Final Reflections on the PUMP-CS Researcher-Practitioner Partnership and Systems Change

Lessons Learned and the Path Ahead

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1. Introduction

PUMP-CS (Preparing Urban Milwaukee Pathways in Computer Science) is a researcher-practitioner partnership (RPP) among Milwaukee Public Schools (MPS), Marquette University, the Learning Partnership, and the American Institutes for Research® (AIR®). The partnership's goal is to solidify and strengthen a preK–12 computer science pathway throughout MPS to provide access to high-quality computer science and computational thinking courses and experiences for all public school children in the city, regardless of their race, socioeconomic circumstances, or geographic location. As the PUMP-CS evaluator, AIR participated in regular partnership meetings, periodically measured teachers' and principals' computer science perceptions and practices, and collected feedback on the health of the RPP.

The evaluation questions (EQs) driving this work were as follows:

- **EQ1.** To what extent do teachers' and principals' computer science perceptions and practices change across time?
- **EQ2.** To what extent did the quality of relationships within the partnership improve from 2019 to 2023?
- **EQ3.** To what extent has the research produced been relevant, timely, and rigorous?
- **EQ4.** What types of support were put in place to aid the use of the research produced? How timely and useful have these supports been?
- **EQ5.** To what extent has the capacity of the researcher and practitioner partners to engage in partnership work improved from 2019 to 2023?
- **EQ6.** To what extent did the RPP develop and share knowledge, tools, and routines within the district and with the computer science field more broadly from 2019 to 2023?

The purpose of this report is to inform next steps for the PUMP-CS partners as they explore opportunities for continuing to work together. During the life of the PUMP-CS grant, AIR synthesized findings and facilitated conversations with the RPP to make sense of the data collected and develop strategic plans for the current and future years. This report highlights key takeaways about teacher and principal computer science perceptions and practices across time. It also features changes in the RPP's health and considerations for the path forward. It draws on survey and interview findings about the health of the RPP from 2019 to 2023 as well as teacher survey data (2021–2023) and principal survey data (2021–2022).

The remainder of this report has three sections: (a) the methods used to answer the EQs, (b) the findings from the teacher and principal surveys; and (c) and the results from the RPP evaluation aligned to the five dimensions of an effective RPP (Henrick et al., 2017).

2. Methods

This report draws on information collected through teacher and principal surveys and RPP member surveys and interviews.

2.1. Teacher and Principal Surveys

The teacher survey had 12 items measuring teachers' computer science perceptions and 15 items measuring teachers' practices. Administration of the teacher survey occurred in the spring of each year from 2021 to 2023.

The principal survey had 20 items measuring their perceptions and practices related to computer science. Administration of the principal survey occurred in the summer of each year from 2021 to 2022.

To analyze the evolution of changes in responses for each item, we first examined each survey document for consistency in wording for each item. For the teacher survey, some items were added or modified in response to how well the items performed. In other instances, RPP members requested additional items so that more information might be available. In comparison, teacher survey items that did not appear in all 3 years or were inconsistent across the years were discarded for the analysis. AIR then examined the scales for each item for all 3 years to determine how to compare responses across years.

The 2021 teacher perception survey items used a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). With the lack of variation in the response items, AIR collapsed the response options to a 4-point Likert scale from 1 (*strongly disagree*) to 4 (*strongly agree*). This scale was used for the teacher perception items in 2022 and 2023. To make each year comparable, we collapsed the scale into two categories: agree and disagree. Items with more than 4.5% of the responses with "neither agree nor disagree" from the 2021 survey were removed from the analysis. For further details on which items were removed, please see Appendix A.

The principal survey did not change from 2021 to 2022.

2.2. RPP Surveys and Interviews

AIR administered surveys and conducted interviews to assess the five dimensions of effective RPPs. These dimensions originated from Henrick et al. (2017). AIR used an interview protocol from Regional Educational Laboratory Southwest (Scholz et al., 2021) to collect the data.

- Dimension 1: Building trust and cultivating partnership relationships
- Dimension 2: Conducting rigorous research to inform action
- Dimension 3: Supporting the partner practice organization in achieving its goals
- Dimension 4: Producing knowledge that can inform educational improvement efforts more broadly
- Dimension 5: Building the capacity of participating researchers, practitioners, practice organizations, and research organizations to engage in partnership work

From 2020 to 2023, AIR also administered the Are We a Partnership Yet? (AWAPY) survey to members of the RPP leadership team and conducted interviews using the Interview Protocol to Assess RPP Health tool with members of the RPP leadership team, which consisted of representatives from the Learning Partnership, MPS, and Marquette University. See Exhibit 1 for the RPP interview and survey timeline.

Exhibit 1. Interview and Survey Timeline

Interviews					Are We a Partnership Yet? survey
Dimension 1	**Dimension 2**	**Dimension 3**	**Dimension 4**	**Dimension 5**	
April 2020 January 2021	April 2020 January 2021 July 2021 January 2022 July 2022 January 2023	April 2020 January 2021 July 2021 January 2022 July 2022 January 2023	April 2020 January 2021	April 2020 January 2021 July 2021 January 2022 July 2022 January 2023	April 2020 January 2021 July 2021 January 2022 July 2022 January 2023

The AIR research team analyzed the survey data by reporting the accumulated responses for each individual dimension and displaying the data to compare them with the findings from the previous survey administration (when available). The AIR research team coded interview notes in a spreadsheet based on the dimensions and aligned interview questions. By analyzing the responses associated with the main topics, the research team identified emerging themes, examples, and illustrative quotes to share perspectives and insights of the PUMP-CS participants.

After the first two rounds of interviews, the RPP decided to focus primarily on Dimensions 2, 3, and 5 moving forward. The RPP made this decision to prioritize AIR's work in key areas. Dimension 1 was removed because the RPP felt more confident in that area than in others. Dimension 4 was no longer a priority because the district's delays in providing the RPP with data prevented the partnership from producing studies that could inform improvement efforts more broadly.

3. Teacher and Principal Survey Results

In this section, we begin with a selected subset of the teacher survey results and then describe noteworthy results from the principal survey. For transparency, the results for all items included in the analysis are in Appendices A and B. The motivation for elevating some results in this report is to draw particular attention to some consistent findings as well as fluctuations that may be of interest to the RPP based on our annual discussions regarding these data points.

It is important to note that these survey results did not come from a representative sample of teachers and principals, and the respondents' sample sizes varied from year to year. So, although AIR recommends using caution when interpreting these results, they still may be valuable in informing future decisions about efforts to change perceptions and practices.

We rounded all findings, so some totals may be more or less than 100%. In some instances, when fewer than 5% of the respondents endorsed a category, the exact percentage is not provided in the graph because of space and formatting constraints.

3.1. Teacher Sample

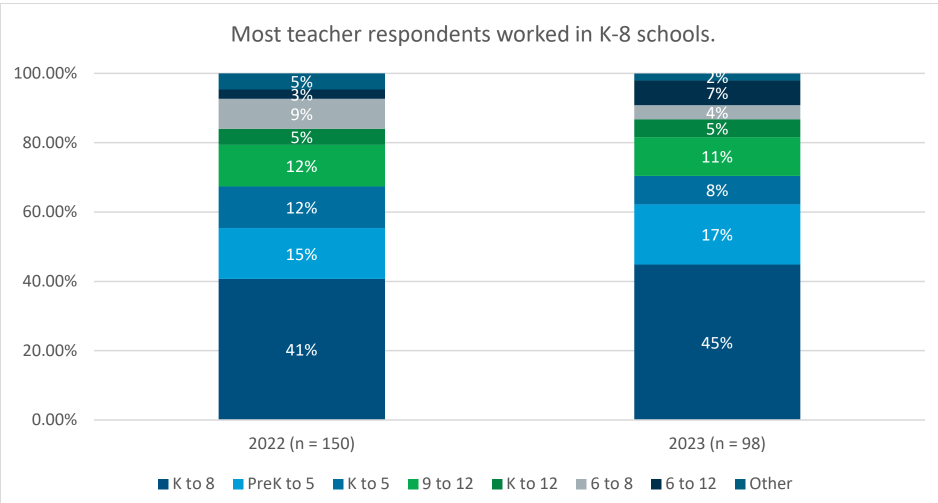
The total number of MPS teacher respondents across the years ranged from 87 to 152. See Exhibit 2 for the sample by year and the response rate.

Exhibit 2. Teacher Survey Response Rates

	Surveys		
	2021	2022	2023
Surveys administered	249	503	511
Number of teacher participants	87	152	98
Response rate	35%	30%	19%

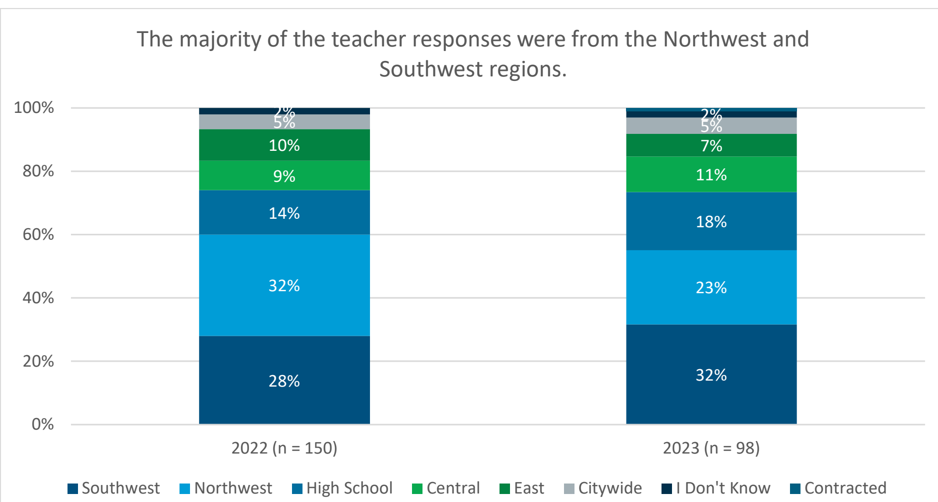
In 2022 and 2023, the survey included items asking about grade levels taught and the region in which their schools were located. In terms of grade levels, in both 2022 and 2023, most teacher respondents worked in K–8 schools. See Exhibit 3.

Exhibit 3. Teacher Response by School Type



The regions with the highest teacher response rates were Northwest and Southwest (Exhibit 4).

Exhibit 4. Teacher Response by Region



3.2. Teacher Results

In this section, we highlight teachers' perceptions about students and computational thinking, the extent to which teachers reported that professional development (PD) opportunities emphasized computational thinking, and teachers' reported practices.

The major takeaways from the teacher survey results were as follows:

- From 2021 to 2023, a greater percentage of teachers perceived their PD experiences emphasized **computational thinking integration, inquiry-based activities,** and **monitoring students' understanding of computational thinking**.
- Teachers reported integrating computational thinking the most in their math classes.
- On average, teachers reported integrating pattern recognition and algorithms the most.
- From 2021 to 2023, the percentage of teachers reporting that they used inquiry methods increased, whereas the use of whole-class discussion decreased.
- From 2021 to 2023, more than one third of the teachers reported that their PD placed little to no emphasis on the difficulties that students may have with particular computational thinking skills.
- From 2021 to 2023, more than 40% of the teachers reported that their PD placed little to no emphasis on the incorporation of students' cultural backgrounds into computational thinking.

3.2.1. Teachers' Perceptions About Students and Computational Thinking

Across all 3 years, at least 97% of the teachers surveyed (2021, *n* = 85; 2022, *n* = 133; and 2023, *n* = 98) agreed (responded with either "somewhat agree," "agree," or "strongly agree") that

Commented [WJ1]: What sample size? Does "agree" mean "agree and strongly agree"? In this statement?

Commented [SC2R1]: @Srikanth, Ajay can you address this one in the text, please?

Commented [SA3R1]: Added sample sizes for all 3 years.

Commented [SC4R1]: @Srikanth, Ajay Joey also wanted to know whether agree means agree and strongly agree. Can you address that in the text, if it includes strongly agree, too?

Commented [SA5R1]: Just added as a parenthetical- includes "Somewhat Agree", "Agree", and "Strongly Agree"

Commented [SC6R1]: thank you!

- their students can learn and develop computational thinking skills, regardless of the year;
- the students they teach will need to have computational thinking skills for future employment; and
- computational thinking should be integrated across content areas.

At least 96% of the teachers reported that they held a positive attitude toward their own computational thinking abilities.[1]

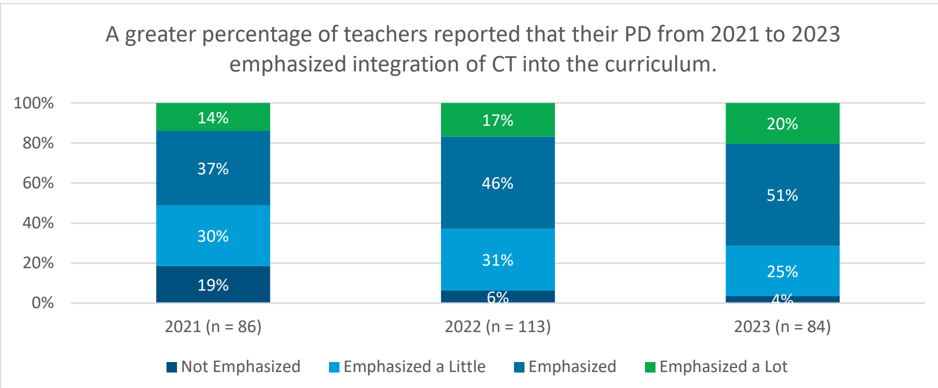
3.2.2. Teachers' Perceptions About Their Professional Development

Teachers' perceptions about the emphasis on particular aspects of computer science in their PD experiences during the last 4 years increased almost across the board. There was an increase in the percentage of teachers reporting that the following were "emphasized" or "emphasized a lot" in their PD experiences (Exhibit 5): (a) integrating computational thinking into the curriculum, (b) deepening their understanding of how computational thinking is done, (c) engaging students in computational thinking through inquiry-based activities, (d) learning about potential difficulties that students may have with particular computational thinking skills, (e) monitoring students' understanding of computational thinking, (f) differentiating

[1] In 2021, this item was phrased as "I take a positive attitude toward my computational thinking abilities."

computational thinking instruction to meet the needs of diverse learners, and (g) incorporating students' cultural backgrounds into computational thinking instruction. For more information on the extent to which teachers reported each experience as being emphasized during the last 4 years, see Exhibits 5–11.

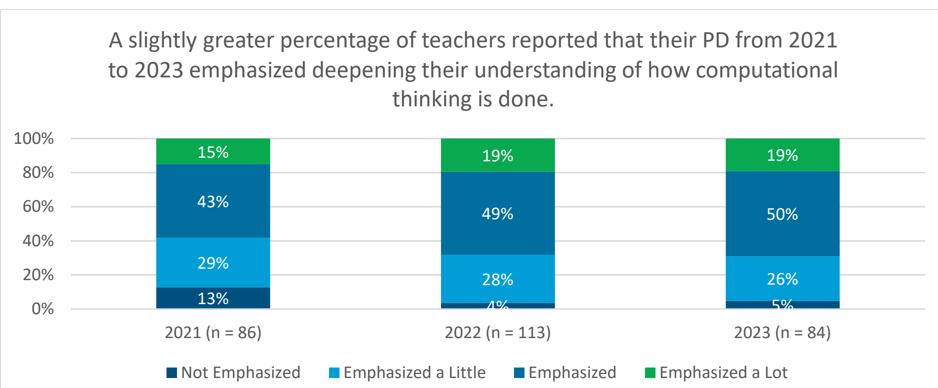
Exhibit 5. PD Emphasis on Integrating Computational Thinking Into the Curriculum



Note. CT = computational thinking; PD = professional development.

The percentage of teachers who responded with "emphasized" or "emphasized a lot" increased from about 50% in 2021 to greater than 70% in 2023 (Exhibit 6).

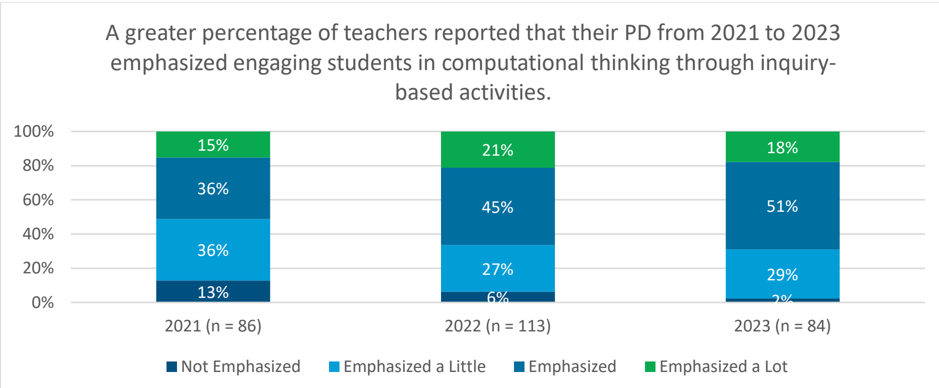
Exhibit 6. PD Emphasis on Deepening Teachers' Understanding of How Computational Thinking Is Done



Note. Deepening understanding could mean, for example, breaking problems into smaller parts. PD = professional development.

The percentage of teachers who responded with either “emphasized” or “emphasized a lot” increased from nearly 60% in 2021 to approximately 70% in 2023 (Exhibit 7).

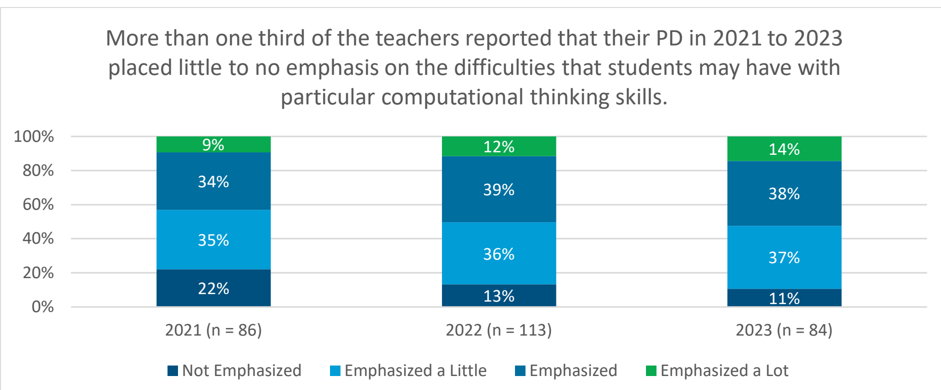
Exhibit 7. PD Emphasis on Engaging Students in Computational Thinking Through Inquiry-Based Activities



Note. PD = professional development.

More than 66% of the respondents in 2023 reported that engaging students in computational thinking through inquiry-based activities was “emphasized” or “emphasized a lot” in their PD compared with only 50% in 2021 (Exhibit 8).

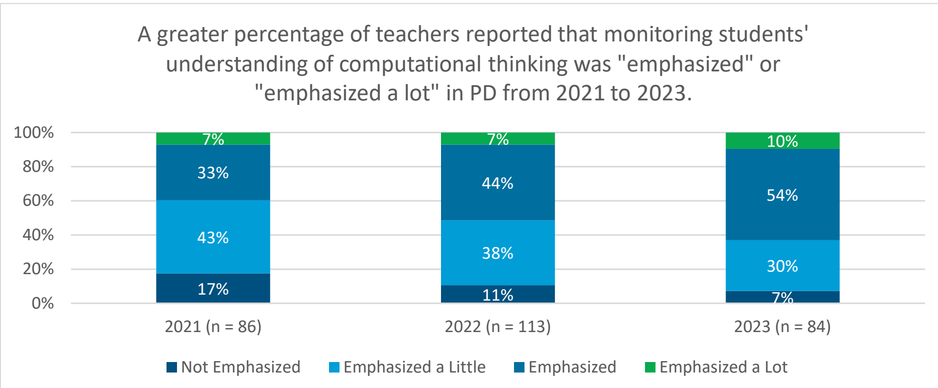
Exhibit 8. PD Emphasis on Learning About Difficulties Students May Have With Particular Computational Thinking Skills



Note. PD = professional development.

The percentage of teachers responding “not emphasized” decreased from 22% in 2021 to 11% in 2023 (Exhibit 9).

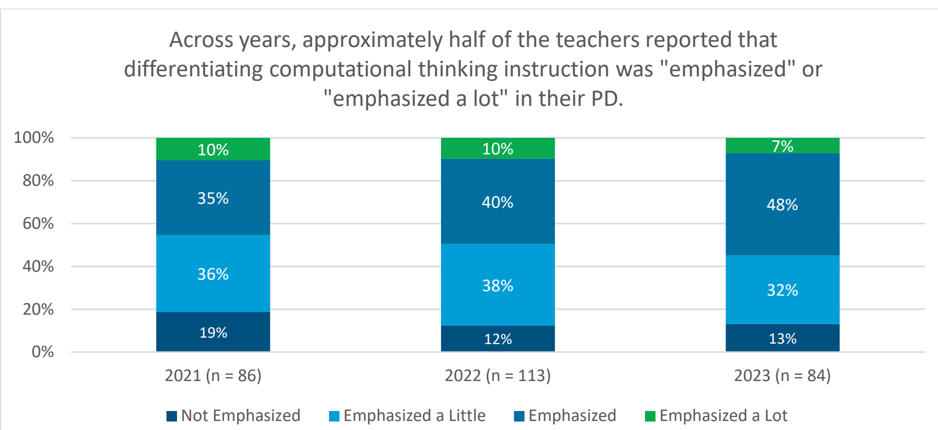
Exhibit 9. PD Emphasis on Monitoring Students’ Understanding of Computational Thinking



Note. PD = professional development.

The percentage of teachers responding that monitoring students’ understanding of computational thinking is “emphasized” or “emphasized a lot” increased from about 40% in 2021 to greater than 60% in 2023 (Exhibit 10).

Exhibit 10. PD Emphasis on Differentiating Computational Thinking Instruction to Meet the Needs of Diverse Learners



Note. PD = professional development.

There was a slight increase in the percentage of teachers responding that PD addresses diverse learners, going from slightly less than 50% of the respondents in 2021 to about 55% in 2023 (Exhibit 11).

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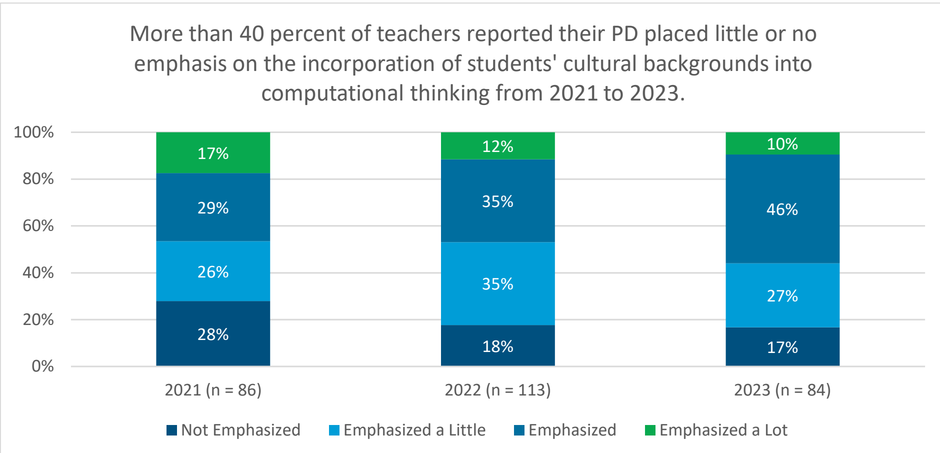
Exhibit 11. PD Emphasis on Incorporating Students' Cultural Backgrounds Into Computational Thinking Instruction



Note. PD = professional development.

There was a slight increase in the percentage of teachers responding that PD addresses incorporating students' cultural backgrounds into computational thinking instruction, going from slightly less than 50% of the respondents in 2021 to about 56% in 2023.

3.2.3. Teachers' Reported Practices

Across all years, teachers reported that computational thinking was **most integrated at their schools in math and least integrated in social studies**. There appears to be no substantial change across years in the percentage of teachers reporting that computational thinking is integrated into a specific subject. A slightly higher percentage of teachers reported not knowing whether computational thinking was integrated in 2023 (6.12%) than in 2021 (3.45%) and 2022 (4.26%). See Appendix A for more information.

Across years, teachers rank-ordered the computational thinking skills—pattern recognition, abstraction, decomposition, debugging, and algorithms—they integrated into their teaching. On average, teachers, **reported integrating pattern recognition and algorithms the most** each year. Debugging and abstraction were the least integrated skills. Between 2021 and 2023, teachers reported an average increase in their use of debugging by .5 point on a 5-point scale.

During this same time period, abstraction remained relatively the same with only a .19 increase on a 5-point scale.

Teachers' **most commonly reported instructional strategies for integrating computational** thinking were, on average, whole-class lectures/teacher demonstration (69%), inquiry methods (65%), and whole-class discussion (57%). Taking a closer look, the percentage of teachers reporting that they used inquiry methods increased from 57% in 2021 to 71% in 2023, and the use of whole-class discussion decreased by 11% during that same time period.

Teachers' **least commonly reported strategies** were project-based learning (42%), student demonstrations/presentations (40%), and homework done in class (22%). Notably, project-based learning increased by 10% from 2021 to 2023 and student demonstrations/presentations increased by 6% in the same time frame.

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Finally, teachers reported how often they used specific assessment practices to measure students' computational thinking skills. The **assessment practice that teachers most frequently reported using** either "weekly" or "daily" across the years, on average, was think-alouds (72%). The **least frequently used strategies** were peer evaluation and student portfolios (25%). For a complete list of the other strategies and their frequencies, see Appendix A.

3.3. Principal Results

In this section, we highlight principals' perceptions about student and teacher capacity related to computational thinking, perceptions about PD available to teachers, and the extent to which principals value computational thinking. We conclude with what principals report about computer science learning opportunities for students. The principal response rates are in Exhibit 12.

Exhibit 12. Principal Survey Response Rates

	Surveys	
	2021	2022
Surveys administered	150	144
Number of principal participants	33	70
Response rate	22%	49%

The major takeaways from the principal survey results were that from 2021 to 2022, a greater percentage of principals reported

- satisfaction with their teachers' ability to teach computational thinking skills,
- that their teachers take a positive attitude toward students' computational thinking abilities, and
- that their teachers had PD opportunities to teach computational thinking.

Despite these increased percentages, there is a lot of opportunity for growth in principals' perceptions about their teachers and their PD opportunities.

3.3.1. Principals' Perceptions About Students, Computational Thinking, and Teacher Capacity

In 2021 and 2022,

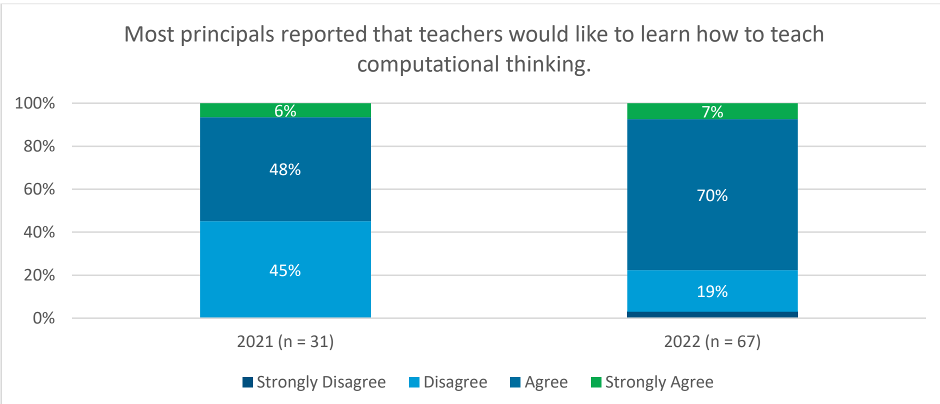
- more than 90% of the principals agreed or strongly agreed that students have a critical need for and are interested in computational thinking;
- nearly all responded that their students could learn and develop computational thinking skills—skills needed for future employment; and
- 97% of the principals responded that computational thinking should be integrated across content areas.

In 2021, less than 33% of the principals were satisfied with their staffs' ability to teach computational thinking skills. However, in 2022 this percentage increased substantially to more than 50% of the principals reporting that they are satisfied with their staffs' ability to teach computational thinking. Similarly, in 2021, 40% of the principals reported that their teachers take a positive attitude toward students' computational thinking abilities, but 60% agreed with this statement in 2022.

3.3.2. Principals' Perceptions of Professional Development Needs and Offerings

Across both years, 90% of the principals reported that their teachers needed additional training or PD in how to teach computational thinking. Approximately 25% of the principals in 2021 compared with 40% in 2022 agreed that all their teachers had the opportunity to learn how to teach computational thinking. The percentage of principals responding that teachers would like to learn how to teach computational thinking skills increased from slightly more than 50% in 2021 to nearly 80% in 2022 (Exhibit 13).

Exhibit 13. Principals' Perceptions About Teachers Liking to Learn How to Teach Computational Thinking



In 2022, more than 80% of the principals reported feeling confident in their ability to support staff in teaching computational thinking; this represents an approximate 10% increase from 2021.

3.3.3. Principals' Perceptions About Computer Science Offerings

A greater percentage of principals in 2021 reported more increases and decreases in student learning opportunities. In 2022, however, principals were more likely to report that opportunities had stayed the same. See Exhibit 14.

Exhibit 14. Opportunities to Learn Computer Science

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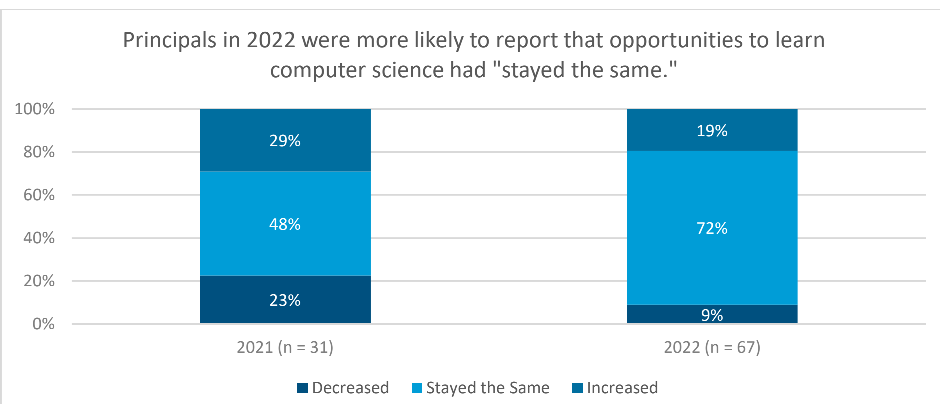


4. PUMP-CS RPP Evaluation Results

Five EQs drove the RPP evaluation (EQs 2–6 of the full evaluation). In this section, we present the findings using evidence from the surveys and interviews. We also highlight potential growth opportunities for the RPP to consider.

4.1. To what extent did the quality of relationships within the partnership improve from 2019 to 2023 (EQ2)?

Members consistently rated the RPP as "on track toward maturing" for the Cultivating Partnership Relationships dimension of the AWAPY survey.

This question most closely aligns with Dimension 1 (building trust and cultivating partnership relationships), which the group deprioritized because of its relative confidence in this area. From 2020 to 2021, the dimension Cultivating Partnership Relationships consistently received an "on track toward maturing" rating.

4.1.1. Strengths

The RPP highlighted specific accomplishments in this area, including regular meetings with consistent attendance and centrally located and organized meeting agendas. Early in the partnership, the RPP created specific norms such as these to enable open and flexible communication among the partnership members. Once these norms were established (and there is clear evidence that they were established by 2020), the norms guided meetings and relationships throughout the partnership.

When RPP interviews first began, members noted that a common language was not always used. Research jargon sometimes was spoken in team meetings, and the practitioners did not always understand the topic under discussion. There also was confusion about the term "champion" and who might be considered the partnership's champion within MPS. These issues were discussed explicitly at leadership meetings, and stronger cohesion was evident during the next round of interviews.

4.1.2. Potential Growth Opportunity

The relationship between the leadership team and the steering committee is worth noting because of its variability during this time. The steering committee met regularly, but, like all groups, the COVID-19 shutdowns had impacts. Though the committee did return, it did not operate with the same consistency, and its purpose did not always have a clear definition. The leadership team verbally expressed a desire to reengage with the steering committee at prepandemic levels, but this goal was never fully realized.

4.2. To what extent has the research produced been relevant, timely, and rigorous (EQ3)?

Member ratings advanced from "early or in development" to "on track toward maturing" for the Conduct Rigorous and Relevant Research dimension of the AWAPY survey.

This question most closely aligns with Dimension 2 (conducting rigorous research to inform action), which was a dimension that the group prioritized. Ratings for the Conduct Rigorous and Relevant Research dimension of the AWAPY survey advanced throughout the course of the partnership, moving from "early or in development" to "on track toward maturing."

4.2.1. Strengths

The researchers in the RPP displayed systems and structures for collecting, organizing, analyzing, and synthesizing data. Being an RPP with two researcher partners, it was necessary to work together and streamline data collection to paint a full picture.

4.2.2. Potential Growth Opportunities

Data access for research purposes has been inconsistent throughout the partnership. A large reason for this has been a change in staffing in the MPS research office that has, at times, significantly delayed access to needed data. This issue also delayed scheduled research in the partnership timeline.

One recurring issue was the disconnect between data organization and data availability to members of the RPP. During several rounds of RPP interviews, MPS expressed a desire to have more data at their fingertips. One interviewee said,

> I would like to have something quick that I can share with people in passing. It's a lot easier for me to show a visual rather than a document because when you give any document, it depends on how much time the person has to read it. In a visual, it's all right there. It's a lot easier to present to a larger audience rather than a whole bunch of reading.

The disconnect, however, is a continued barrier between understanding what the practitioners need and how that differs from what is delivered. Throughout multiple rounds of interviews, one RPP member noted that they struggled to fully understand how to respond to the MPS's needs regarding the data. Evidence of this disconnect was visible throughout most of the RPP's existence.

To address these challenges, the partnership developed and maintains a shared data summary table. The purpose of the table was to centralize all data findings in an accessible format to maximize the data's usefulness for each intended audience. Links to this data summary table and other data sources also were placed in the team meeting invites and running agenda so that everyone could find it when needed. The RPP also developed a Tableau map that summarizes data geographically.

4.3 What types of support were put in place to aid the use of the research produced? How timely and useful have these supports been? (EQ4)

Members consistently rated the RPP as "on track toward maturing" for the Impact Local Improvement Efforts dimension of the AWAPY survey.

This question most closely aligns with Dimension 3 (supporting the partner practice organization in achieving its goals), which was a dimension that the group prioritized. As the partnership matured, so did the group's emphasis on examining the data they had available. The RPP created multiple methods and protocols for holding data discussions to ensure that the data played an important role in the work. Ratings for the Impact Local Improvement Efforts dimension of the AWAPY survey generally stayed steady throughout the partnership, remaining at the "on track toward maturing" level.

4.3.1. Strengths

As more data became available, the partnership adopted and adapted High Tech High's Data for Equity Protocol for examining and discussing data during leadership meetings. Reactions to the adoption of this protocol were very positive because the protocol focused heavily on a structured process of understanding, interpreting, and goal setting concerning the information available. RPP members expressed their appreciation for the opportunities afforded by the data examination protocol. One RPP member said, "It's so interesting what we come back with. It depends on the lens. It's fascinating." Dedicated time was added to the meeting agendas to undertake this process.

The group also put processes in place to make sure the data were visible to partnership members when needed. As discussed earlier, the partnership developed and maintains a shared data summary table and Tableau map.

4.3.2. Potential Growth Opportunities

The actual usage of data has not been consistent throughout the partnership. RPP interviews uncovered a lack of awareness of content in the data summary table, even after multiple internal discussions of its use. A disconnect still exists between the availability of the data and its actual use in communicating the work of the partnership. Relatedly, the group has never fully articulated a dissemination plan for sharing data with other stakeholders. One RPP member noted, "What we don't have is a sense for what [MPS] are doing with the results." Opportunity exists for further growth concerning data discussions and barriers.

4.4. To what extent has the capacity of the researcher and practitioner partners to engage in partnership work improved from 2019 to 2023? (EQ5)

Members consistently rated the RPP as "on track toward maturing" for the Develop Capacity to Engage in Partnership Work dimension of the AWAPY survey.

This question most closely aligns with Dimension 5 (building the capacity of participating researchers, practitioners, practice organizations, and research organizations to engage in partnership work), which was a dimension that the group prioritized. Ratings for the Develop Capacity to Engage in Partnership Work dimension of the AWAPY survey stayed constant throughout the partnership, remaining at the "on track toward maturing" level.

4.4.1. Strengths

The RPP has found success with the diversity of expertise that each individual brings to the table. One RPP member stated, "Everyone brings unique perspectives, and we try to build consensus among the group." These varied backgrounds enabled the RPP to accomplish objectives from multiple angles. One example is the development of the principal and teacher surveys. Researchers initially created the content, but practitioners reviewed and edited the content extensively to add context that the researchers did not have. The administration of the surveys also benefited from research and practice minds working together to accomplish the goal. The continued collaborative refinement processes helped build the RPP's ownership of the surveys and led to a deeper discussion among RPP members about the value of building principal and teacher awareness of the role that computational thinking should play across subject areas and grade levels, even if their schools do not currently offer a course labeled "computer science."

4.4.2. Potential Growth Opportunities

During the RPP interviews, it became apparent that collaborative goal setting is a potential area in which the partnership could grow. There was some disagreement about the specific, measurable, attainable, realistic, and timely goal for Advanced Placement (AP) participation, for example. A practitioner noted,

> The AP goal didn't come from us. It came from research. I could have told you we're not going to meet this goal. I think, in creating these goals, we need to be a little more collaborative. The outside people don't always understand all of the roadblocks that are put up for us.

Structures for better collaboration on goal setting could be an opportunity moving forward. In addition, there is an opportunity to improve the preparation of partnership members to share about the work. Interviews revealed a desire and a need for more supports in sharing updates and collected data. As discussed earlier, the disconnect in data organization and availability between researchers and practitioners is a problem to address. This disconnect also led to issues with sharing data outside the partnership.

4.5. To what extent did the RPP develop and share knowledge, tools, and routines within the district and with the computer science field more broadly from 2019 to 2023? (EQ6)

Member ratings for the Inform the Work of Others dimension of the AWAPY survey alternated between "early or in development" and "on track toward maturing."

This question most closely aligns with Dimension 4 (producing knowledge that can inform educational improvement efforts more broadly), which was not a dimension that the group prioritized. Ratings for the Inform the Work of Others dimension of the AWAPY survey varied throughout the partnership, alternating between "early or in development" and "on track toward maturing."

4.5.1. Strengths

During the partnership, interest and participation in computer science improved at MPS. In the RPP interviews, one RPP member said, "The word is getting out more. Teachers are interested, and there are more schools every year." The data show an increase in participating schools, but other RPP-specific connections also can be made. The district RPP members used the PUMP-CS RPP logic model during the SCRIPT meetings to build buy-in for the computer science work within the MPS system. This process allowed the group to showcase the logic model and the progress made on it.

The researchers' past experiences also have been very helpful in the RPP's work. The Learning Partnership's experiences doing similar work in Chicago Public Schools resulted in opportunities to share what worked and did not work in the past, which can be beneficial to the Milwaukee project. Marquette University's experience working in this realm and connections in the field also provided incredible value to the project.

Although the disconnect between data organization and availability was previously documented and will be listed as a growth area in this section, the partnership has continued to revisit strategies for making data more accessible and operational for MPS. The partnership decided to add data needs and data sharing opportunities as a standing item for the RPP leadership calls. The shared data summary table and Tableau map, which the partnership developed and maintains, also create an opportunity for MPS to access the data.

4.5.2. Potential Growth Opportunities

The data organization and availability disconnect is a continuing growth opportunity. One RPP member said, "I don't feel that I have that at my fingertips. Mostly, I'm looking for data for when I go in to talk to principals." To successfully share knowledge, the practitioners must feel as if they have the information they need. This is a continued struggle as the researchers try to understand those needs.

Much talk is ongoing about developing a dissemination plan to share knowledge, tools, and routines more broadly, but this talk has not yet resulted in a strong plan. Discussions also are in progress to better use the PUMP-CS website to share information, and this area could be developed more in the future.

The steering committee could be repurposed to better focus on sharing information more broadly. There is no clearly agreed-on purpose and mission for this committee, which has resulted in some inconsistency. The committee could be positioned to strategically communicate key contacts within and beyond the district.

References

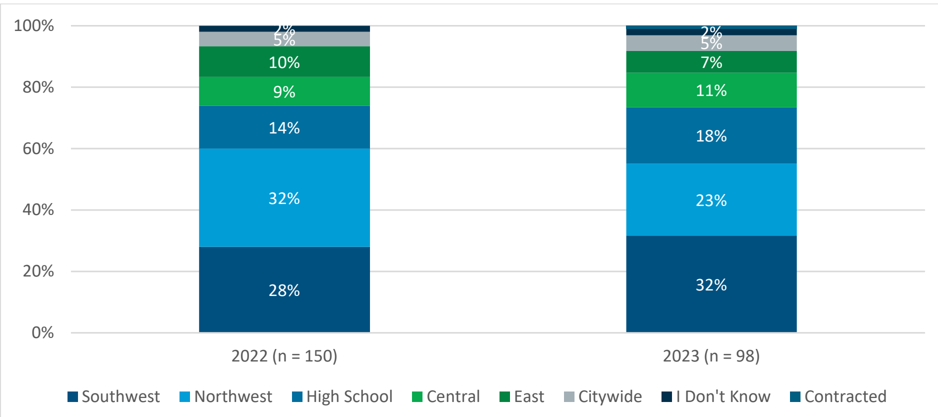
Henrick, E. C., Cobb, P., Penuel, W. R., Jackson, K., & Clark, T. (2017). *Assessing research-practice partnerships: Five dimensions of effectiveness*. William T. Grant Foundation. https://rpp.wtgrantfoundation.org/wp-content/uploads/2019/09/Assessing-Research-Practice-Partnerships.pdf

Penuel, W. R., & Gallagher, D. (n.d.). *Are we a partnership yet?* Design Based Implementation Research. http://learndbir.org/resources/diagnostic-rubric-are-we-a-partnership-yet

Scholz, C., LaTurner, J., & Barkowski, E. (2021). *Tool for assessing the health of research-practice partnerships* (REL 2021–057). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest. https://ies.ed.gov/ncee/rel/regions/southwest/pdf/REL_2021057.pdf

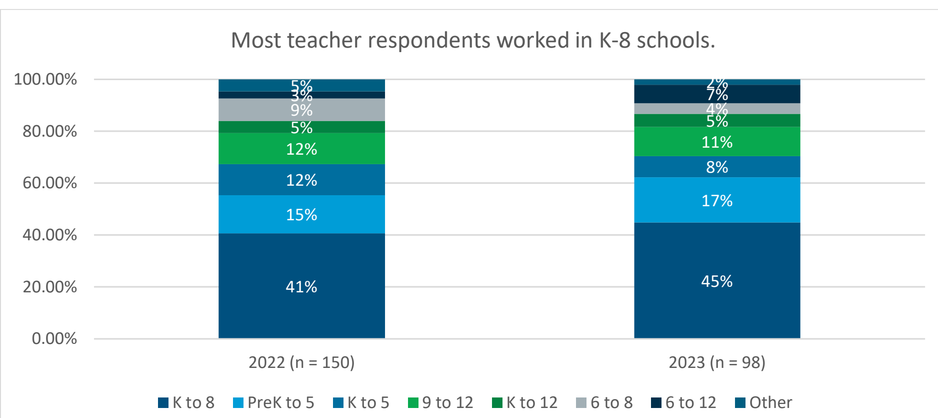
Appendix A. PUMP-CS Teacher Survey Analysis

Exhibit A1. Teacher Respondents by Region



In 2023, about one third of the respondents were from the Southwest region and slightly less than one quarter of the respondents were from the Northwest region.

Exhibit A2.Teacher Respondents by School Type



In both 2022 and 2023, more than two thirds of the respondents were in schools that served students in Grades K–8, PK–5, or K–5. More than 40% of the respondents are from schools serving Grades K–8.

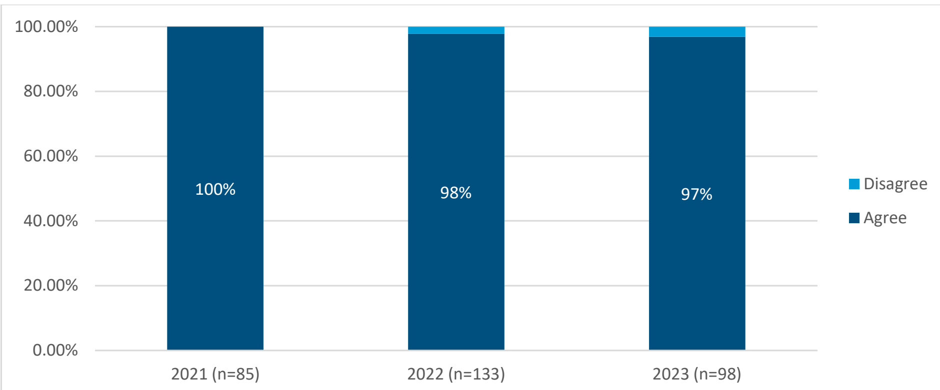
Commented [CW10]: The first sentence states that two thirds are from K-8, and this sentence says 40%. Isn't this an inconsistency in data?

Commented [SA11R10]: Not inconsistent. The first sentence talks about three different school structures (K-8, PK-5, K-5). The second talks about one school structure (K-8).

Teacher Perceptions Survey Items

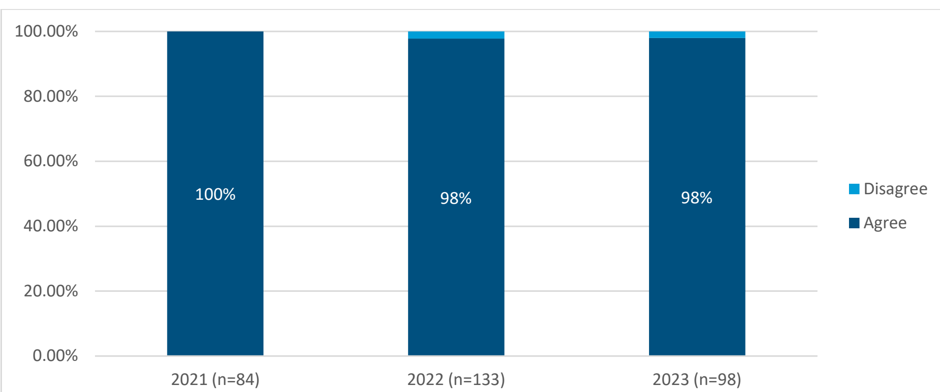
Survey Item: The students I teach can learn and develop computational thinking skills.

Exhibit A3. Key Finding 1: Nearly all teachers believe that their students can learn and develop computational thinking skills, regardless of the year.



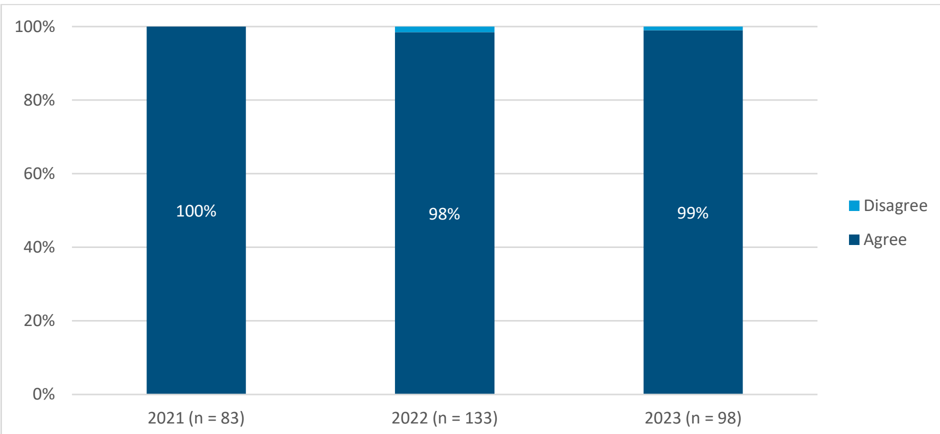
Survey Item: The students I teach will need to have computational thinking skills for future employment.

Exhibit A4. Key Finding 2: Nearly all teachers believe that students will need to have computational thinking skills for future employment.



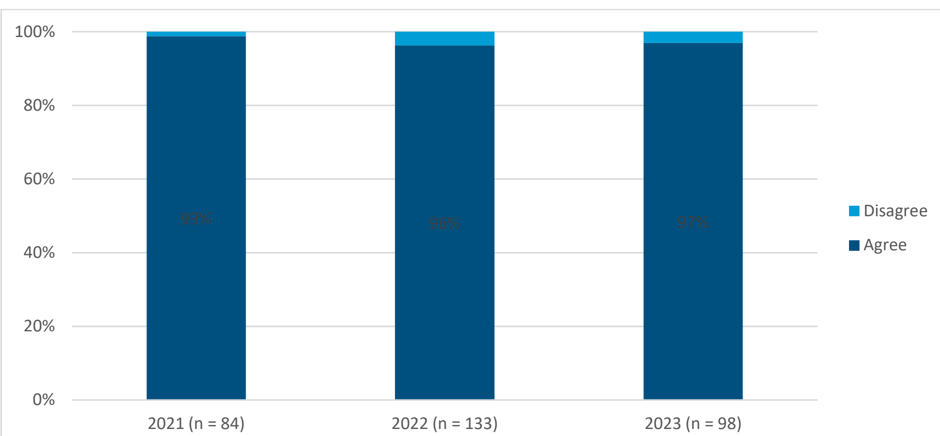
Survey Item: Computational thinking should be integrated across content areas.

Exhibit A5. Key Finding 3: Nearly all teachers believe computational thinking should be integrated across content areas.



Survey Item: I hold a positive attitude toward my computational thinking abilities.[2]

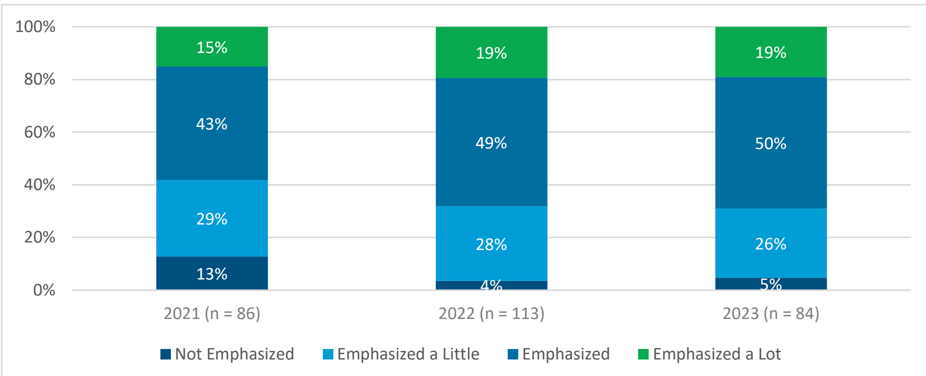
Exhibit A6. Key Finding 4: Nearly all teachers believe that they hold a positive attitude toward their own computational thinking abilities.



[2] In 2021, this item was phrased as "I take a positive attitude toward my computational thinking abilities."

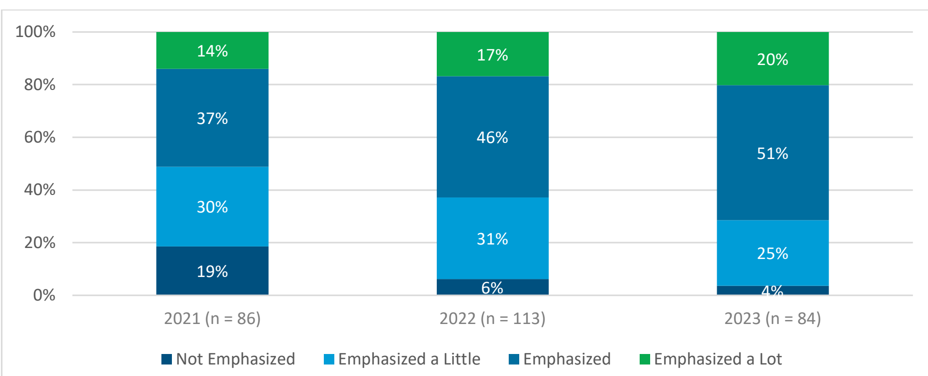
Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: Deepening your understanding of how computational thinking is done (for example, breaking problems into smaller parts)?

Exhibit A7. Key Finding 5: The percentage of teachers who responded with either "emphasized" or "emphasized a lot" increased from nearly 60% in 2021 to approximately 70% in 2023.



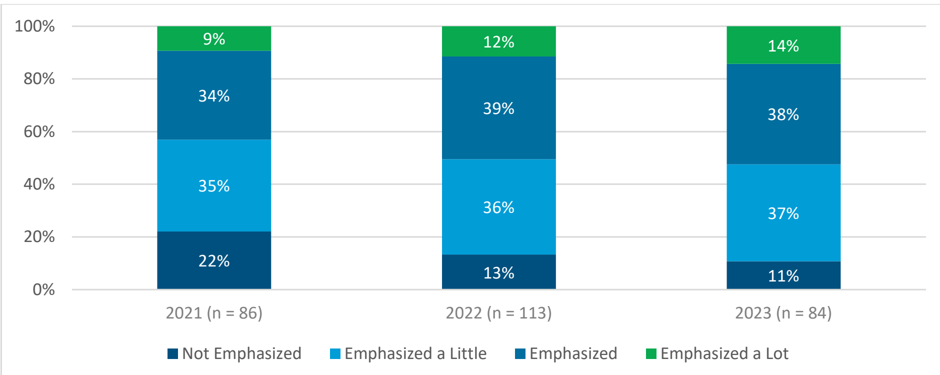
Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Integrating computational thinking into your curriculum?*

Exhibit A8. Key Finding 6: The percentage of teachers who responded with either "emphasized" or "emphasized a lot" increased from about 50% in 2021 to greater than 70% in 2023.



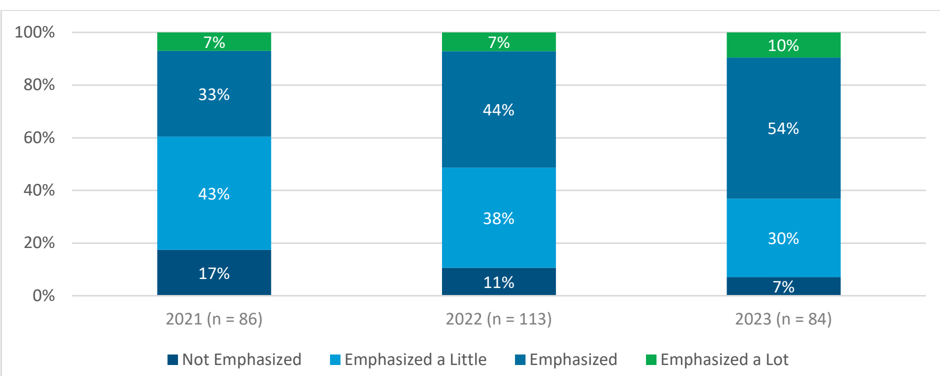
Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Learning about difficulties students may have with particular computational thinking skills?*

Exhibit A9. Key Finding 7: The percentage of teachers responding "not emphasized" decreased from 22% in 2021 to 11% in 2023.



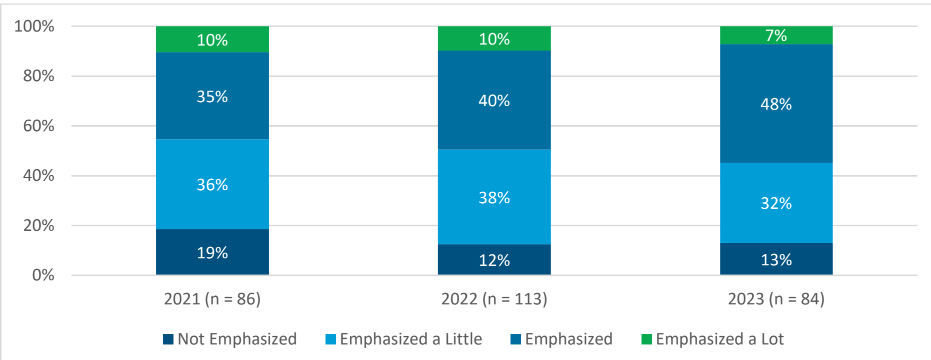
Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Monitoring students' understanding of computational thinking?*

Exhibit A10. Key Finding 8: The percentage of teachers responding that monitoring students' understanding of computational thinking is "emphasized" or "emphasized a lot" increased from about 40% in 2021 to greater than 60% in 2023.



Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Differentiating computational thinking instruction to meet the needs of diverse learners?*

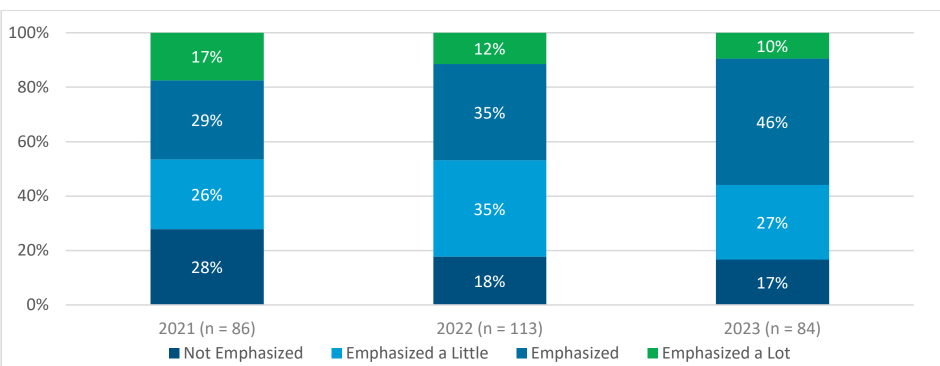
Exhibit A11. Key Finding 9: There was a slight increase in the percentage of teachers responding that PD addresses diverse learners, going from less than 50% of the respondents in 2021 to about 55% in 2023.



Note. PD = professional development.

Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Incorporating students' cultural backgrounds into computational thinking instruction?*

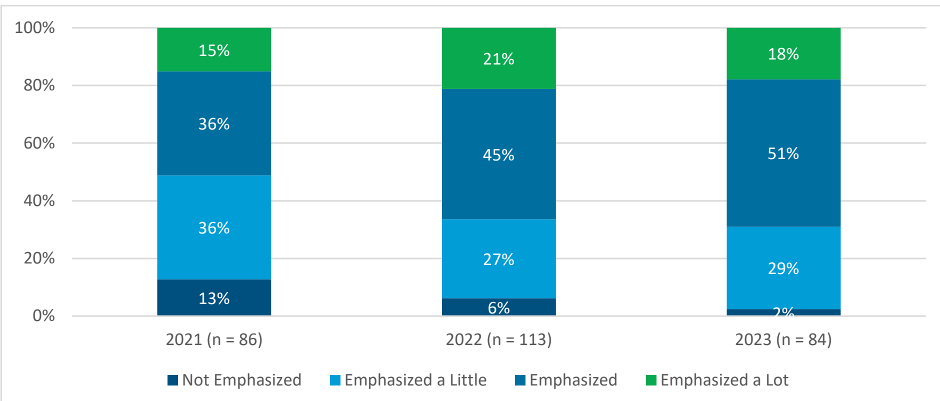
Exhibit A12. Key Finding 10: There was a slight increase in the percentage of teachers responding that PD addresses incorporating students' cultural backgrounds into computational thinking instruction, going from less than 50% of the respondents in 2021 to about 55% in 2023.



Note. PD = professional development.

Survey Item: Thinking about computer science professional development you have attended or engaged in during the last 4 years, to what extent was each of the following emphasized: *Engaging students in computational thinking through inquiry-based activities?*

Exhibit A13. Key Finding 11: More than 66% of the respondents in 2023 reported that PD "emphasized" or "emphasized a lot" engaging students in computational thinking through inquiry-based activities, an increase from about 50% in 2021.



Teacher Perception Items Removed From the Analysis

The following items were removed from the analysis because of too many "neither agree nor disagree" responses:

- The students I teach are interested in computational thinking. (18.6%)
- Over the last five years, I have had the opportunity to learn how to incorporate computational thinking into my instruction. (7.0%)
- I am able to complete tasks that require computational thinking as well as most other colleagues. (4.65%)
- I have had positive experiences integrating computational thinking into my teaching. (8.14%)
- On the whole I am satisfied with my ability to integrate computational thinking into my teaching. (9.3%)

The following items were discarded because of changes in phrasing from 2021 to 2022–23:

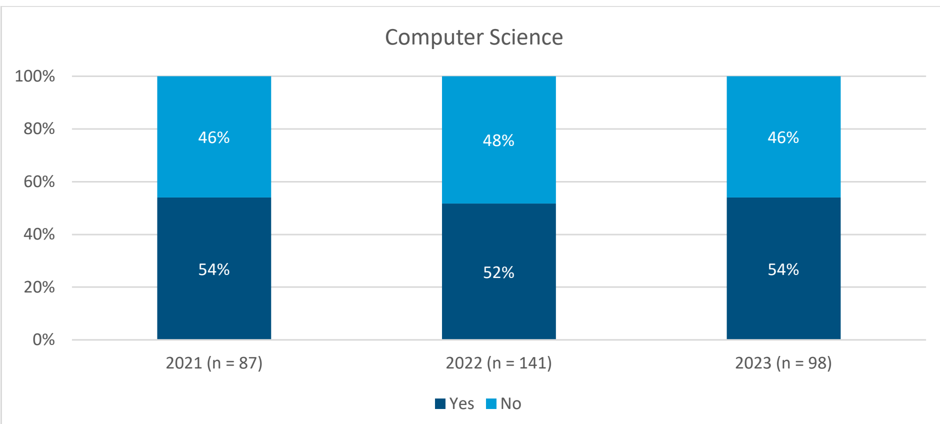
- The students I teach are old enough to develop computational thinking skills.
- The students I teach have a critical need for computational thinking skills.
- I would like to learn how to better integrate computational thinking into my teaching.

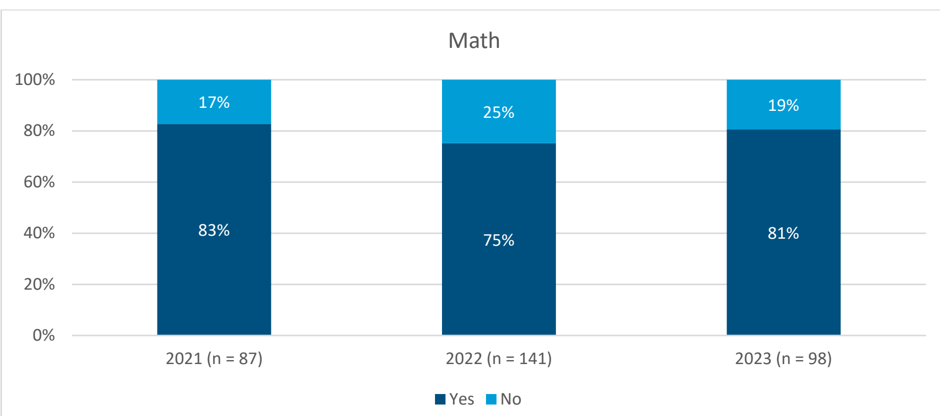
Teacher Practice Survey Items

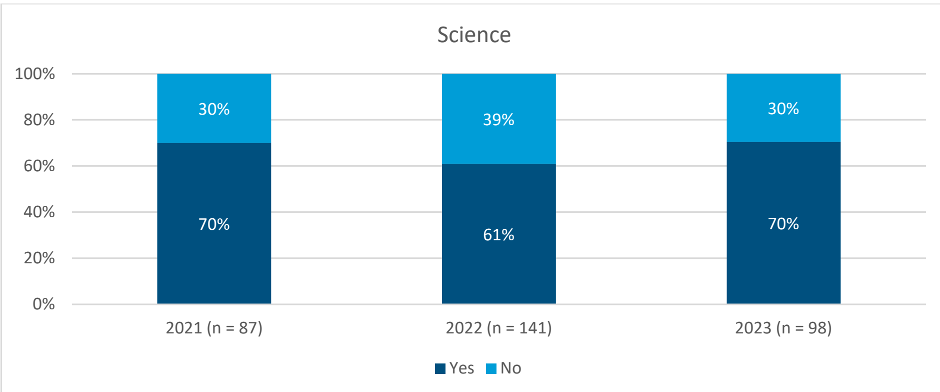
Survey Item: Computational thinking is integrated at my school in the following content area(s) [computer science, math, science, English/ELA, and social studies].

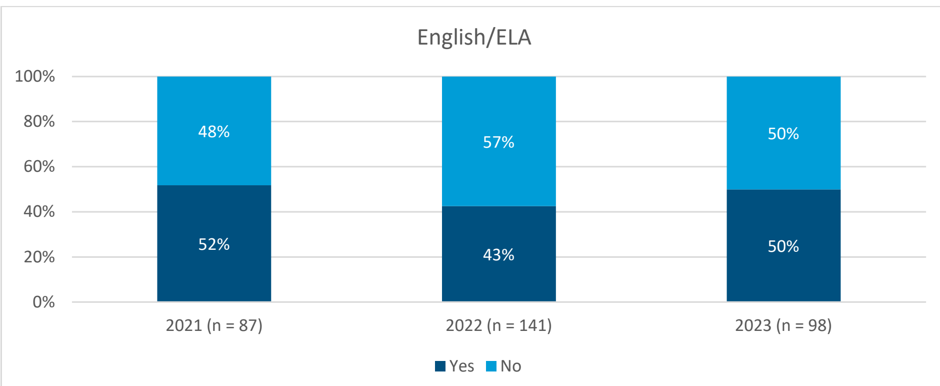
Commented [CW12]: Likely the survey used bullet points or some other subdivision for each area, but the question still is recommended for complete presentation. The brackets indicate the variation in the format. (The same applies to some later questions.)

Exhibit A14. Key Finding 1: Across all years, computational thinking is most integrated into math and least integrated into social studies. No substantial change across years was apparent in the percentage of teachers reporting that computational thinking is integrated into a specific subject. A higher percentage of teachers reported not knowing whether computational thinking was integrated in 2023 than in 2021 or 2022.






Science
100%
80%
60%
40%
20%
0%
30%
39%
30%
70%
61%
70%
2021 (n = 87)
2022 (n = 141)
2023 (n = 98)
Yes
No


English/ELA
100%
80%
60%
40%
20%
0%
48%
57%
50%
52%
43%
50%
2021 (n = 87)
2022 (n = 141)
2023 (n = 98)
Yes
No

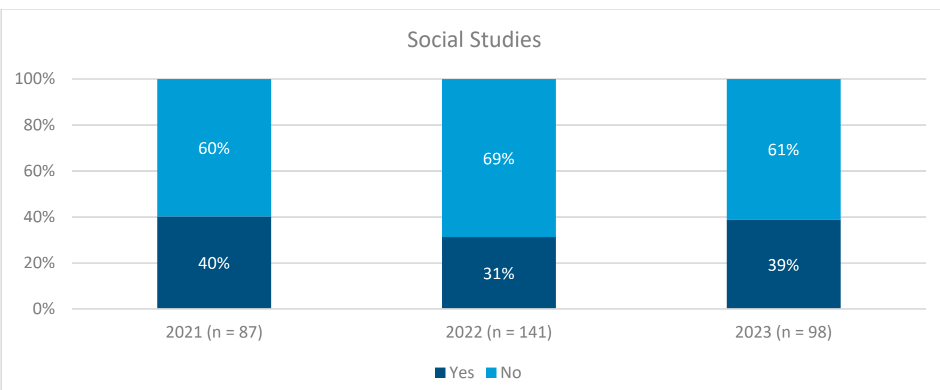
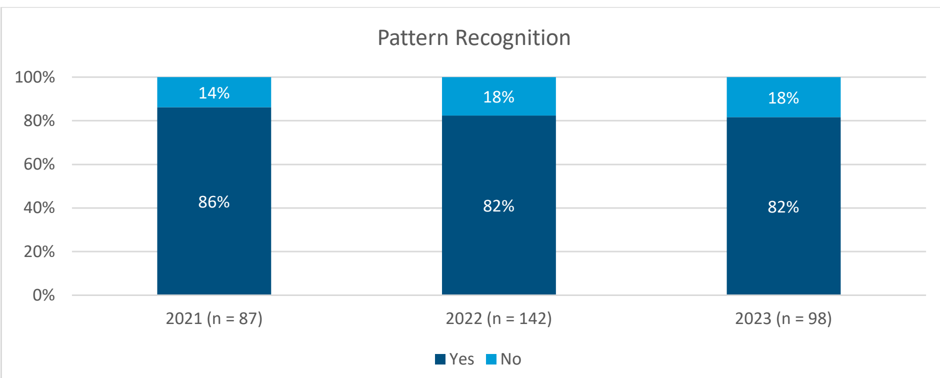

Social Studies
100%
80%
60%
40%
20%
0%
60%
69%
61%
40%
31%
39%
2021 (n = 87)
2022 (n = 141)
2023 (n = 98)
Yes
No

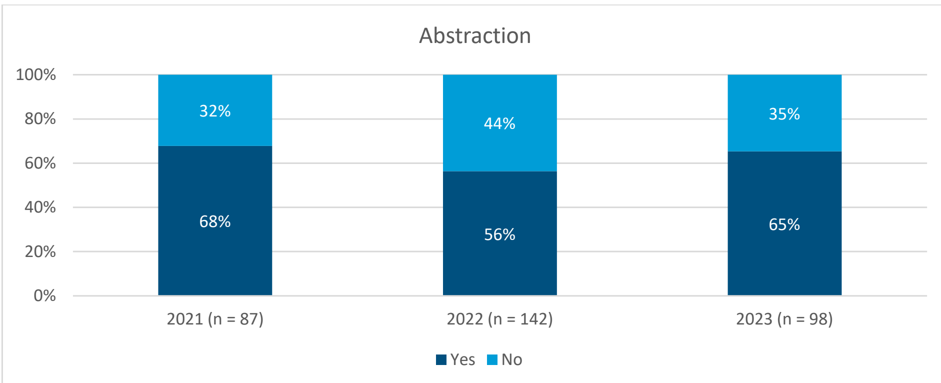
Exhibit A15. In response to "Computational thinking is integrated at my school in the following content area(s)," some teachers reported "none," and others reported "I don't know."

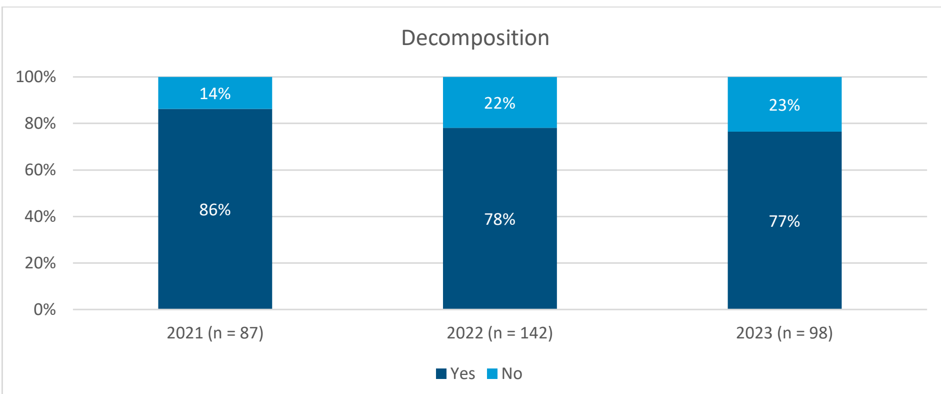
None		I Don't Know	
Year	Percentage none	Year	Percentage I don't know
2021	1.15%	2021	3.45%
2022	2.13%	2022	4.26%
2023	1.02%	2023	6.12%

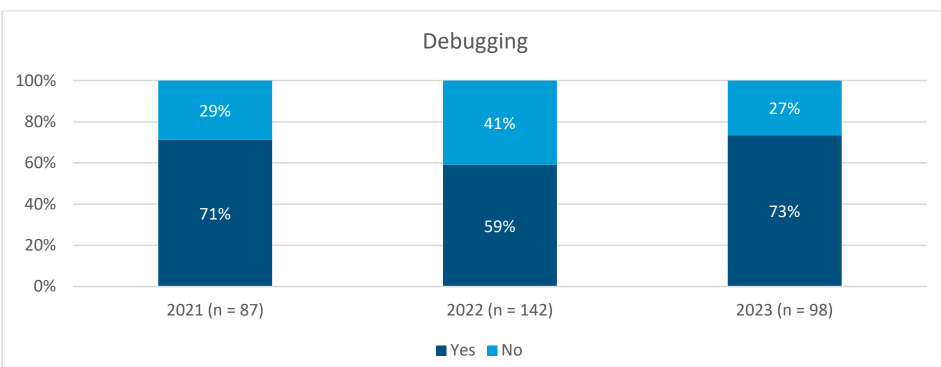
Survey Item: Which of these computational thinking skills have you integrated into your teaching [pattern recognition, abstraction, decomposition, debugging, algorithms]? Select all that apply.

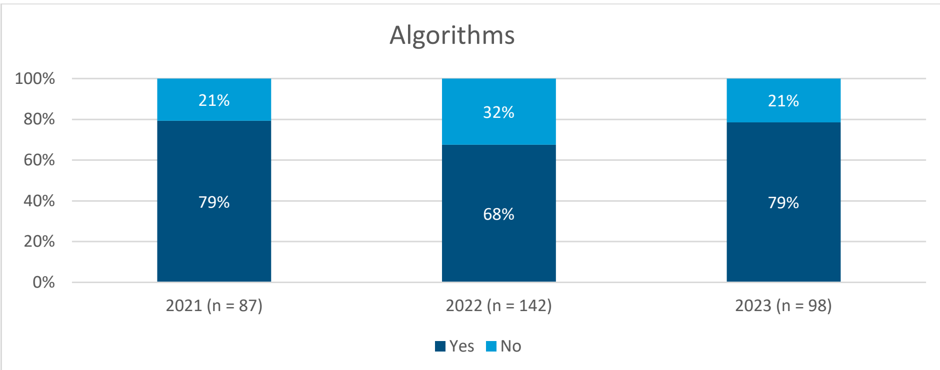
Exhibit A16. Key Finding 2: Pattern recognition and algorithms are the most integrated skills for teaching. Abstraction is the least integrated skill.




Abstraction
100%
80%
60%
40%
20%
0%
32%
44%
35%
68%
56%
65%
2021 (n = 87)
2022 (n = 142)
2023 (n = 98)
Yes
No


Decomposition
100%
80%
60%
40%
20%
0%
14%
22%
23%
86%
78%
77%
2021 (n = 87)
2022 (n = 142)
2023 (n = 98)
Yes
No

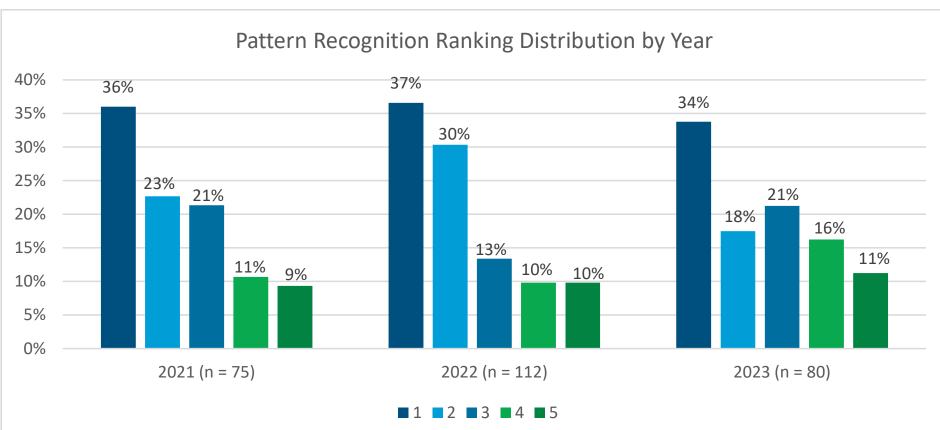

Debugging
100%
80%
60%
40%
20%
0%
29%
41%
27%
71%
59%
73%
2021 (n = 87)
2022 (n = 142)
2023 (n = 98)
Yes
No



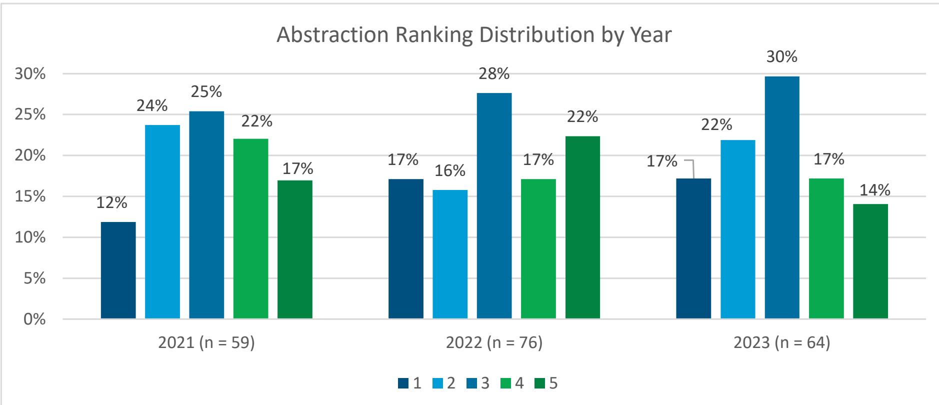
Survey Item: Rank order the computational thinking skill(s) you have integrated into your teaching this school year, starting with 1 = integrated the most.

Exhibit A17. Key Finding 3: Across all years, pattern recognition and algorithms have the greatest percentage of respondents listing them as the most integrated skills. Debugging is the least integrated skill. However, the mean rank for debugging improved from about 3.5 (on a 5-point scale) to 3.0 (on a 5-point scale). Lower values represent more integration.

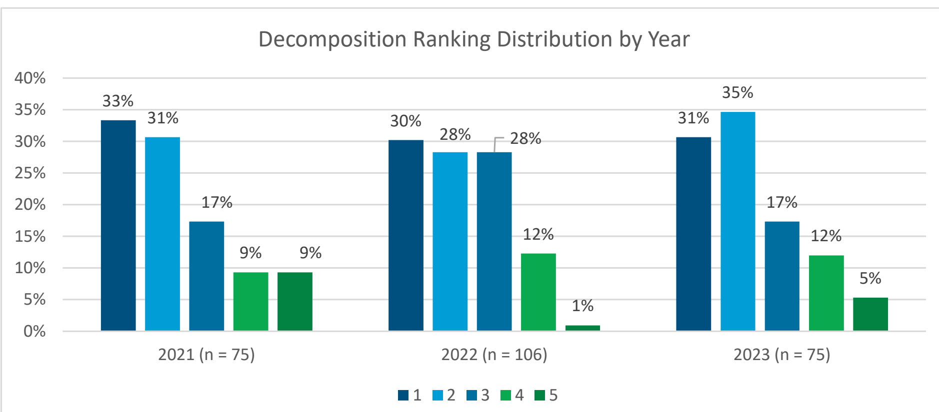
	2021	2022	2023
Mean pattern recognition rank	2.35	2.26	2.54



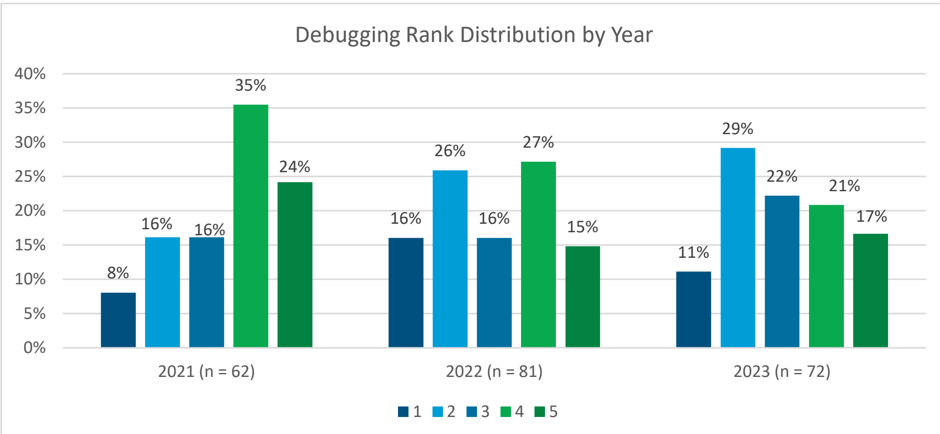
	2021	2022	2023
Mean abstraction rank	3.08	3.12	2.89



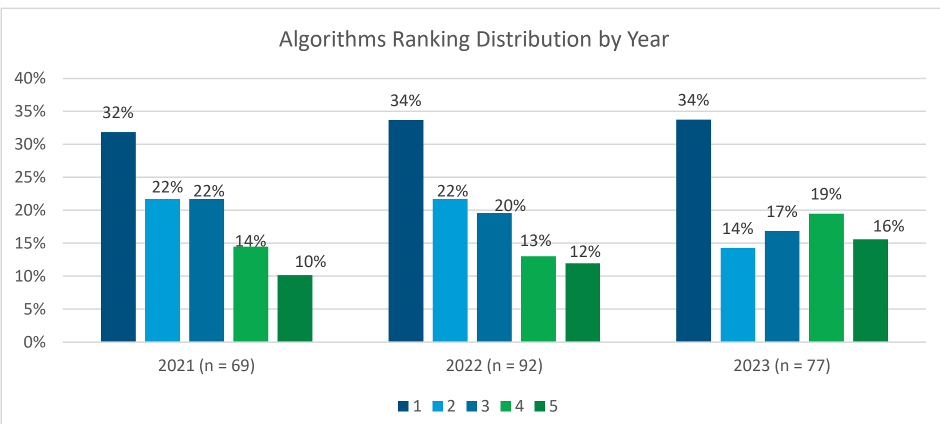
	2021	2022	2023
Mean decomposition rank	2.31	2.25	2.27



	2021	2022	2023
Average of debugging rank	3.52	2.99	3.03

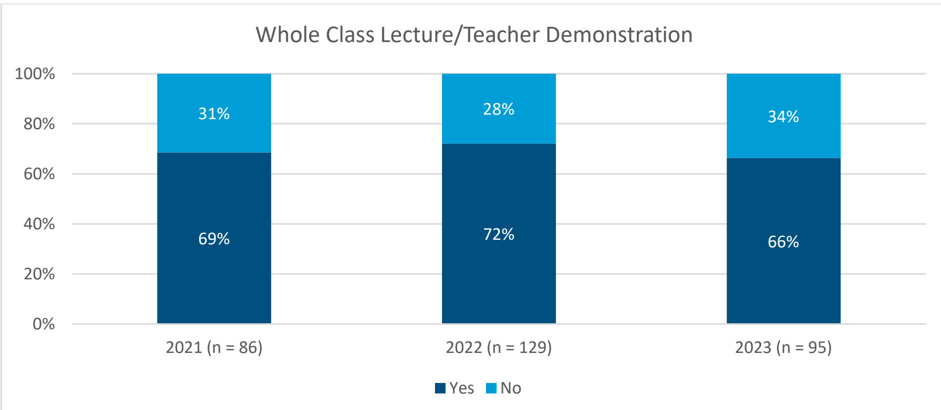


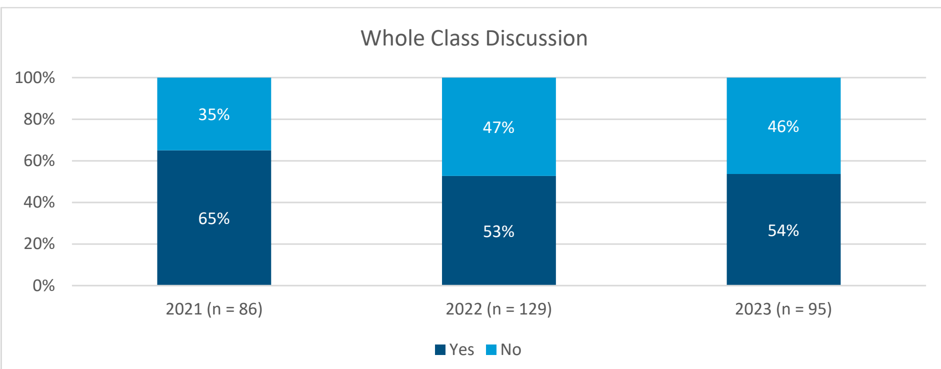
	2021	2022	2023
Mean algorithms rank	2.49	2.48	2.69

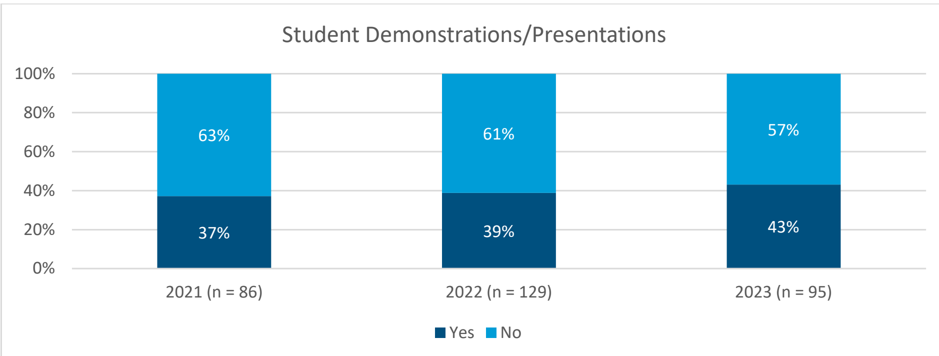


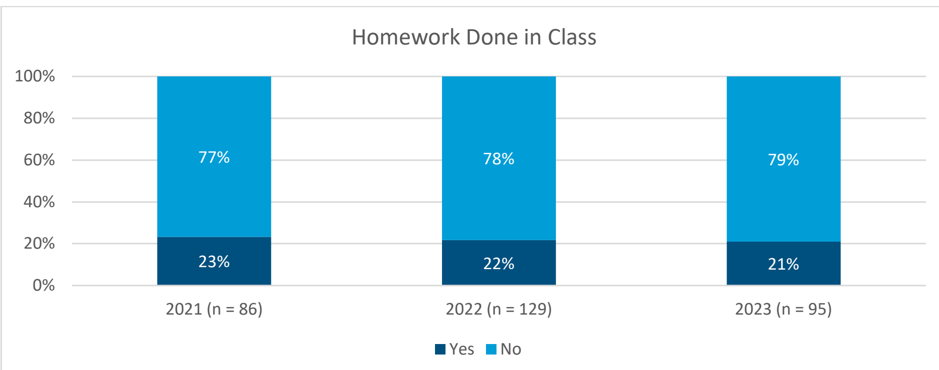
Survey Item: From the options below [whole-class lecture/teacher demonstration, whole-class discussion, student demonstrations/presentations, homework done in class, inquiry methods, and project-based learning], select up to three instructional strategies you use most to integrate computational thinking.

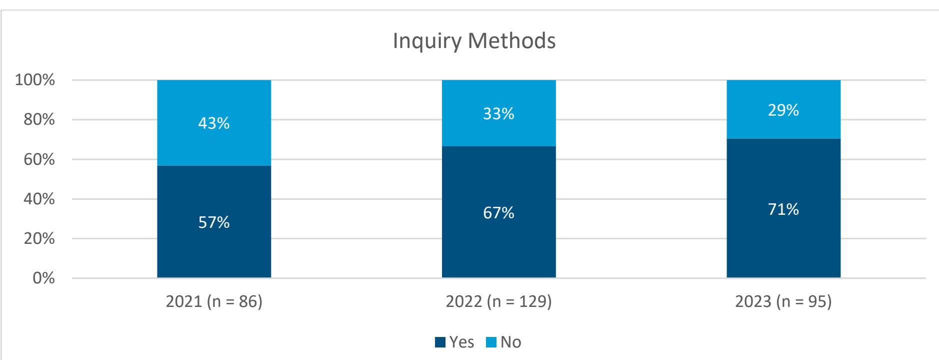
Exhibit A18. Key Finding 3: The most commonly used instructional strategies for integrating computational thinking are inquiry methods, whole-class lecture/teacher demonstration, and whole-class discussion. The least used method is homework done in class.

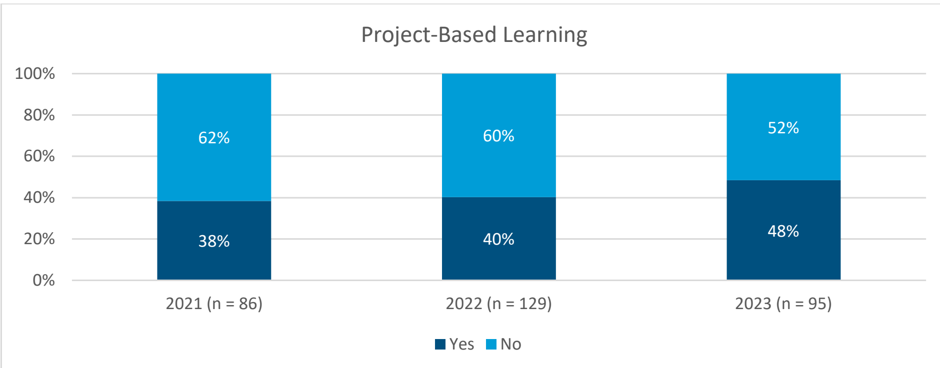





Student Demonstrations/Presentations
100%
80%
60%
40%
20%
0%
63%
61%
57%
37%
39%
43%
2021 (n = 86)
2022 (n = 129)
2023 (n = 95)
Yes
No

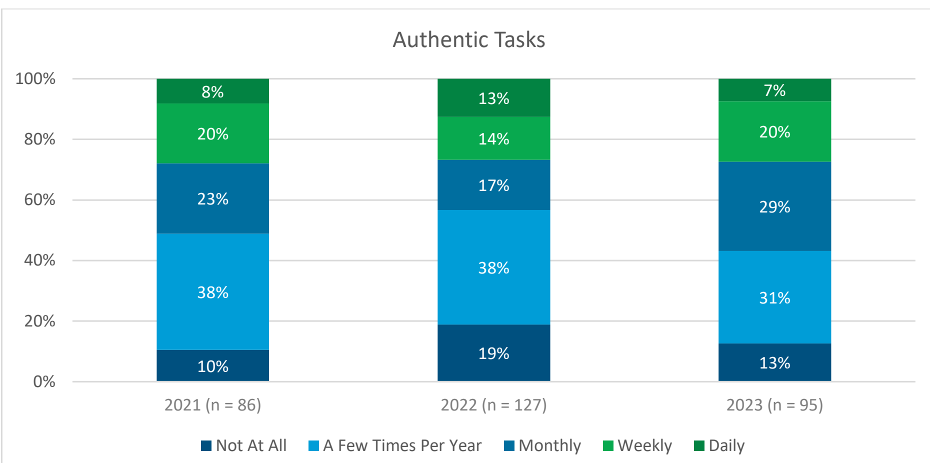

Homework Done in Class
100%
80%
60%
40%
20%
0%
77%
78%
79%
23%
22%
21%
2021 (n = 86)
2022 (n = 129)
2023 (n = 95)
Yes
No

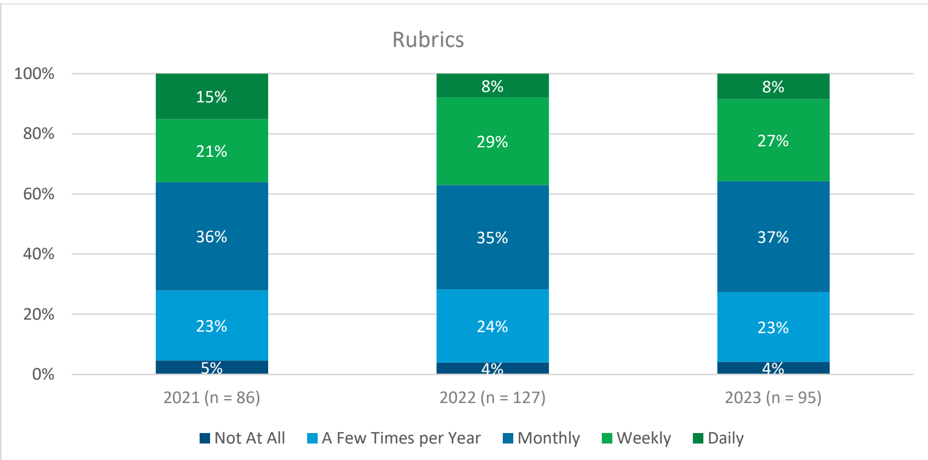

Inquiry Methods
100%
80%
60%
40%
20%
0%
43%
33%
29%
57%
67%
71%
2021 (n = 86)
2022 (n = 129)
2023 (n = 95)
Yes
No

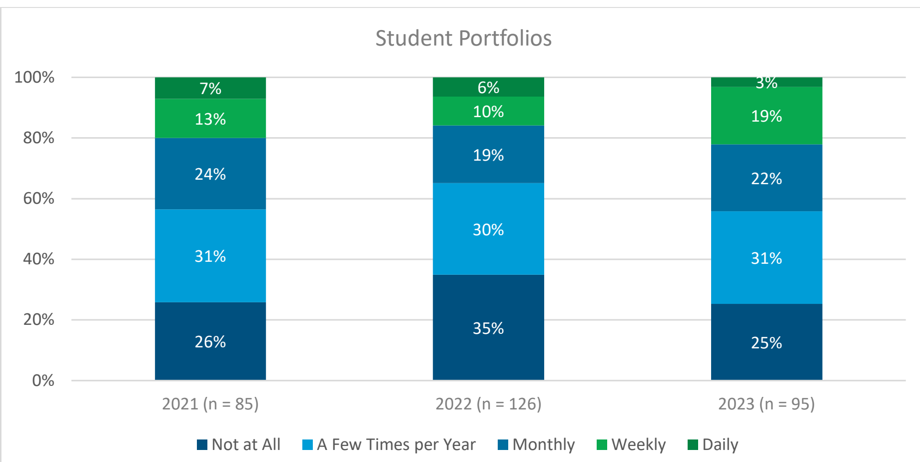


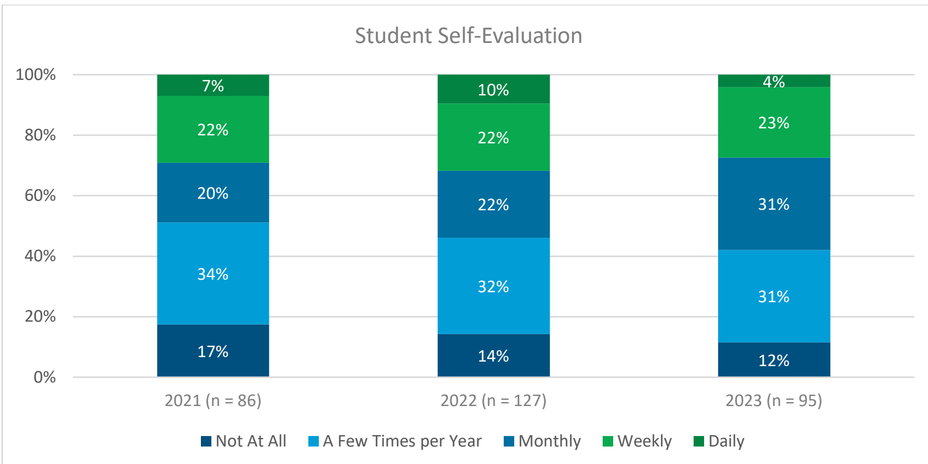
Survey Item: How often do you use these assessment practices [authentic tasks, rubrics, student self-evaluation, student portfolios, student presentations, think-alouds, and tests] to measure students' computational thinking skills?

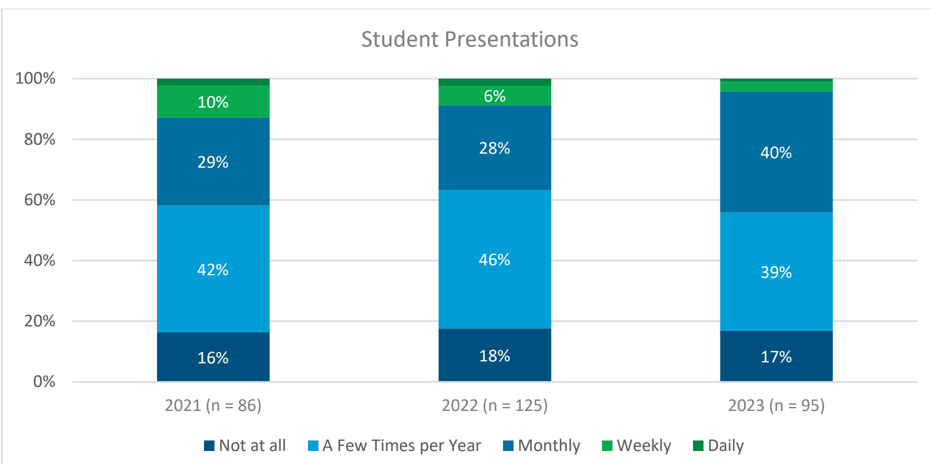
Exhibit A19. Key Finding 4: The assessment practices that teachers most frequently reported using either "weekly" or "daily" were think-alouds (72%). Peer evaluation and student portfolios were most frequently reported as not being used at all (25%).

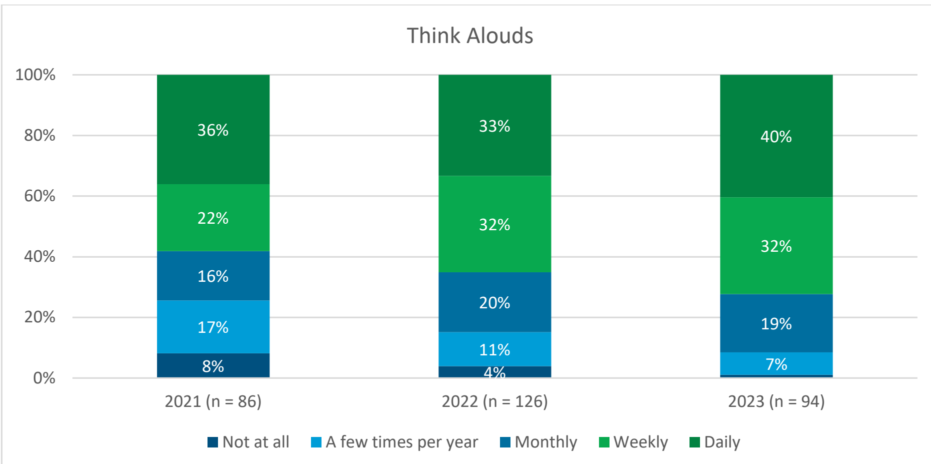


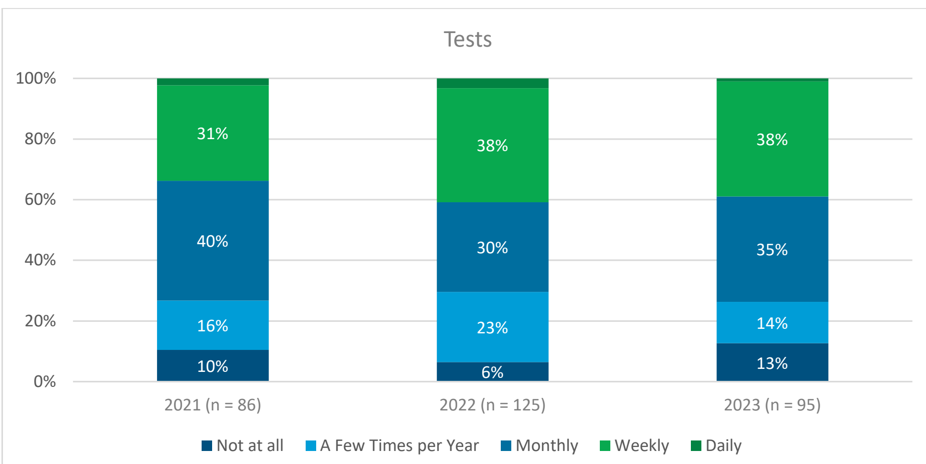

Rubrics
100%
80%
60%
40%
20%
0%
15%
21%
36%
23%
5%
8%
29%
35%
24%
4%
8%
27%
37%
23%
4%
2021 (n = 86)
2022 (n = 127)
2023 (n = 95)
Not At All
A Few Times per Year
Monthly
Weekly
Daily


Student Portfolios
100%
80%
60%
40%
20%
0%
7%
13%
24%
31%
26%
6%
10%
19%
30%
35%
3%
19%
22%
31%
25%
2021 (n = 85)
2022 (n = 126)
2023 (n = 95)
Not at All
A Few Times per Year
Monthly
Weekly
Daily


Student Self-Evaluation
100%
80%
60%
40%
20%
0%
7%
22%
20%
34%
17%
10%
22%
22%
32%
14%
4%
23%
31%
31%
12%
2021 (n = 86)
2022 (n = 127)
2023 (n = 95)
Not At All
A Few Times per Year
Monthly
Weekly
Daily


Student Presentations
100%
80%
60%
40%
20%
0%
10%
29%
42%
16%
6%
28%
46%
18%
40%
39%
17%
2021 (n = 86)
2022 (n = 125)
2023 (n = 95)
Not at all
A Few Times per Year
Monthly
Weekly
Daily





Teacher Practice Items Removed From the Analysis

- **Survey Item**: Computational thinking is integrated at my school in the following content area(s). Select all that apply. (*Rationale*: In 2021, the options for "special education" and "career or technical education" were not available. Therefore, they were discarded from the analysis across all years.)
- **Survey Item**: During this school year, how much instructional time have you spent integrating the skill you ranked as 1 in the previous question? (*Rationale*: In 2021, the options for this question were as follows:
  - 1–5 hours

– 5–10 hours
– 10–15 hours
– 15 or more hours

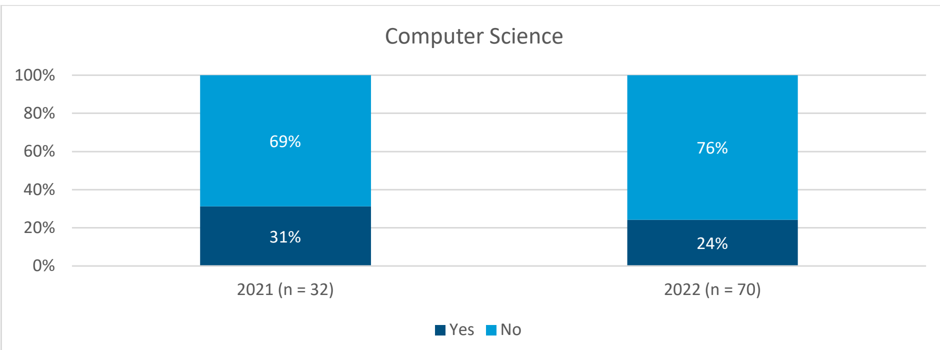
However, in 2022 and 2023 the options switched to the following:

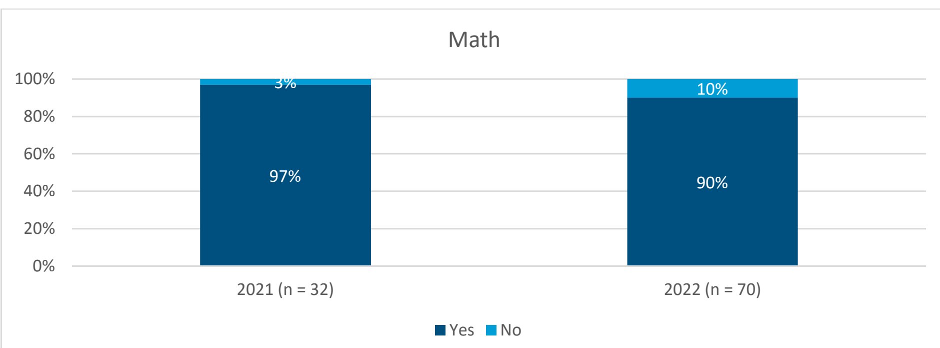
– A few times per year
– Monthly
– Weekly
– Daily)

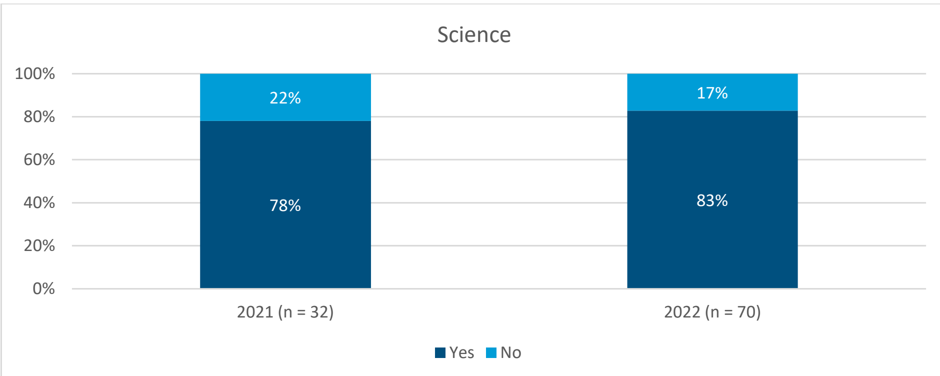
Appendix B. PUMP-CS Principal Survey Analysis

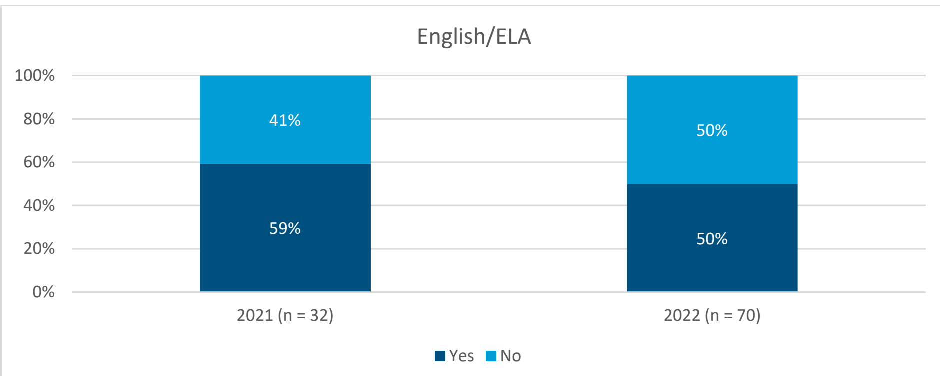
Survey Item: In what content area(s) is computational thinking taught in your school?

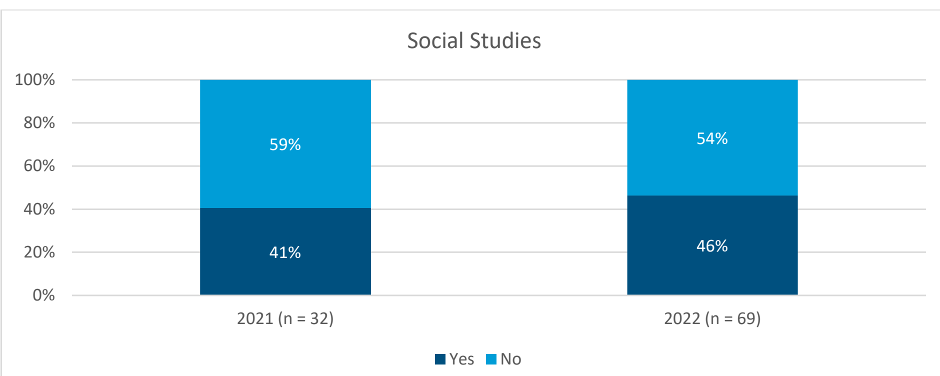
Exhibit B1. Key Finding 1: Principals reported that computational thinking is most integrated into math and least integrated into computer science. The top three most integrated subjects are math, science, and English/ELA.





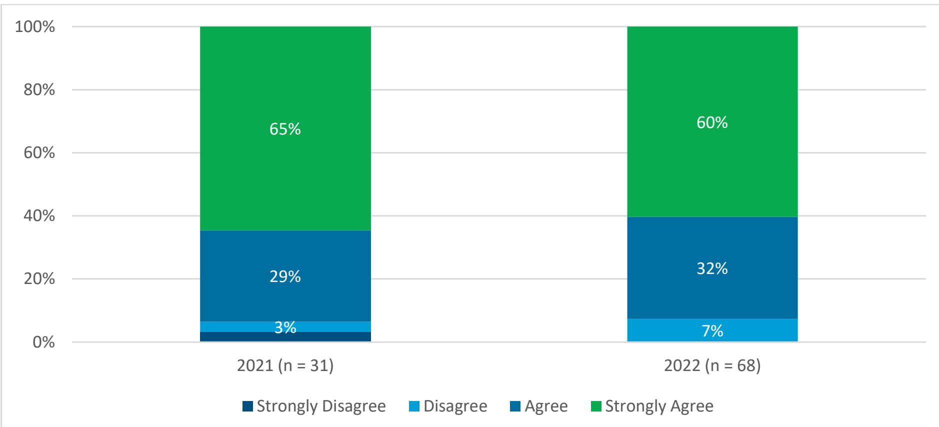

Science
100%
80%
60%
40%
20%
0%
22%
78%
17%
83%
2021 (n = 32)
2022 (n = 70)
Yes No


English/ELA
100%
80%
60%
40%
20%
0%
41%
59%
50%
50%
2021 (n = 32)
2022 (n = 70)
Yes No


Social Studies
100%
80%
60%
40%
20%
0%
59%
41%
54%
46%
2021 (n = 32)
2022 (n = 69)
Yes No

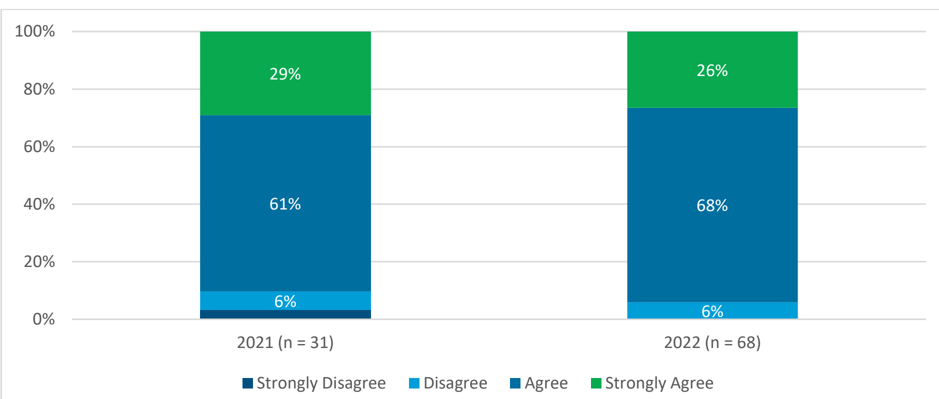
Survey Item: Our students have a critical need for computational thinking skills.

Exhibit B2. Key Finding 2: More than 90% of the principals in 2022 and 2023 responded that students have a critical need for computational thinking skills.



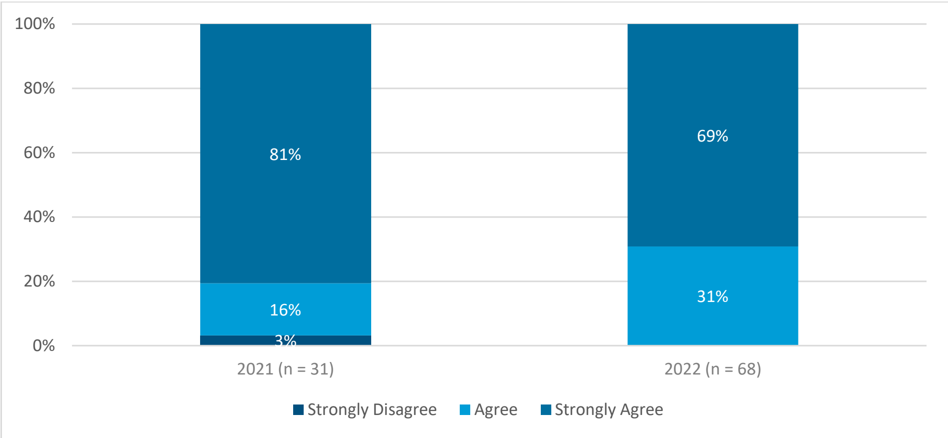
Survey Item: Our students are interested in computational thinking.

Exhibit B3. Key Finding 3: Nearly all principals in 2022 and 2023 responded that their students are interested in computational thinking.



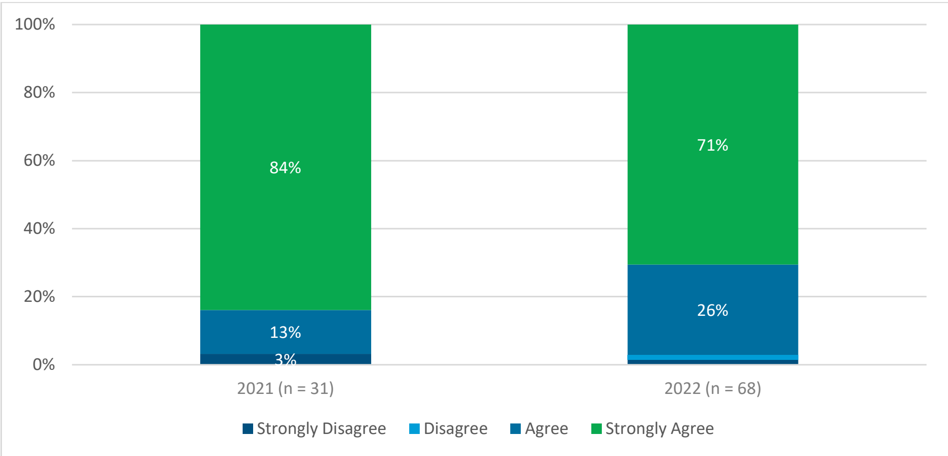
Survey Item: Our students can learn and develop computational thinking skills.

Exhibit B4. Key Finding 4: Nearly all principals responded that their students could develop computational thinking skills.



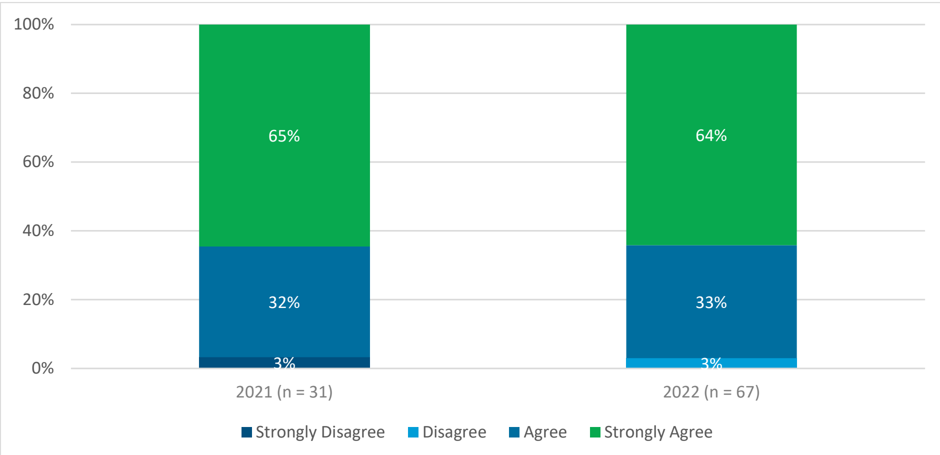
Survey Item: Our students will need to have computational thinking skills for future employment.

Exhibit B5. Key Finding 5: Nearly all principals responded that their students will need computational thinking skills for future employment.



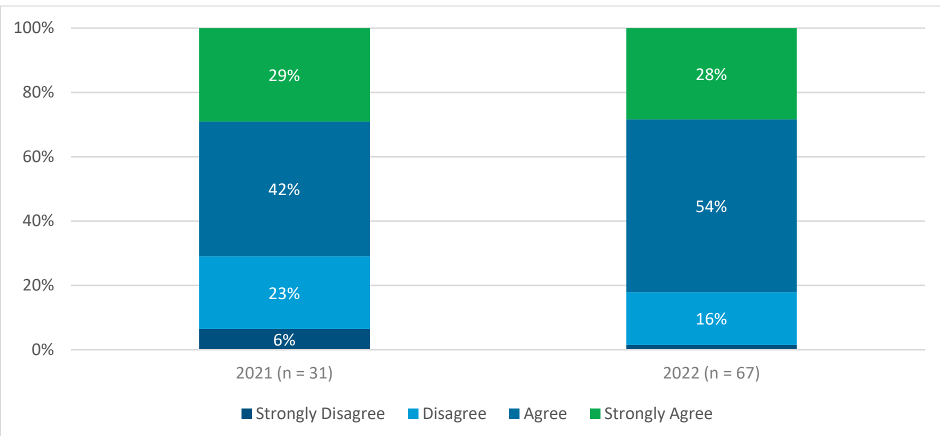
Survey Item: Computational thinking should be integrated across content areas.

Exhibit B6. Key Finding 6: Nearly all principals responded that computational thinking should be integrated across content areas.



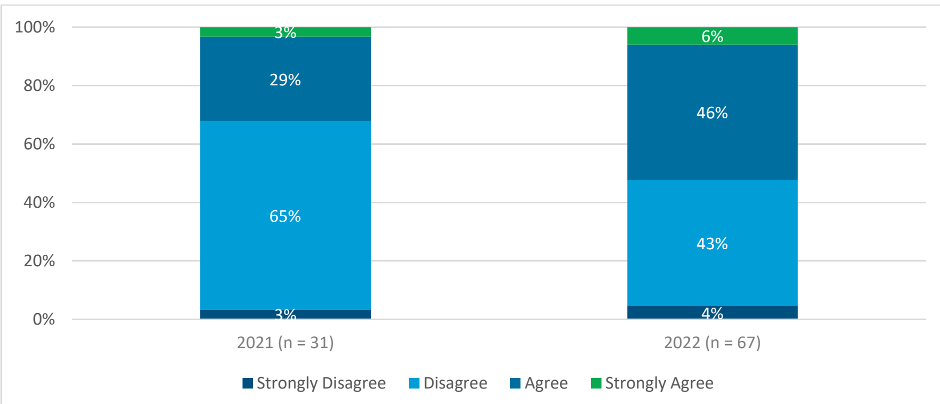
Survey Item: I am confident in my ability to support all my staff in teaching computational thinking.

Exhibit B7. Key Finding 7: In 2022, more than 80% of the principals reported feeling confident in their ability to support staff in teaching computational thinking; this represents an approximate 10% increase from 2021.



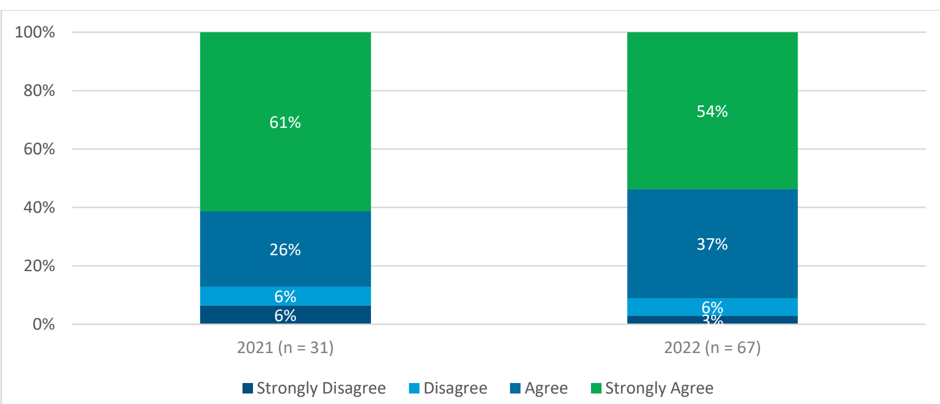
Survey Item: On the whole, I am satisfied with our staff's ability to teach computational thinking skills.

Exhibit B8. Key Finding 8: In 2021, less than one third of the principals were satisfied with their staff's ability to teach computational thinking skills. However, in 2022, satisfaction increased substantially to more than half of the principals reporting that they are satisfied with their staff's ability to teach computational thinking.



Survey Item: Teachers in our school need additional training or professional development in how to teach computational thinking.

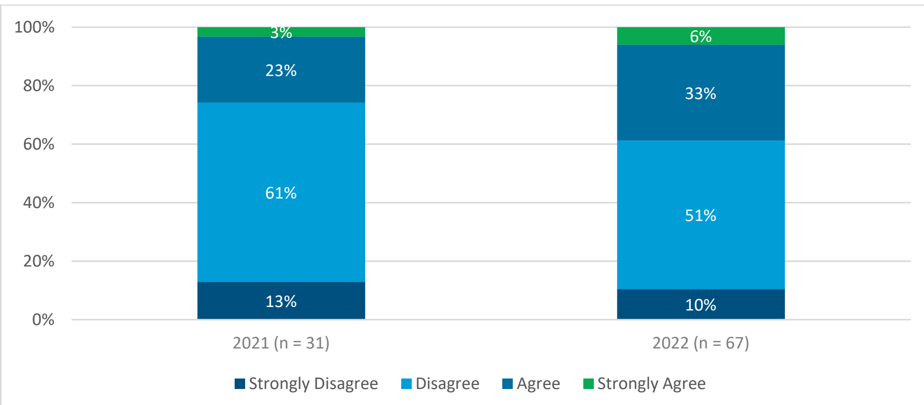
Exhibit B9. Key Finding 9: About 90% of the principals reported that their teachers needed additional training or PD in how to teach computational thinking.



Note. PD = professional development.

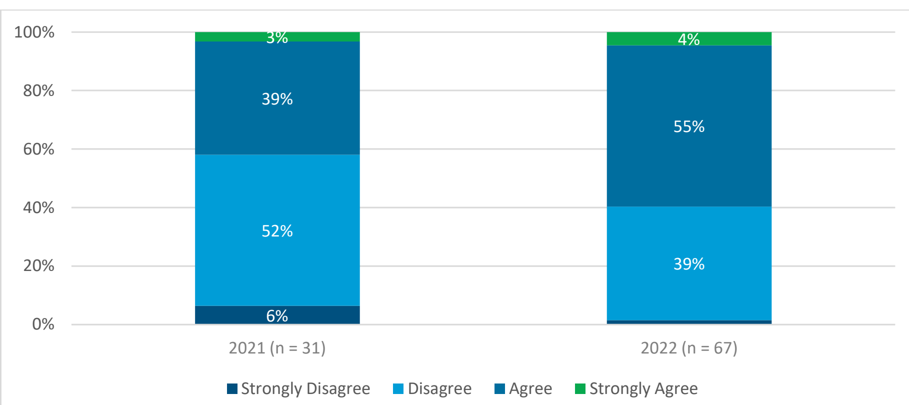
Survey Item: All teachers in our school have had the opportunity to learn how to teach computational thinking.

Exhibit B10. Key Finding 10: The percentage of principals responding that all teachers have had the opportunity to learn how to teach computational thinking increased from about 25% of the principals in 2021 to about 40% in 2022.



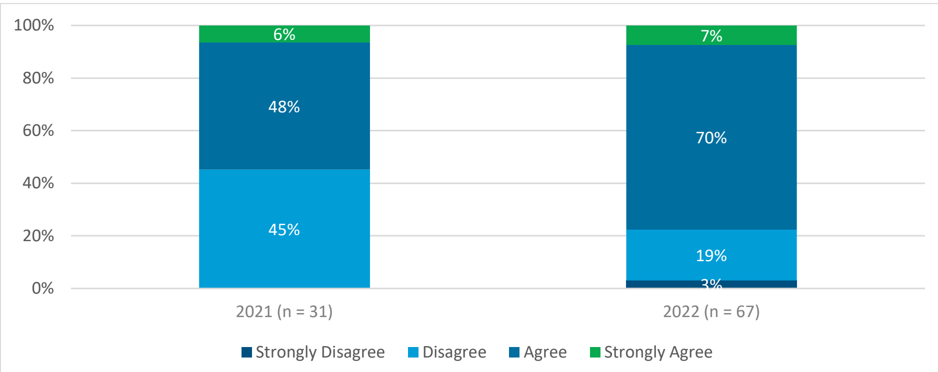
Survey Item: All teachers in our school take a positive attitude toward their students' computational thinking abilities.

Exhibit B11. Key Finding 11: The percentage of principals responding that their teachers take a positive attitude toward their students' computational thinking abilities increased from about 40% in 2021 to approximately 60% in 2022.



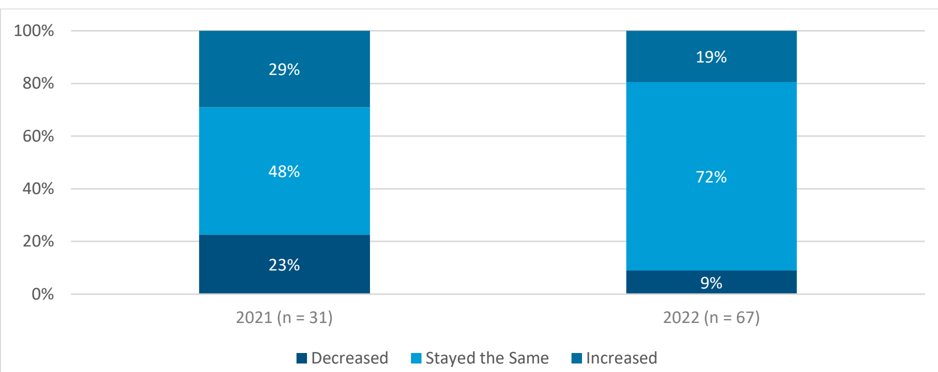
Survey Item: All teachers in our school would like to learn how to teach computational thinking skills.

Exhibit B12. Key Finding 12: The percentage of principals responding that teachers would like to learn how to teach computational thinking skills increased substantially from slightly more than 40% in 2021 to nearly 80% in 2022.



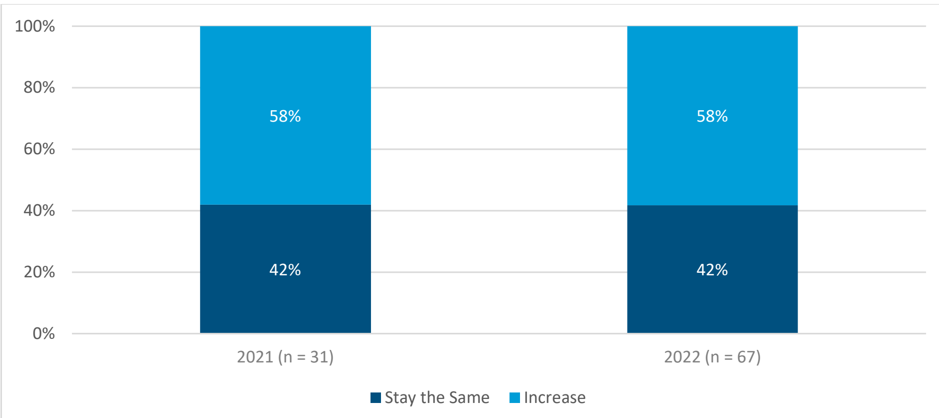
Survey Item: From fall 2020 to spring 2021, have students' opportunities to learn computer science skills during or after school increased, stayed the same, or decreased? Please respond to this item based on the school where you worked from fall 2020 to spring 2021.

Exhibit B13. Key Finding 13: The percentage of principals reporting that students' opportunities to learn computer science skills during or after school have "stayed the same" increased from nearly 50% in 2021 to more than 70% in 2022. In addition, the percentage of principals responding that students' opportunities to learn computer science skills during or after school have "increased" reduced from nearly 30% to less than 20%.



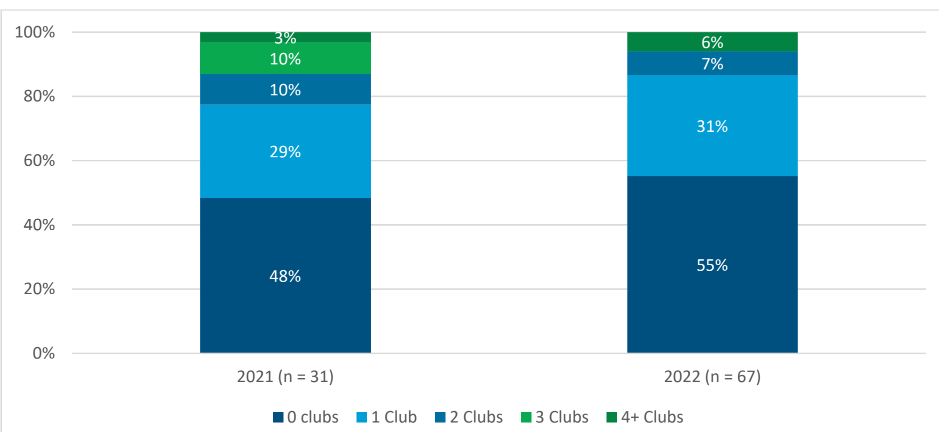
Survey Item: From fall 2022 to spring 2023, do you anticipate students' opportunities to learn computer science skills during or after school will increase, stay the same, or decrease?

Exhibit B14. Key Finding 14: In both 2021 and 2022, nearly 60% of the principals responded that they anticipate students will have greater opportunities to learn computer science skills.



Survey Item: How many school clubs or afterschool activities does your school offer that expose students to computer science?

Exhibit B15. Key Finding 15: The percentage of principals reporting having at least one club or afterschool activity that exposes students to computer science dropped slightly from 52% to 44%.



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