education system - differing policies for different states and districts
  - 44 of the 50 states have some policy in place to bring computing into K-12 schools (Code.org)

Research Question

Over the last seven years (2012-2018), what have been the major trends in K-12 computer science education research in the U.S.?

- Locations of students/interventions studied
- Type of articles (research, experience, position paper)
- Program data (e.g., concepts taught, when activity offered, etc.)
- Student data (e.g., disabilities, gender, race/ethnicity, SES)

Why is this important?

- If the data is robust:
  - Analysis can provide a longitudinal trend of what the research shows and we can start to see trends develop to help predict future trends
  - Identify gaps in what is being researched

- If the data is not robust:
  - Gives us data needed to improve the state of the field
  - Gaps in what is reported

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Methodology

- Analyzed the data from CSEdResearch.org dataset
  - Ten publication venues (ACM/IEEE + a couple of others)
  - 2012-2018
  - All manually curated data
- Most of the data is from U.S. researchers at present, so we chose to focus on U.S. only for now
- Focused on articles that had K-12 students as participants
- The dataset is available to the public (just contact us)
- SQL queries were added to a Tableau workbook that pulled data from the site
- Visual graphics were created from the results

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- Evaluation instruments for computing
- Data manually curated from articles
- Research guides

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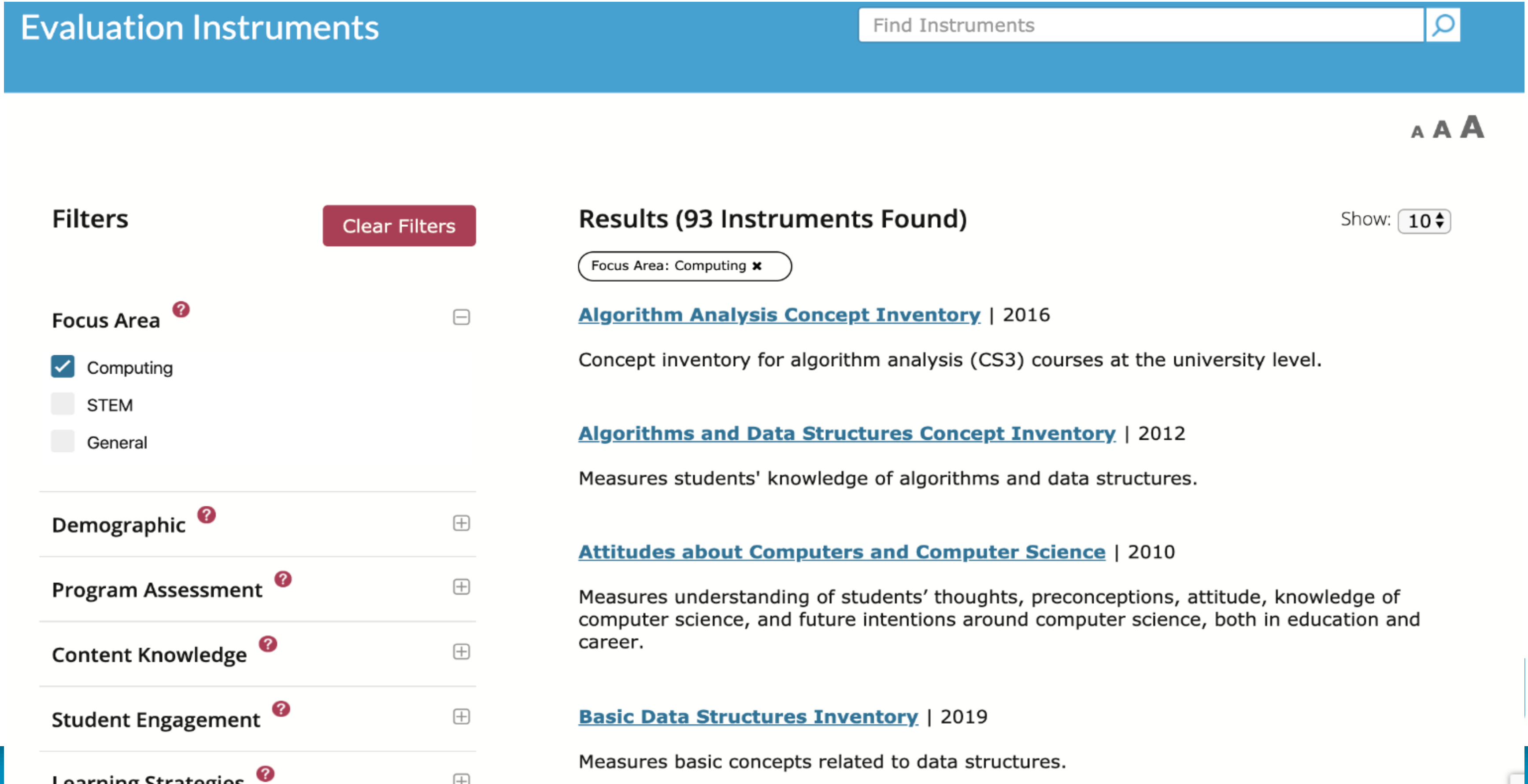
Evaluation Instruments for CS Ed



Article Summary Search Capability

Filters

Clear Filters

Focus Area ?

- [ ] Activity (for Students)
- [x] Curriculum (for Students)
- [ ] Learner

Student ?

Age

Grades

- [x] Elementary
  - [x] Preschool
  - [x] Kindergarten
  - [x] 1st
  - [x] 2nd

Gender

Race

Results (52 articles found)

Show: 10 Sort by: Default

Focus Area:

Area: Curriculum (for Students) ✖

Student Filters:

Grades: Preschool ✖ Kindergarten ✖ 1st ✖ 2nd ✖ 3rd ✖ 4th ✖ 5th ✖

Text-based Programming in Elementary School: A Comparative Study of Programming Abilities in Children with and without Block-based Experience

Marcos J. Gomez, Marco Moresi, Luciana Benotti | ACM ITiCSE (2019)

A K–8 Debugging Learning Trajectory Derived from Research Literature

Kathryn M. Rich, T. Andrew Binkowski, Carla Strickland, Diana Franklin | ACM SIGCSE (2019)

A Middle-School Code Camp Emphasizing Digital Humanities

Yesheng Chen, Zhen Chen, Shyamala Gumidyala, Annabella Koures, Seoyeon Lee, James Msekela, Halle Remash, Nolan Schoenle, Sarah Dahlby Albright, Samuel A. Rebelsky | ACM SIGCSE (2019)

An Analysis Through an Equity Lens of the Implementation of Computer Science in K-8 Classrooms in a Large, Urban School District

Jean Salac, Max White, Ashley Wang, Diana Franklin | ACM SIGCSE (2019)

Article Summaries

General Characteristics

Venue	ACM ITiCSE
Publication Year	2019
Abstract	"We describe lessons learned from using the ai Norwegian upper secondary school to compute
Authors	Bjørn Fjukstad Nina Angelvik Morten Grønnesby Maria Wulff Hauglann Hedinn Gunhildrud Fredrik Høisæther Rasch Julianne Iversen Margaret Dalseng Lars Ailo Bongo
URL	https://doi.org/10.1145/3304221.3325527
Citation (APA Style)	Fjukstad, B., Angelvik, N., Grønnesby, M., Hau M. & Bongo, L.A.. (2019). ACM Innovation and and Programming in Norwegian Schools Using https://doi.org/10.1145/3304221.3325527 .
Citation (Bibtex Style)	@inproceedings{fjukstad2019teaching, author Hauglann, Maria Wulff, Gunhildrud, Hedinn , Ra and Bongo, Lars Ailo}, year={2019}, title={Te the air:bit Sensor Kit}, booktitle={ACM Innova {https://doi.org/10.1145/3304221.3325527}

Report Type	Experience
Focus Area	Activity (for Students)
Study Design	Cross-Sectional
Research Approach	Quantitative
What Measured	Satisfaction, how much time the students spent working, if students used online materials, the part, prior experience, and if the students learned the programming specific learning outcome
Replication Study	No

Student Characteristics

Number Student Participants	164
Student Grades	9th, 10th, 11th, 12th
Student Country	Norway
Student Prior Experience	When surveyed, most students had little or some knowledge of programming.

Instructor Characteristics

Number Instructor	11

Research Guide

Write a Research Question

Before you begin writing your research question, it is first important to craft a purpose statement. What can be a purpose of your study?

Examples of a purpose for a quantitative study include:

- Examining a relationship between students who take computing classes in high school and those who pursue computer science as a major in college,
- Evaluating the effectiveness of an outreach activity among underrepresented students, or
- Measuring engagement or interest in computing among middle school students.

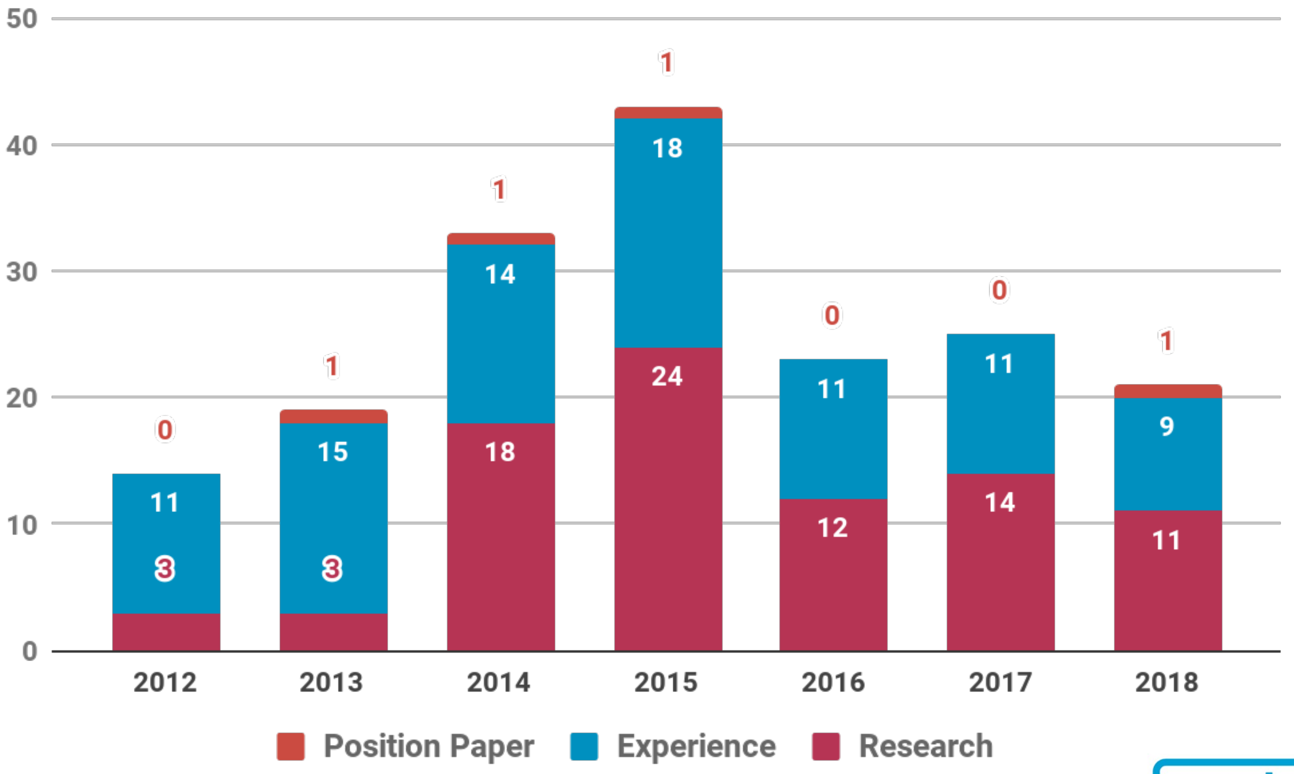
Examples for a qualitative study include:

- Exploring parent stories about helping their students with computing homework or
- Developing a theory of effective management techniques in a computer lab.

Once you define the purpose of your study, you can then create a clear purpose statement. Purpose statements help you define your research in a straightforward manner. Here is an example of a well-defined purpose statement.

> The purpose of this study is to examine the relationship between the completion of an 9-week computational thinking unit among 7th and 8th grade students in a rural middle school and student achievement on mathematics exams.

Results: Type of Articles



N = 178

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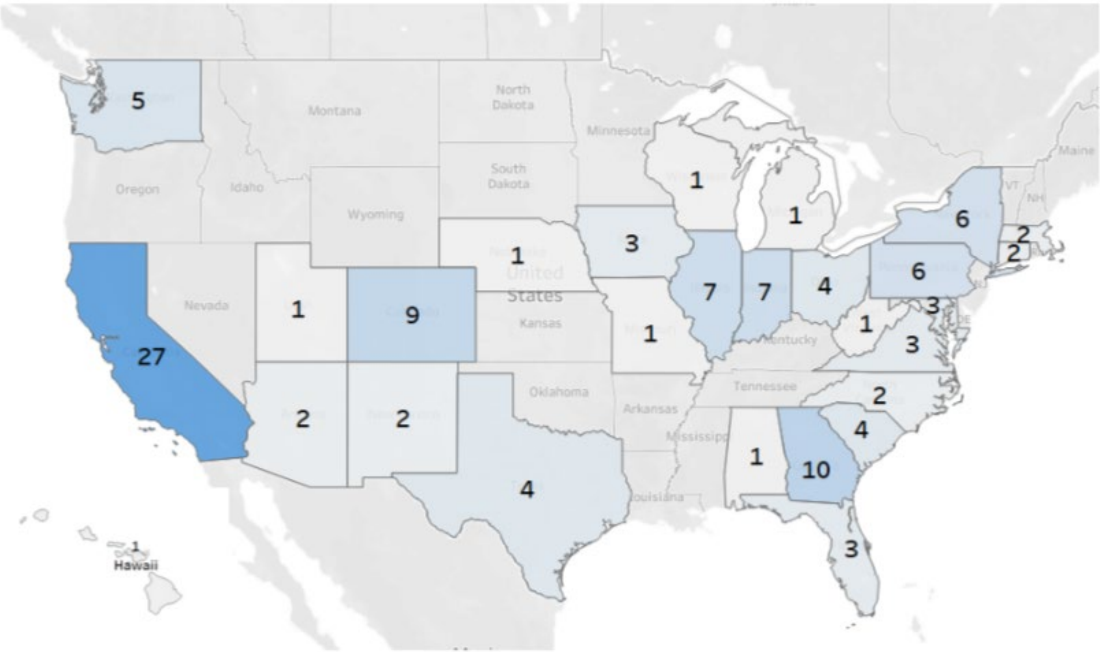
Locations of Student Participants



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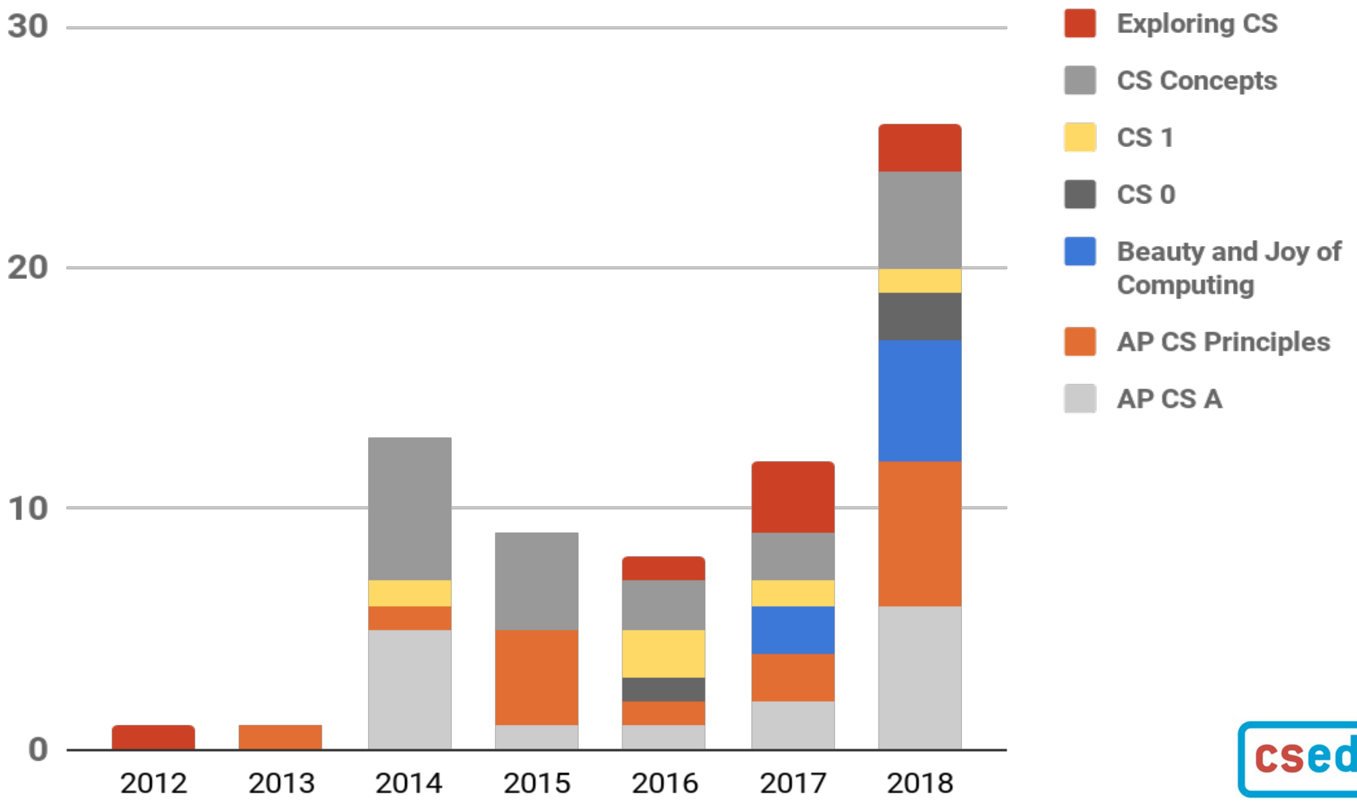
Program Data: Curriculum Taught



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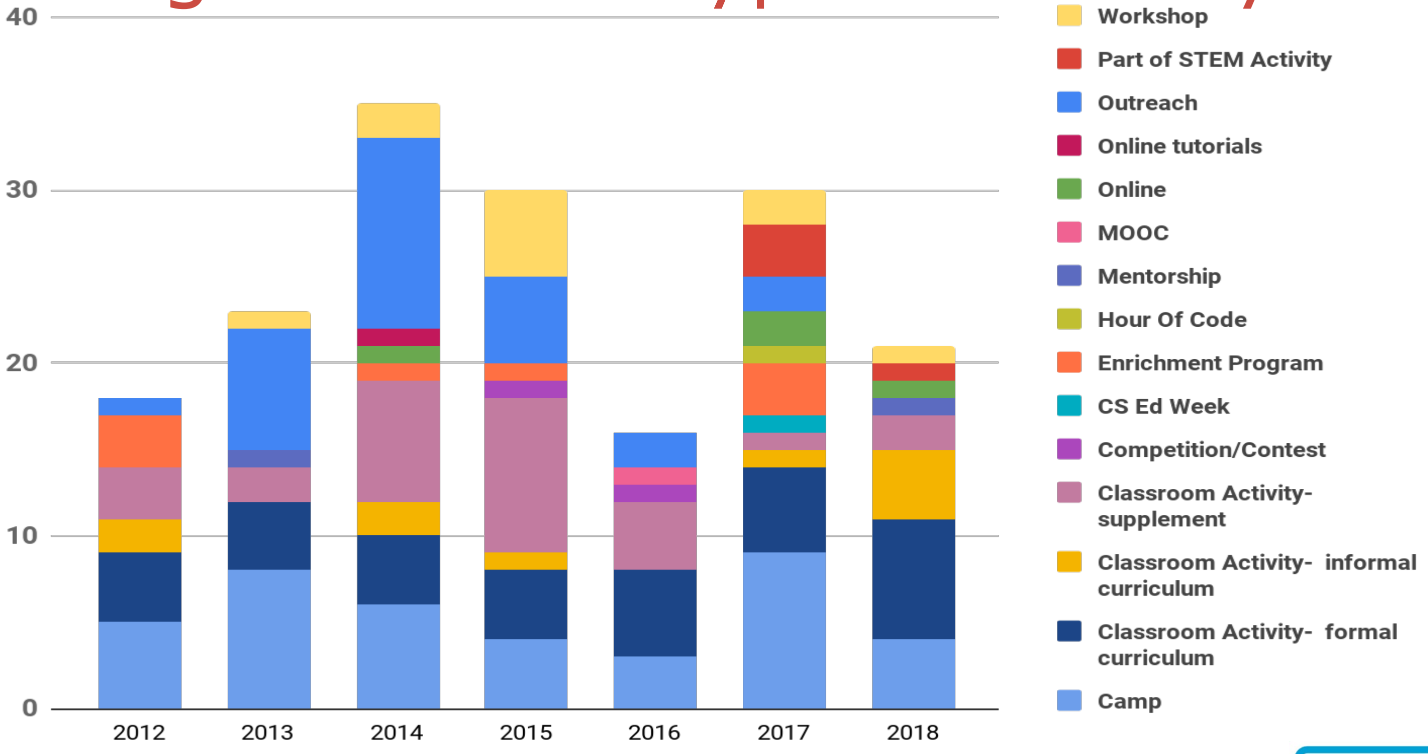
Program Data: Most Frequent Concepts Taught

2012	2015	2018
Programming (11)	Programming (20)	Programming (6)
AI (3)	Problem Solving Skills (12)	Computational Thinking (4)
Design Skills (3)	Computational Thinking (12)	Abstraction (4)
Problem Solving Skills (3)	Abstraction (8)	Variables (3)
Video Game Design and Dev (3)	Iteration (7)	Game Programming (2)
Video Game Design (2)	Video Game Design(6)	Video Game Design (2)
Computational Thinking (2)	Algorithms (4)	Debugging (2)
Internet (2)	3D Modeling (4)	Cybersecurity (2)
Cryptography (2)	Algorithm Logic (4)	Computing Concepts (2)
	Mobile App Development (4)	
	Robotics (4)	

Program Data: Type of Activity



N = 172

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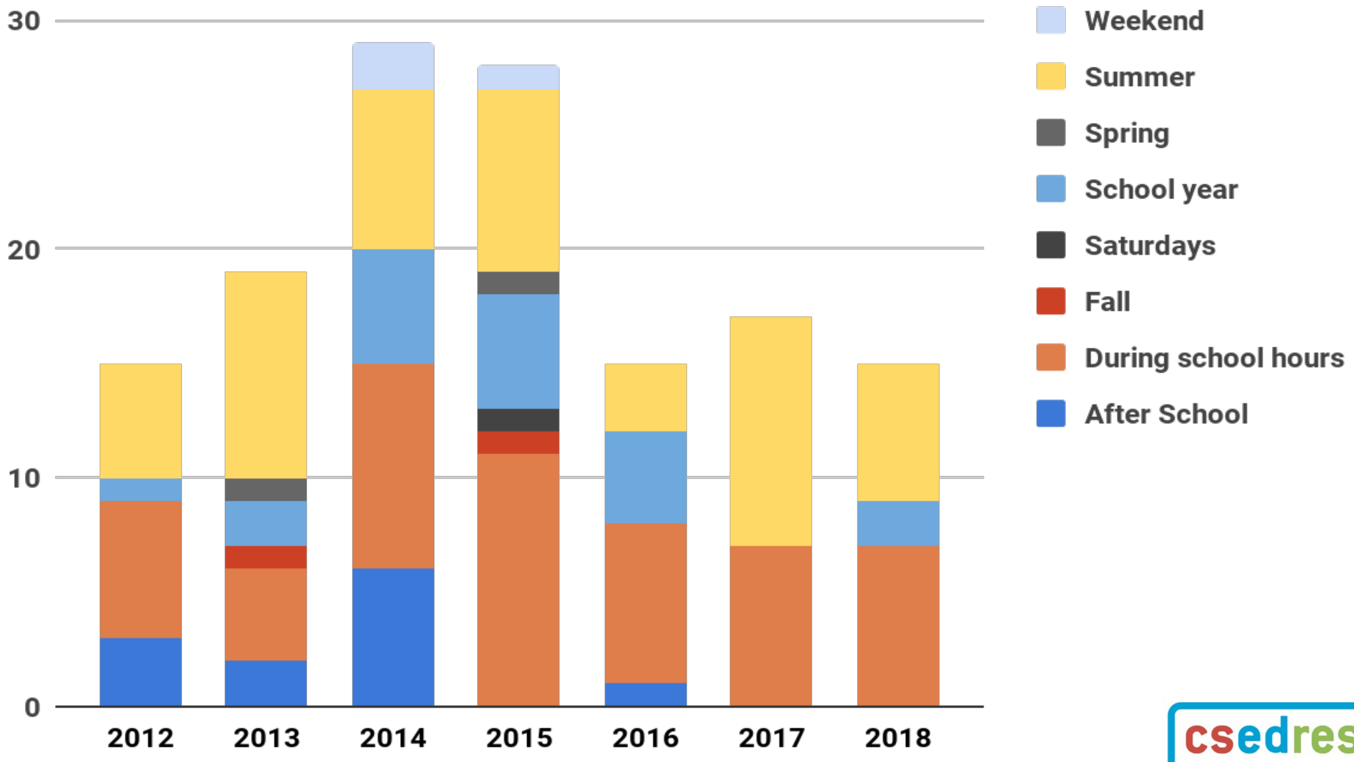
Program Data: When Activity was Offered



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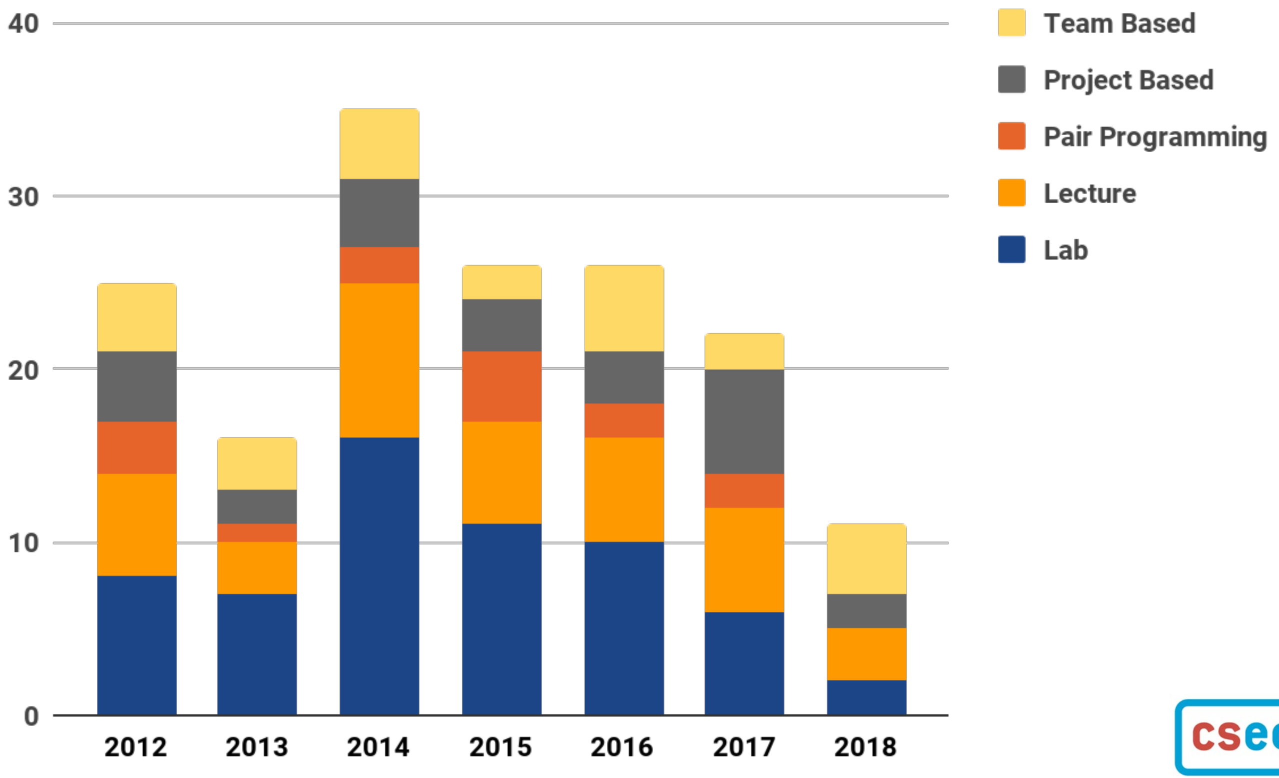
Program Data: Teaching Methods



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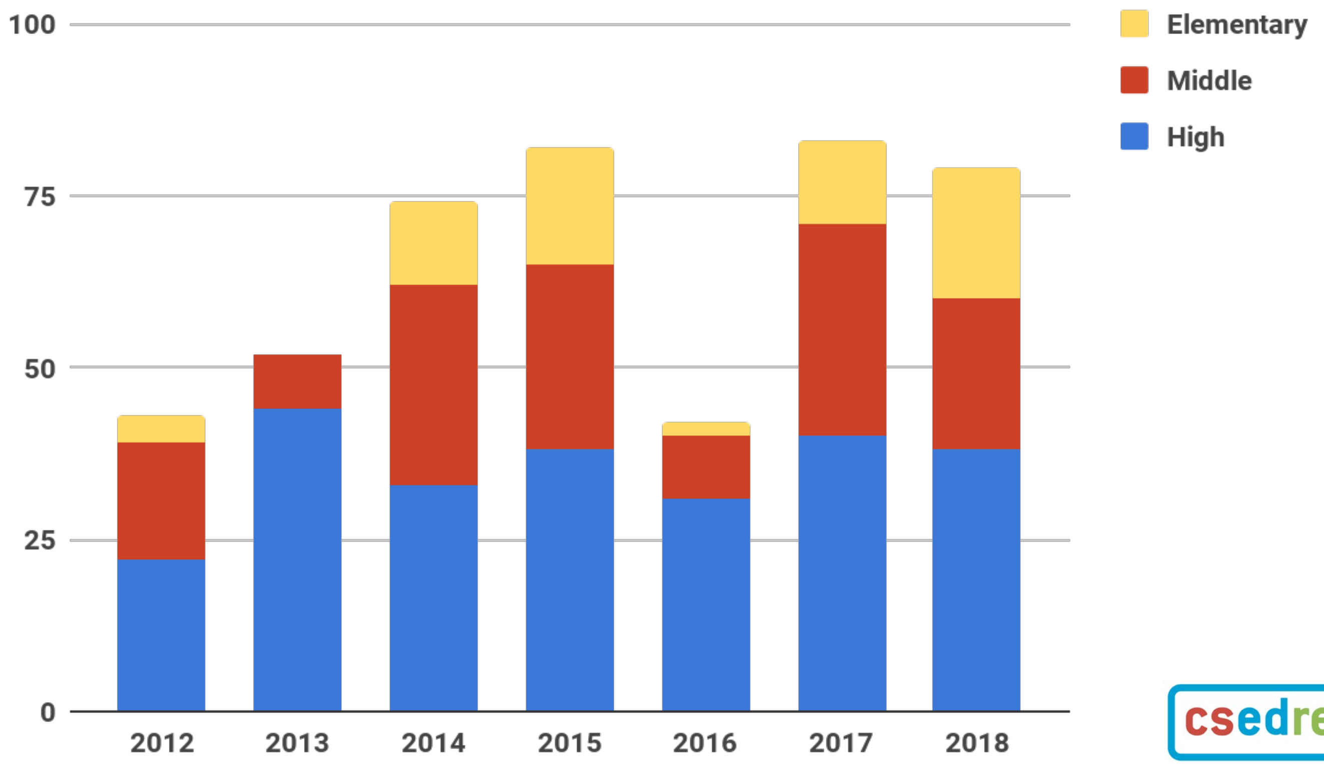
Program Data: Tools, Languages, Environments

Top 3 across these years

2012	2015	2018
Scratch (9)	Scratch (19)	Scratch (15)
CS Unplugged (3)	Java (6)	Java (4)
Java (2)	AppInventor (6)	Python (4)
App Inventor (2)	Python (4)	App Inventor (3)
Python (2)		Arduino (3)
Alice (2)		
CSS (2)		

Student Data: Grade Levels



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Student Data: Disabilities

- Only 5 out of 178 articles reported information related to disabilities
- Information curated related to disabilities:
  - Disability instruction
  - Receiving disability services
  - Reported Disabilities

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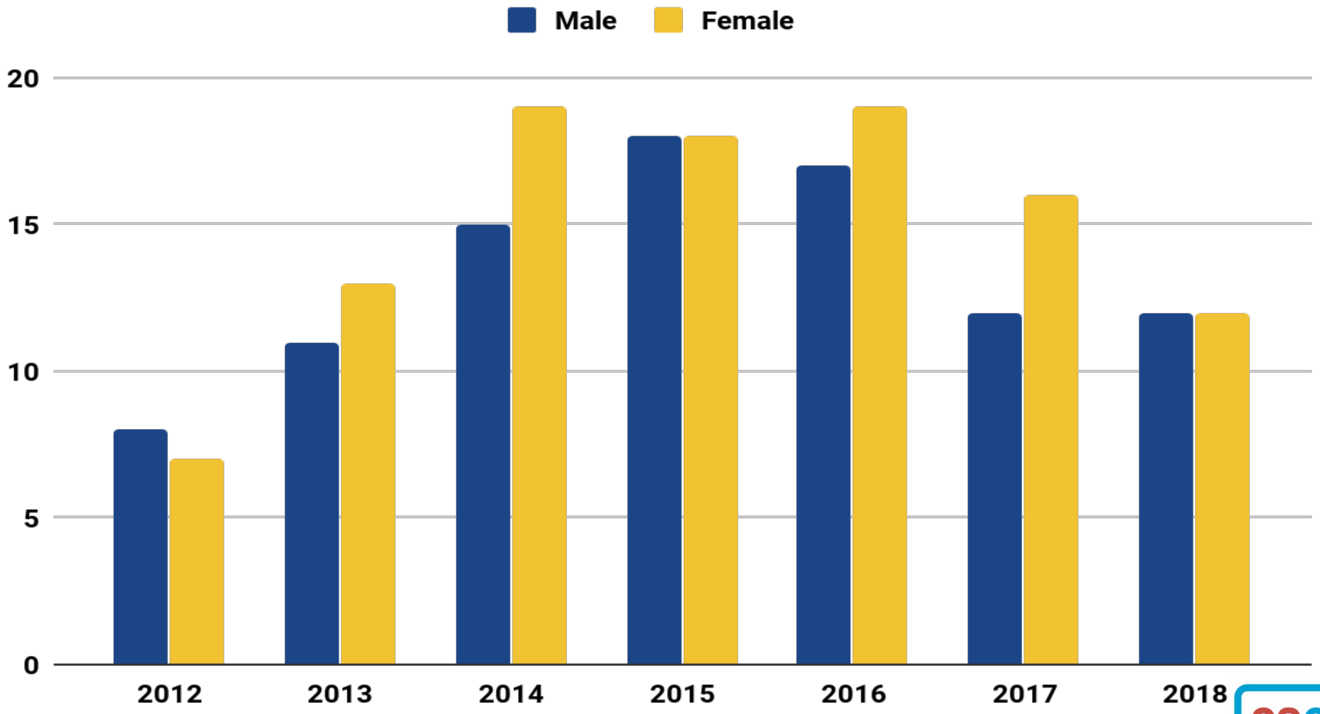
Student Data: Gender



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Student Data: Race/Ethnicity

	2012	2015	2018
Black/African American	7	15	13
White	5	9	6
Asian/Pacific Islander	2	9	11
Latinos	3	9	12
Total	17	42	42

Student Data: Socio-economic status (SES)

	Low SES	Working Class	Middle SES/ Professional	High SES	Total
2012	1	0	0	1	2
2013	0	0	1	0	1
2014	9	0	0	0	9
2015	3	0	1	0	4
2016	1	0	0	0	1
2017	7	0	1	0	8
2018	4	1	1	1	7
Total	25	1	4	2	32

Discussions and Recommendations

- Lack of consistency in reporting of SES, disabilities, gender, location, and Race/Ethnicity of the students.
    - As well as program data!

- Seems fairly consistent over the last 7 years
    - Indicates lack of progress in reporting

Discussion

- Fewer K-12 articles published in 2018 than previous years
- Other factors (e.g. Policies) that affect the reporting of the location of students in the articles.
- Outreach programs and workshops being researched appears to be decreasing as CS is being integrated in the formal curriculum.

Recommendations

- Consistency in the reporting of data
  - Reporting states instead of region
  - Both school groups and age
- Reporting of demographic data regardless of the focus of the study
  - If there were participants, there’s demographic data

Limitations

- Data is manually curated and thus prone to data entry errors
    - Mitigated by a two-reviewer process
- Data curation only categorizes location of students/intervention, not the researchers
    - So, if authors did not mention where in which state student participants were located, it is not on the map (underrepresentation)
- Several articles may report on one study (overrepresentation)
- Significant underreporting with demographics (underrepresentation)
- Limited to U.S., but this can serve as a model for investigating article data from other countries

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Conclusion

- Initial indications is that the research landscape is not equitable, but with underreporting difficult to determine
- Lack of reporting of the key demographic data has not improved over the years
- What may have worked in a primarily white upper-middle class suburban school may not work for a poverty level rural school or an ethnically diverse urban school.
  - Or it just may?
  - Wouldn’t it be nice to have the data to show this?

Thank you!

Questions?

Bishakha Upadhyaya
Knox College
bupadhyaya@knox.edu

Dr. Monica McGill
Knox College & CSEdResearch.org
monica@csedresearch.org
Twitter: VirtuallyFine

Dr. Adrienne Decker
University at Buffalo
adrienne@buffalo.edu
Twitter: AdrienneMDecker

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