Measuring Teacher Growth Based on the CSTA K-12 Standards for CS Teachers

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ABSTRACT

Professional learning programs for computer science (CS) teachers primarily rely on self-reported data from participants to understand the learning impact on teachers and improve teacher growth. We developed and piloted a set of standardized measures of teacher growth aligned with Standards 2-5 of the Computer Science Teachers Association (CSTA) Standards for CS Teachers. We created a rubric from the 29 indicators across the four standards by merging similar concepts. We reduced these 29 indicators into 18 rubric items placed in one of three groups: Planning (9 items), Assessing (3 items), and Professional Development (6 items). We also created scales for measuring progress on each item based on the criteria for each standard. After creating an entry form based on the rubric items, we conducted a two-cycle pilot process, with teachers (n=24) completing the entry form and providing feedback in the form and in focus groups. We then applied revisions to the process, and conducted a second pilot with a different set of teachers (n=29). Teachers reported multiple ways to improve the process, including understanding their own growth path as a CS teacher. In this *experience report*, we describe the process of creating the rubric, the two-phase pilot used to gather feedback from the teachers, and the changes that we made to the rubric based on teacher feedback. We also provide a high-level description of the 18 items in the rubric, lessons learned, and recommendations.

CCS CONCEPTS

• **Social and professional topics** → **Computer education**; **Computer education programs**; **Computer science education**.

KEYWORDS

Teacher, standards, CSTA, rubric development, professional development

1 INTRODUCTION

As in any profession, it is important for teachers to engage in continuous reflective practices with the overall goal of growth. An effective practice of continuous improvement is through the process of both self-reflection, or internal evaluation, and external types of evaluation, which often include a professional in the same field, but outside of the teacher's daily work [6]. These intersecting practices are a starting point for the development of a professional growth plan. When such a plan is developed it sets "a trajectory of positive professional growth" [4, p.1] that is often based on standardized measures for teachers in general education settings [9].

Primary and secondary (K-12) computer science (CS) education has a lack of standardized measures of teacher growth [1]. Due to this, professional learning programs for CS teachers currently must rely on self-reported confidence and efficacy data from participants to evaluate and improve teacher growth [8].

To address this gap, we developed a set of pre- and post-professional development (PD) measures of teacher growth across the Standards for CS Teachers. The Standards have been created to identify key knowledge, development and implementation practices in which teachers engage. The purpose of our newly piloted measures is to assess and track teacher progress across these Standards. Beyond this project, a widely accepted measure of teacher growth would enable teachers to identify their areas of need based upon PD programs to support their growth, allow schools of education to assess future CS teachers' preparedness, and support policy makers as they develop new endorsement and certification requirements for CS teachers.

The Standards for CS Teachers currently consists of five Standards [3] as shown in Figure 1:

- Standard 1: CS Knowledge and Content
- Standard 2: Equity and Inclusion
- Standard 3: Professional Growth and Identity
- Standard 4: Instructional Design and
- Standard 5: Classroom Practice.

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Figure 1: The CSTA Standards for CS Teachers

Each category consists of five or more indicators with a description of each indicator. For example, for Standard 3, the first indicator is *3a. Pursue targeted professional development* and the definition is *Develop and implement a plan for targeted professional development to continuously deepen their CS content and pedagogical knowledge and skills.* When a teacher completes targeted PD, they are contributing to their understanding of their Professional Growth and Identity.

For this pilot, we began by focusing on Standards 2-5 and set aside Standard 1 for future assessment development, since that was more heavily focused on CS content and skills. We developed and piloted a process to measure CS teacher growth connected to CS PD offerings by engaging in the following:

- Develop a rubric and entry form based on Standards 2-5 of the Standards for K-12 CS Teachers
- Pilot the entry form with teachers from Indiana
- Collect feedback from participating teachers from Indiana
- Revise the process based on feedback
- Pilot the revised entry form with teachers from South Carolina
- Collect feedback from participating teachers from South Carolina

In this experience report, we provide a summary of each of these steps, our lessons learned, and our recommendations moving forward.

2 CREATING A RUBRIC FOR STANDARDS 2-5

When beginning this project, tools and resources related to the Standards for CS Teachers had already been developed and published. We reached out to the authors of the Standards for CS Teachers to gain insight into the goals, reasoning, and any other background information. Four of the authors agreed to have one-on-one meetings to discuss the project and the Standards. In those meetings, we learned of more resources that had previously been developed and

the thoughts and rationale behind them. Additionally, we shared our work with the "CS Teacher Standards Resource Dissemination & Development Full Group', which is an internal group within CSTA. After the presentation, the group provided positive feedback with overall excitement and potential for this work.

Once we completed these interviews, we began the process of translating the standards into competencies and common areas. We took the 29 indicators and cross-walked them to combine similar standards into one rubric item where feasible. As an example, for the rubric item *Align learning experiences to standards (CS and non-CS)*, we grouped together three indicators: 1) 4a. Analyze CS curricula, 2) 4b. Develop standards-aligned learning experiences, and 3) 4d. Build connections between CS and other disciplines.

As we did this, three themes emerged: Plan, Assess, and Professional Development. After this process was completed, we had created 18 rubric items from the 29 indicators and placed each item within one of the three aforementioned groups. In Table 1, we show how each rubric item aligned with each indicator.

We then created a 4-point scale for each rubric item. Table 2 shows an example of a scale for the rubric item *Targeted Professional Development*. We also extended each rubric item to include possible documentation that could be submitted to serve as evidence for this item as well as potential submission prompts.

3 CREATING THE PROCESS

After creating the rubric, we developed supporting materials to introduce teachers to the process (i.e., its purpose, the Standards) and the entry form for teachers to submit their responses to prompts that were intentionally aligned with rubric items and supporting documentation.

3.1 Creating the Entry Form

We developed the entry form using the secure, internally-hosted REDCap survey system [5]. This system provides us with the capability to create virtually any type of response item while also keeping sensitive teacher data internal to our organization.

We created four subsections on the entry form, demographics and a section for each of the three item groupings that teachers would be assigned to complete. We added logic to the form so that teachers would select one of the three groupings to which they were assigned.

For each of the three groupings, we defined a set of unique rubric items and provided suggestions for artifacts to support how they meet each item. We also provided a text box for teachers to explain how they met the rubric criteria and a place for them to upload artifacts to support their explanation.

After each section, we asked the participants to approximate how much time it took to complete that section. We did this so we can work to align the entry form to CSTA's desired one hour time for teachers to complete the entire entry form (including Standard 1 once we finalize it).

3.2 Creating Supporting Materials

To explain the data collection process to teachers, we embedded instructions as appropriate into the entry form. We also created supporting materials focused on general instructions, which was

Table 1: Rubric items aligned with Standards

Area	Competencies	Indicator Alignment
Plan	Align learning experiences to standards (CS and non-CS)	4a. Analyze CS curricula 4b. Develop standards-aligned learning experiences 4d. Build connections between CS and other disciplines
	Align learning experiences to student interests	4e. Plan projects that have personal meaning to students
	Inquiry-based learning leading to self-efficacy	5a. Use inquiry to facilitate student learning 5c. Promote student self-efficacy
	Classroom climate	5b. Cultivate a positive classroom climate
	Peer to peer communication	5e. Encourage student communication
	Examines issues of equity	2e. Use accessible instructional materials
	Accessibility	2d. Use data for decision-making to improve equity 2e. Use accessible instructional materials 4a. Analyze CS curricula
	Inclusivity	2b. Minimize threats to inclusion 4c. Design inclusive learning experiences
	Diverse Perspectives	2c. Represent diverse perspectives
Assessment	Assessment informed instruction	4f. Plan instruction to foster student understanding 4g. Inform instruction through assessment
	Student-to-student feedback	5d. Support student collaboration 5f. Guide students' use of feedback
	Data use for improved equity	2d. Use data for decision-making to improve equity 4g. Inform instruction through assessment 5f. Guide students' use of feedback
Professional Growth	Targeted professional development	3a. Pursue targeted professional development
	Model continuous learning	3b. Model continuous learning
	Counteract personal biases	2b. Minimize threats to inclusion 3c. Examine and counteract personal bias
	Commit to the mission of CS for All	3d. Commit to the mission of CS for all students
	Leverage community resources	3e. Leverage community resources
	Participate in CS education PLCs	3f. Participate in CS professional learning communities

Table 2: Rubric item with possible supporting documentation and a proposed submission question as a prompt for data entry.

	Level 4	Level 3	Level 2	Level 1
Targeted PD	Implement a plan for targeted PD to focus on areas of improvement for CS content knowledge and skills.	Develop a goal-oriented plan for targeted PD to focus on needed areas of improvement for CS knowledge and skills.	Attend PD with no clear goal-oriented plan for improving CS content knowledge and skills.	Does not yet plan to or attend PD with a clear goal-oriented plan for improving CS content knowledge and skills.
Possible documentation	Documentation of attendance and utilize what is learned at PD Documentation of PD goals and connection to personal goals			
Proposed Submission question	Provide documentation (artifacts uploaded for Section 2) and justification of meeting the concepts outlined in this item. If N/A, please provide a justification or reasoning. Additionally provide information on steps (1-2) you could do to begin progress on this rubric item.			

enhanced by creating a video recording that walked through the goals of the pilot and a high level overview of the submission process.

Additional materials included a more detailed explanation of the three areas (plan, assess, and professional growth), the rubric with examples of possible documentation, and justification examples. Links were also provided to the CSTA Roadmap for Professional Learning [2], CSTA Standards for CS Teachers, and self-reflection that was already built as part of the initial work focused on the

Table 3: Strata for the project. In each state, 36 teachers were asked to complete a portion of the entry form and we anticipated that 27 teachers would complete it.

Grades	Group A (first 6 items)	Group B (second 6 items)	Group C (last 6 items)
K-5	3	3	3
6-8	3	3	3
9-12	3	3	3

Standards. The CSTA Roadmap for Professional Learning was developed by the authors of the CSTA Standards for CS Teachers to "assist teachers in improving their practice by identifying areas of focus for professional learning" [2, online] through a process of self-reflection. The goal of the Roadmap was to provide a tool to CS teachers, but also to school and district administrators who are working with CS teachers.

4 PILOTING THE EVIDENCE COLLECTION PROCESS

Before piloting the entry form, we developed a strata to ensure adequate representation of CS teachers across grade bands from the two states who participated. We split the teachers in each of the grade bands (K-5, 6-8, 9-12) into three groups: group A only received portions of the entry form that were aligned with the first 6 rubric items, group B only received portions of the entry form aligned with the second set of 6 rubric items, and group C only received portions of the entry form aligned with the last set of 6 rubric items. We wanted to have three teachers in each group from each pilot (Table 3), and we invited four teachers in each group to account for attrition.

We also provided an opportunity for teachers to attend a webinar that walked them through the process; however, only one person was able to attend for about 15 minutes of the full 60 minutes. We recorded the session and provided it as a resource to teachers who were completing the rubric and entry form.

During the one week PD that teachers attended, we conducted focus group feedback sessions with the teachers who completed the entry form. Each day of the first three days, we met with elementary teachers (groups A-C) (day 1), middle school teachers (groups A-C) (day 2), and high school teachers (groups A-C) (day 3). Finally, on day four, all of the teachers who completed the entry form met to hear what the other focus groups shared, and share any additional information. At this meeting their feedback from the week was also displayed in the form of a new instruction manual, which was a large piece of the feedback received during the focus groups earlier in the week.

4.1 Pilot 1 (Indiana)

In all, 24 teachers in the first pilot completed the entry form. At the beginning of each focus group during the week we asked the participants *Before engaging in this work, what was your level of knowledge regarding the Standards for CS Teachers?* Of the 23 who responded, 12 had never heard of the standards prior to completing the pilot work.

4.1.1 Feedback collected on entry form. Participating teachers found the following to be clear:

- Demographics section. (9)
- All parts of this form were extremely clear. Doing it through a survey made it easy to submit. (6)
- Standards I needed to share information about. (4)
- Having justification examples was very helpful. (2)
- Suggested artifacts were straightforward. (2)
- Everything except the part of submitting documentation (2)
- The warnings for missing artifacts were helpful.

We reviewed the other comments and grouped these into the following categories: purpose/ expectations of the entry form and this process, technical considerations, instructions related, artifact collection related, standards related, process related, and time related. While five teachers had no additional comments to these questions, we summarize the other comments here.

Process related. While two teachers mentioned that the process was quite interesting and helped them reflect on their practices, two teachers noted feelings of cognitive overload, with a new teacher finding it difficult to grasp how to align their lessons to the Standards and another not confident they addressed the artifacts and justifications properly. Three teachers mentioned that they would rather just provide descriptions/justifications without the artifacts, as this would take less time, be less stressful, and be more straightforward. Another teacher noted that for someone who is not strictly a CS teacher (e.g., someone who taught integrated CS), the artifact section is a little more difficult.

Purposes/expectations. Six teachers remarked that the purpose for this process wasn't clear, particularly with respect to the rubric and what was expected of them.

Instructions related. One teacher suggested simplifying the instructions, with other teachers stating that the video that we created to walk them through the entry form was very helpful. Another teacher thought that it would be helpful to have a video that emphasized how to find and upload the artifacts. Two teachers were concerned about naming conventions for the artifacts and were thought that they were all to be named the exactly the same. Another teacher poignantly asked: *What about things a teacher might be doing but there are no formal artifacts?*

Artifact collection related. Three teachers found it difficult to find artifacts to use, particularly during the summer when school was no longer in session. Another teacher was unsure if the artifacts conveyed their intentions.

Standards related. One teacher noted that they wished they had a more in depth understanding of the standards before they started the process.

Entry form technical issues. Six teachers mentioned technical issues with the entry form, including a case of the Save and come back later feature not working, difficulty uploading artifacts, a broken link, and a suggestion to embed the CSTA Standards for CS Teachers as well as simplifying the presentation of the items in the form.

Time related. Seven teachers mentioned the time it took to collect the artifacts and to complete the entry form was too long.

4.1.2 Focus Group Feedback. We received additional feedback during the in-person focus groups.

Simplify the entire process. During the in-person feedback sessions, one person suggested a more simplified process honing in on the idea that most administrators will provide bullet pointed information with available additional resources that teachers can access if they choose. Additionally, some teachers found the usage of the entry form cumbersome and wanted more guidance on what to upload, how to upload, and how to ensure there were no warning messages for incomplete sections.

Provide explicit benefits for teachers. Similar to the entry form feedback, teachers wanted more details on why they should take the time to go through this process. Based on this feedback and with their guidance, we revised the opening paragraph of the supporting resources to provide more clarity around professional growth benefits as a reflective teacher.

Embed more guidance throughout the entire process. The teachers who were asked to participate in this pilot were provided the opportunity to attend a webinar session to describe the process. However, only one person was able to attend for about 15 minutes of a 60 minute webinar. We recorded the session and then provided the video to all of the participating teachers. Teachers who watched the video reported it was very helpful.

Start the process earlier. Due to time constraints, providing the process for collecting and entering data earlier in the school year was not possible for the pilot. However, in the future we will open the form early in the school year and send a reminder email sent two months prior to summer break for teachers to begin the reflection and optional artifact collection process.

4.1.3   Changes made based on the feedback. Based on this feedback, we made the following changes:

- Created a brief video on how to complete the form and shared with teachers.
- Streamlined documentation (reduced text to bare essentials) to just one main document with links for those who want to learn more.
- Stated several times that justifications were required in the opening letter.
- Provided space for additional artifacts to be uploaded.
- Streamlined the entry form to require justifications and removed the warnings for artifacts.
- Artifacts are now optional to upload. Users can choose to enter a URL.
- Each rubric item was defined, and under each, the user could enter one or more artifacts or URLs.

4.2   Pilot 2 (South Carolina)

In total, 29 teachers in the second pilot completed the entry form. As with the first pilot, we asked participants *Before engaging in this work, what was your level of knowledge regarding the Standards for CS Teachers?* Of the 26 who responded, 17 had heard of them and used them some to often prior to completing the pilot work.

4.2.1   Feedback collected on the entry form. Teachers in the second pilot found the following to be very clear with the process:

- I think all parts of this form were clear and did not have issues with the questions. (9)
- Demographics. (8)

- The information that is needed to be uploaded. The upload portions were easy to use and the directions to upload were detailed and clear. (4)
- The introduction was very clear. (2)
- Standards. (2)
- The justification part of the form was more clear than the other portions because of the opportunity to justify and/or explain why you chose the artifact or share why it was used.
- Statements of requirements.

We reviewed the other comments and followed the same grouping that we used in the first pilot. One exception was that there was no feedback about the standards during this pilot, likely due to the fact that this group of teachers were much more familiar with the standards. Of those providing feedback, 10 did not have any additional comments.

Process related. Three teachers stated that this process has made them reflect on what they are and are not doing and what they could do to become a more effective teacher of CS. Another three teachers remarked that they were overwhelmed by the process and simplification is needed. Three other teachers remarked that the pilot should not be used during a CS PD week as it diverts their focus from learning what the state is requiring as well as the other courses teachers are teaching. When giving this survey, it is best to give it when school is in session so documentation will be fresh in my mind and more easily attainable.

Two teachers noted that there should be a section for teachers that do not teach CS but want to learn how to incorporate CS into their classrooms. Two other teachers remarked that a clearer section is needed for teachers who are teaching a class for the first time when they don't have the artifacts.

Instructions related. One teacher remarked that there were many rubric items to dissect, and the rubric items were worded differently than the Standards. Another thought the form was too academic and not relatable to teachers. Another mentioned that the definitions within each item were very helpful. One teacher added that the video explanation helped. They thought that an actual overview or training session displaying the form requirements and real-world examples would help. Another remarked that adding an example next to the information being asked would have made it smoother for them, while one teacher remarked that it wasn't clear whether one or more of the bullet points of suggested documentation needed an artifact to support the standard or not.

Artifact collection related. One teacher remarked that providing justifications for standards seemed to be a little confusing, due to the fact that they followed a canned curriculum. Two teachers remarked that they wish they had more time to gather artifacts, particularly with summer break going on. One teacher could not figure out how to label artifacts, while another was concerned about sharing artifacts that may contain student data. One teacher recommended removing the Harvard bias test, as they thought the test impeded on their privacy.

Entry form technical issues. Teachers noted that links should open in a different window than the form and that there were minor logic errors that needed to be addressed. Despite our adding more spaces for more artifacts, teachers noted that there was still insufficient space to upload artifacts. Presentation improvements

can also be made by moving the artifacts submitted to be directly with or below each question. Lastly, the Save and Return Later feature did not work for some teachers and needs further review.

Time related. Three teachers remarked that they needed more time, and the time they needed to complete it was excessive (4 to 5 hours).

4.2.2 Focus group feedback. Similar to the first pilot, we conducted focus group feedback sessions with teachers who completed the entry form. The only difference in the focus groups was that they were conducted virtually since the PD was conducted virtually.

Feedback from the second pilot fell into four main themes: 1) add clarity to the entry form, 2) excellent process for reflection and growth as a CS educator, 3) embed more guidance throughout the entire process, and 4) provide the task earlier in the school year.

Confusing Entry Form. Some teachers reported confusion with the entry form. Based on that feedback we plan to: 1) provide a video to show how to submit and 2) ensure that user experience is top priority as edits are made. We will also change the form so users can upload as many artifacts as they want.

Excellent process for reflection and growth as a CS educator. Teachers in South Carolina overwhelmingly appreciated completing the process and the professional reflection. While each teacher only completed 6 of the total 18 rows, most of these teachers stated that they learned something new in the process about their own professional practice.

Embed more guidance throughout the entire process. The feedback from teachers in the second state mirrored the feedback from the first state regarding more guidance. The same growth areas will be a focus as we move into the next year of implementation for this project. One way to provide more guidance would be through year-long PD, but also to have teachers who have been through the process guide other teachers regarding tips and tricks.

Provide the task earlier in the school year. Agreeing with the teachers in the first state, the teachers in the second state also requested the information be provided earlier in the school year.

5 LESSONS LEARNED

As we reflected on the process and teachers' feedback, we learned several lessons that will enable us to improve the process:

- Cognitive overload issues. Teachers became overwhelmed and stressed with this process, in great part due to unknown expectations, an inordinate amount of information in the instructions and entry form, the way the items in the entry form were presented, and the lack of time to collect artifacts (particularly during summer break).
- The excessive amount of time to complete. The form takes too much time to complete.
- Teachers with no CS teaching experience were in the pilot group. This led to confusion on what they should be entering, since they had no artifacts to enter and could not relate to the questions being asked.
- Tension between completing the entry form rather than just asking teachers what PD they need. As we read the comments about expectations and the time it took to complete the form, teachers wanted a simpler process. Asking them what they need may be more appropriate.

- Teachers who integrate CS may need a different form. Teachers needed a way to interpret the rubric items for their unique situations in integrated CS/CT situations.

6 RECOMMENDATIONS

Some thoughts we have center on this question: *How do we make the process more palatable to teachers while still keeping it meaningful as a tool?* This elicits additional thoughts:

- Can the rubric items be reduced from 18 to a fewer amount by collapsing some of them?
- Can the process be completed over a few months time rather than all at once?
- Can the set of items be staged over multiple years?
- What would we find if we simply asked teachers to signify which PD they needed across the standards in a manner that elicits thoughtful responses and compared those to the results of the rating process? If the delta between the two is an acceptable range, would that be a better process to use given the cost and time to complete and rate the responses from every teacher?
- Would a badging or credentialing system of some sort also incentivize teachers?

Based on the cumulative feedback from teachers in both states who participated in the pilot, we will engage in the following next steps:

- Review teacher submissions, which will provide more information that will impact year 2 implementation.
- Address the overall feedback, including the recommendations of a year-long reflective PLC with CS teachers around the country and extensive clarity on the entire submission process.
- Launch year 2 earlier than May, which will provide teachers the ability to 'leisurely' reflect on their practice and put together their information.

7 CONCLUSION

There is still a documented lack of professional growth opportunities for K-12 CS educators [7]. Through the concerted efforts of professionals in the field of both education and CS, there is movement towards a process that values the professionalism of CS teachers and provides focused opportunities for individualized professional growth. This experience report outlines the first year of work on increasing opportunities for CS educators to reflect, receive feedback, and focus professional learning on their specific needs. It provides a first step for others to also build on this effort to create other measurement methods situated on the CSTA Standards for CS Teachers and suitable for teacher PD.

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