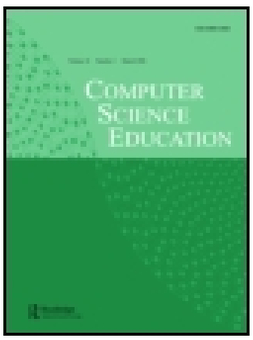

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Helping teachers make equitable decisions: effects of the TEC Rubric on teachers' evaluations of a computing curriculum

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ABSTRACT

Background and Context: Educators make consequential curricular decisions, often with little support, particularly as it relates to equity and how to support all students.

Objective: This paper investigates the use of a rubric to support educators evaluating computer science curricula, especially with regards to equity.

Method: Seventeen in-service elementary teachers evaluated a computer science curriculum with and without the Teacher Accessibility, Equity, and Content (TEC) Rubric. We examine teachers' responses to prompts and completed TEC Rubrics to understand if and how the rubric supported their evaluations.

Findings: The TEC Rubric helped teachers attend not only to curricular factors related to instructional design but also to issues of equity and accessibility and to identify opportunities to draw on the cultural resources of students and their communities.

Implications: We contribute evidence supporting curricular evaluation instruments, specifically the TEC Rubric, and their use to direct teachers' attention to attributes of equitable computing instruction.

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Computer science education; rubrics; equity; K-12

Introduction

The push to bring computer science (CS) to all students in K-12 education has resulted in efforts to integrate the subject into classrooms around the world. As governments and school districts work to bring CS to all learners, those tasked with carrying out this vision face numerous challenges. These challenges include recruiting and training CS teachers and acquiring the requisite resources (e.g., computers, classrooms) to integrate it into existing school infrastructure (Astrachan et al., 2011; Delyser et al., 2018; Google Inc. & Gallup Inc., 2016b). Another consequential but often overlooked challenge is selecting the curricular materials to use for instruction. This decision is important as mismatches between curricula, tools, teachers, and students can undermine the ultimate effectiveness of a given educational initiative. Further, decisions related to introducing CS into a K-12

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context often need to be made by educators or administrators with little prior experience teaching CS. The situation is further complicated by the pace at which new CS tools, technologies, and curricula are being introduced at the K-12 level. As such, choosing a curriculum, technology, or programming language for instruction can be complex and difficult, especially as it relates to the particular needs of a given classroom, school, or district.

In response to this challenge, the Teacher Accessibility, Equity, and Content (TEC) Rubric for Computing Education was designed as a means to help educators make informed and effective curricular decisions around CS curricula and technologies (Weintrop et al., 2019). The TEC Rubric focuses not only on an overall evaluation of the curricula with regards to accessibility and content but also includes measures for evaluating culturally relevant curriculum design and supports for students with exceptionalities. As a note, in this paper, we use the term "exceptionalities" to describe learners who are considered to be above or below what is considered neurotypical with regards to physical, behavioral, or intellectual abilities. This includes students with disabilities, English Language Learners, and students who are identified as gifted. While there is no expectation for a curriculum to exactly meet the particular needs of a given classroom, the TEC Rubric helps educators evaluate the strengths and weaknesses of a curriculum to determine if it is a good match for their context. Further, the TEC Rubric serves as a means to identify shortcomings of curricula to help educators know how best to augment or supplement materials to meet the needs of their specific context (Weintrop et al., 2019). In this paper, we answer the following question: How does the use of a structured rubric, specifically the TEC Rubric for Computing Education, affect teachers' evaluations of an elementary CS curriculum?

To answer this question, we present an analysis of teachers using the TEC Rubric to evaluate an elementary CS curriculum. The goal of this work is to understand if and how the rubric supported teachers' evaluations of the curriculum, with particular attention to how the structures of the TEC Rubric led teachers to be more attentive to the broad nature of equity and accessibility, encouraging teachers to think of equity with regards to race, culture, and student identity as well as student exceptionalities. We use a two-phase study in which teachers first evaluate the curriculum by responding to a series of prompts. Next, teachers re-evaluate the curriculum aided by the TEC Rubric and respond to the same prompts as in phase 1 to present their evaluation. We then examine differences between the two sets of responses to understand how the presence of the TEC Rubric influenced teachers' evaluations of the given curriculum. The paper concludes with a discussion of the utility of structured rubrics for evaluating curricular materials and how they can help education decision makers in their efforts to address issues of equity in CS.

Literature review

In this section, we review research related to the use of rubrics in education and the design and evaluation of CS curricula in K-12 education. We begin by discussing currently available curricula for teaching CS in the K-12 grades (ages 5–18) to highlight the consequentiality of educators' curricular decisions. Next, we review how rubrics are used in education and specifically rubric use in CS education. Finally, we review literature on equity in CS including efforts to broaden participation of women and minoritized

populations in CS fields and considerations for students with exceptionalities within CS education.

Computer science curricula

Across K-12 contexts, there are a growing number of CS curricula targeting different age groups and employing various pedagogical strategies from which educators must select. At the high school level, the extant curricula can be separated into two main categories: programming-centric materials and curricula focused on the broader field of CS. Many traditional high school CS courses fall in the former category, programming-centric. For example, the Advanced Placement CS A course (The College Board, 2016) is explicitly focused on teaching students to program. In contrast, a number of new curricula emphasize a broader vision of CS by including topics beyond programming, such as design, robotics, data, and social impacts of computing. For example, the Exploring Computer Science curriculum (Goode & Margolis, 2011) is designed specifically to appeal to a diverse set of learners using hands-on activities focused not only on programming skills but on ways of expressing oneself through code and how CS impacts society.

From an instructional design perspective, there are also different approaches that an educator needs to decide among, especially for K-8 (ages 5–14) curricula. For example, some curricular materials, such as those created by Code.org (Code.Org, 2018), rely on the use of puzzle-based activities, in which students learn CS concepts in a block-based environment by solving puzzles with specific solutions before completing culminating activities that allow for more open-ended creation. Other curricula teach CS through discovery experiences that rely on open-ended activities prioritizing creativity and expression. For example, the Creative Computing Curriculum (Brennan et al., 2014) features creative, student-driven projects with the goal of allowing learners to develop practices through exploration. Increasingly, a blend of these two approaches is being used for middle school (ages 11–14) grades. For example, Scratch Act I (Scratch Act 1, 2018) emphasizes learning through exploration with the scaffolding of the Use, Modify, Create pedagogical strategy (I. Lee et al., 2011) and a project previewing strategy. In doing so, the curriculum scaffolds student learning by coupling guided learning in the early Use and Modify activities with open-ended Create tasks once students have been introduced to the skills. Scratch Encore, a similar curriculum, follows a similar design blending the structured and creative approaches while also attending to the culture of the students incorporating their cultural knowledge through culturally relevant design principles (Franklin et al., 2020). In doing so, the curricula balance structured student learning and open-ended student creativity while promoting CS learning (Franklin et al., 2020b).

Evaluating curricula: rubrics in computer science education

Rubrics are widely used within the educational field as tools to help teachers evaluate student work in a consistent manner (Andrade, 2005; Donathan & Tymann, 2010; Stevens & Levi, 2013) and are especially useful for evaluating artifacts that might otherwise require subjective judgement like essays or art projects. Using rubrics to guide assessment provides static grading criteria, allows for the establishment of consistency, and ensures

that judgement on student work is the result of criteria regardless of the grader (Cateté et al., 2016). The use of rubrics to establish universal grading scales can be especially beneficial for inexperienced teachers (Cateté et al., 2016) due to the rubrics providing a definition of "good" work. As educators with little or no CS experience are often tasked with making curricular decisions, a curriculum evaluation rubric may serve a similar role by identifying high-quality materials in a way that even those with little CS content knowledge can make informed and effective decisions about adoption.

The use of rubrics within education is not limited to evaluating student work. Rubrics have also been used broadly to evaluate the effectiveness of instructional materials (Buffum et al., 2015) and educational technology applications (C.-Y. Lee & Cherner, 2015; Ok et al., 2016; Papadakis et al., 2017; Rodríguez-Arancón et al., 2013). Since schools and districts must evaluate curricula for alignment with standards and the needs of both teachers and students when selecting new materials for use (Bybee & Chopyak, 2017; National Academies of Science Engineering and Medicine, 2018), educators often turn to evaluation rubrics during the process (Briars, 2014; Marshall et al., 2009). Such rubrics include the EQuIP rubrics for Science (Achieve Inc, 2016), Math (Achieve Inc, 2017b), and English (Achieve Inc, 2017a). These rubrics provide a standardized scale on which to judge a curriculum as well as directed means of feedback that can specifically suggestions for improving the curriculum to educators (Marshall et al., 2009). Each rubric is aligned to the appropriate national standards for each subject, Next Generation Science Standards (NGSS Lead States, 2013) for science and the Common Core State Standards for math and English (National Governors Association Center for Best Practices Council of Chief State School Officers, 2010). Evaluation rubrics help evaluators not only with consistency but also to think in terms of new criteria. For example, the EQuIP rubric for Science specifically aims to help direct teachers toward curricula with inquiry-based learning by evaluating them on that standard (Marshall et al., 2009). By highlighting specific standards, rubrics can help teachers become more attuned to specific criteria over time (Cateté et al., 2016). These rubrics are typically validated through use by the development team or a few content experts such as teachers, mostly to receive feedback on and provide validity of the rubric (C.-Y. Lee & Cherner, 2015; Marshall et al., 2009; Papadakis et al., 2017; Rodríguez-Arancón et al., 2013; Ternus et al., 2007). Few, if any, studies have comprehensively examined how these rubrics are utilized by their target populations (i.e. teachers) and how the use of the rubric shaped teacher evaluations.

Not many evaluation rubrics currently exist for CS. The SCRIPTS rubric developed by Computer Science for All focuses on the implementation of new CS programs within districts (CS for All, 2018). The SCRIPTS rubric was created to support districts as they develop and adopt a plan for CS instruction in their schools by providing a structured lens through which to look at all parts of the system that influence the implementation over the period of change associated with the adoption. Leadership, Teacher Capacity and Development, Curriculum and Materials Selection and Refinement, Partners, and Community are all measured as contributing (CS for All, 2020). On a school level, the CS Teaching Rubric is an observation tool that measures teacher effectiveness and classroom behaviors of students and provides a basis on which educators can reflect on CS instruction by examining the actions of the

students in the classroom – revealing both strengths and areas for growth in a teacher's practice (Benedict et al., 2018). In our review of the literature, we were unable to find research on the use or validation of either of these rubrics. A third rubric in the K-12 CS space is the Teacher Accessibility, Equity, and Content (TEC) Rubric which is designed to help educators make decisions about what materials to use in their classrooms and has been previously published and validated (Weintrop et al., 2019). As the TEC Rubric is used in the work presented below, it is reviewed in detail in a later section.

Broadening participation: Exceptionalities and equity in computer science

CS continues to suffer from an underrepresentation of women, people of minoritized races, and individuals with disabilities (Bureau of Labor Statistics, 2018, 2019). This holds true at all levels of education and is, in part, rooted in the availability of early educational experiences for students of minoritized races. Our conceptualization of equity attends both to issues of access to CS instruction as well as a consideration of how instructional materials are designed to support the full diversity of students and the prior knowledge and resources they bring to a given learning context. Access has historically been an barrier to CS as teachers and school counselors often direct women and minoritized individuals away from CS courses (Margolis et al., 2008). Additionally, Black students have less access to CS in formal schooling environments than White students (Google Inc. & Gallup Inc, 2016a). In 2017, only 20% of students who took an AP CS exam identified as American Indian or Alaska Native, Black, Hispanic or Latino, or Native Hawaiian or Other Pacific Islander (racial categories typically considered to be underrepresented in the CS fields; The College Board, 2017) while in the same year 42.1% of public school students identified in one of these racial categories (National Center for Education Statistics, 2019). This underrepresentation continues into tertiary education where there are a low number of CS degrees awarded to students of color and women (Zweben & Bizot, 2018).

In an effort to improve access for all students, especially those traditionally underrepresented in CS, there is a growing push to bring the big ideas of CS, often captured under the term computational thinking, into K-12 instruction across the curriculum (Israel, Pearson et al., 2015; Lee et al., 2014; Weintrop et al., 2016). This includes large-scale implementations at the state level (e.g., Crutchfield et al., 2011; Ericson et al., 2016; Guzdial et al., 2014; White et al., 2018) as well as small-scale implementations on district and school levels (e.g., Brady et al., 2017; DiSalvo et al., 2009, 2014; Goode, 2010; Holbert, 2016; Lachney, 2017; Margolis et al., 2012; Ryoo et al., 2013).

While these projects have largely focused on improving racial and gender diversity, the effort to broaden participation in CS must also include students with exceptionalities (Burgstahler, 2013), including students who are in special education or have disabilities, English Language Learners, and students identified as gifted. Efforts to increase access and engagement for students with exceptionalities in CS education are fewer but tend to focus on including a variety of alternative and scaffolded teaching strategies (Hansen et al., 2016; Israel, Pearson et al., 2015; Israel, Wherfel et al., 2015).

The TEC Rubric

The Teacher Accessibility, Equity, and Content (TEC) Rubric for Evaluating Computing Curricula provides criteria with which to evaluate CS curricula for use within K-12 classrooms (Weintrop et al., 2019). The rubric includes dimensions that attend to how a set of materials support culturally relevant computing and students with exceptionalities, advanced learning of concepts and practices, and teachers as learners. The rubric is organized into three overarching categories, Teacher Accessibility, Equity, and Content, with subcategories delineating specific aspects of these three considerations.

Teacher accessibility

The first category of the TEC Rubric, Teacher Accessibility (Figure 1), focuses on teacher-facing resources included in the curriculum and the extent to which they support teachers with varying experience teaching CS. A high score in this section indicates that the curriculum provides teachers with a variety of aids for instruction and the curriculum is written such that it can be easily followed by teachers with minimal background in CS. Since prior research has identified lack of content knowledge and the ability to stay up to date on CS materials as a fundamental challenge of teaching CS, especially for teachers new to the discipline (Sentance & Csizmadia, 2017), extensive teacher support within a curriculum is essential to helping teachers have successful implementations. The Teacher Accessibility categories are broken down into two subcategories: Teacher Support and Supplemental Materials.

Equity

The second category, Equity (Figure 2), directs evaluators attention to the extent to which a curriculum attends to the principles of culturally relevant curriculum design (e.g., attention to students' personal and community cultures, inclusion of student interests) and supports students with exceptionalities. In the Culture subcategory, raters examine

Teacher Support
Includes a full lesson plan for teacher preparation and planning
Materials are educative and accessible for teachers with differing CS content knowledge (i.e., definitions and examples of CS concepts are offered to support teacher learning)
Makes connections to CS topics covered in past lessons
Materials provide teachers with common misconceptions and challenges that students have regarding the concepts and potential explanations or solutions
Supplemental Materials
Provides student questioning and discussion prompts
Lessons include student facing activity guides that can be given to students in paper form or digitally in order to direct their work
Includes relevant worksheets
Provides teachers with assessment materials

Figure 1. The teacher accessibility category of the TEC Rubric.

Culture (Community-level)
Reflects and highlights the diverse cultures, perspectives, languages, and community values of students with regards to cultural heritage and/or contemporary youth culture (e.g. popular video games or common student interests/activities)
Gives students the opportunity to share their own culture and cultural heritage
Connects learning to students' homes, neighborhoods, and communities
Identity (Individual-level)
Context is meaningful and authentic to students and connects to students' interests
Provides opportunities for students to contribute their knowledge and perspectives about a lesson's topic and share information about their life experiences
Students see themselves represented in the curriculum and classroom materials
Provides opportunities for students to represent themselves in their projects
Exceptionalities (ELL, Special Ed, etc.)
Provides multiple representations within the lesson by adapting for a variety of different types of learners using alternatives to reading, writing, listening, and speaking such as translations, pictures, or graphic organizers
Provides extensions that allow a deeper understanding of topics for students who meet the performance expectations
Assessment methods are accessible to all students and do not penalize or reward students due to exceptionalities

Figure 2. The equity category of the TEC Rubric.

representation of minoritized groups and opportunities for students to exhibit their heritage and youth cultures within the curriculum. In the Identity subcategory, raters focus on student identity, determining if and how the curriculum allows students to see and exhibit representations of themselves. Finally, raters determine whether or not the curriculum supports students with exceptionalities including, but not limited to, students with disabilities, English Language Learners, and gifted students in the Exceptionalities subcategory.

Content

The third category, Content (Figure 3), helps the user of the rubric evaluate the materials with respect to best practices for lesson planning and curriculum development including aligning to standards, pedagogical practices, scaffolding, and assessment. The first subcategory, Computing Content, captures the alignment of content to established standards as well as the use of terminology and a lesson trajectory that will support the introduction of that content. In the Instructional Design subcategories, best practices for teaching in general, rather than specifically the teaching of CS, are included such as clear objectives, varied instructional strategies, opportunities for collaboration, attention to prior knowledge, scaffolding, open-ended learning opportunities, and reflection opportunities. The Theme subcategory pertains to the accurate portrayal of non-CS content within lesson

Computing Content
Content aligns with standards (e.g. K-12 CSTA Computer Science Standards)
Content within the lesson is presented following a trajectory that begins with less complex topics and increases complexity with time
Uses appropriate disciplinary terminology and promotes students' use of disciplinary terminology
Instructional Design - Pedagogical Practices
Lesson is based on clear, measurable objectives (lesson goals) that are provided to the teacher
Each activity includes time for students to apply the skills that are being taught
Includes a mixture of instructional strategies (e.g. discussions, modeling, student activities, worksheets, projects, etc.)
Provides opportunities for students to collaborate
Instructional expectations are easy to understand and directions are easy for students to use
Students are provided with the opportunity to share their work with classmates and receive peer feedback
Instructional Design - Content
Considers students' prior knowledge to incorporate this knowledge into the lesson and/or cover material not previously covered
Questions promote higher order (apply, analyze, evaluate) thinking
Scaffolded to promote greater student understanding and independence as the learner progresses (e.g. gradually fades supports as student advances, utilizes the Use - Modify - Create sequence, etc.)
Lesson provides opportunities for students to explore and provide solutions to open-ended prompts
Content is appropriate to the grade level and complexity students can handle
Provides opportunities for students to reflect on their learning
Theme
Includes accurate coverage of the non-CS topics used as framing (e.g. historical events, groups, cultures, science topics, etc.)
Activities fit together cohesively with a clear storyline
Assessment
Assessments provide teachers with feedback on student progress towards a learning objective
Rubrics are based on objectives and standards and assist in measuring student proficiency
Objective-based formative assessments (i.e., student responses to question prompts, journal prompts) are present throughout the module and are incorporated within the instruction
Objective-based summative assessments are present in the lessons

Figure 3. The computing content category of the TEC Rubric.

(e.g., accurately depicting social studies or science content when they are used to teach CS topics). Finally, the Assessment subcategories ask reviewers to evaluate the formative and summative assessments available within the curriculum.

Teacher Accessibility				
Sub Category		**Evidence and Reasoning**	**Suggestions for Improvement**	**Score**
Teacher Support				
☐	Includes a full lesson plan for teacher preparation and planning			
☐	Materials are educative and accessible for teachers with differing CS content knowledge (i.e., definitions and examples of CS concepts are offered to support teacher learning)			
☐	Makes connection to CS topics covered in past lessons			
☐	Materials provide teachers with common misconceptions and challenges that students have regarding the concepts and potential explanations or solutions			
Supplemental Materials				
☐	Provides student questioning and discussion prompts			
☐	Lessons includes student facing activity guides that can be given to students in paper form or digitally in order to direct their work			
☐	Includes relevant worksheets			
☐	Provides teachers with assessment materials			
	Overall Score:	3: Extensive evidence to meet at least one criteria (and at least adequate evidence for other category) 2: Adequate evidence to meet all criteria in the category 1: Adequate evidence to meet at least one criterion in the category, but insufficient evidence for one other criterion 0: Inadequate evidence to meet two or more of the criterion in the category		

Figure 4. The TEC Rubric format including subcategories, checkboxes for criteria, fields for evidence and reasons, suggestions for improvement, and partial and total Scores.

Applying the TEC Rubric

To apply the TEC Rubric, the educator is asked to review the materials with respect to each of the aforementioned categories and to provide evidence and reasoning for each subcategory. Further, the educator is prompted to provide suggestions for improvements while evaluating. Each criterion in the rubric is accompanied by a check box for reviewers to indicate whether the criteria is met or not (Figure 4). Once a rater has evaluated each sub-category, the subcategory scores are summed into three general scores, one for each broad category, which in turn, produces an overall evaluation. The scores, along with the written notes accumulated during the evaluation, provide the educator or curriculum designer who applied the rubric with a sense of the strengths of the curriculum as well as areas where teachers might want to supplement the curriculum. By using this system of categories and sub-categories comprised concrete criteria, the rubric provides structure for the evaluation of materials and can inform the decision to use the materials in the classroom and possible ways to supplement the materials if gaps are identified.

Methods

Prior research on evaluation rubrics examines how the target audience (i.e., teachers) use rubrics in service of providing rubric validity (e.g., Papadakis et al., 2017; Ternus et al., 2007). Yet, research does not examine how the use of the rubric can shape teachers' evaluations or support them in selecting, refining, and preparing materials for their classrooms. In order to better understand how, if at all, using the TEC Rubric affects the behavior of teachers when evaluating CS curricular materials, we conducted a within-group study in two phases. In the first phase, teachers evaluated a set of curricular materials without any supports for evaluation (i.e. without a rubric), in the second phase, teachers re-evaluated the work with the assistance of the TEC Rubric. By looking across the two phases, we sought to understand if and how the TEC Rubric shaped how

Table 1. Breakdown of teachers by grade level.

Grade level	# Teachers
K (age 5)	2
1 (age 6)	2
2 (age 7)	3
3 (age 8)	3
4 (age 9)	2
5 (age 10)	2
6 (age 11)	1
7&8 (ages 12&13)	2

Table 2. Breakdown of teachers by subject taught.

Subject(s) taught	# Teachers
General education (Math, Reading, Science, Social Studies, Writing)	11
Math	1
Science	2
Math and Writing	1
Math, Science, and Writing	1
Math, Science, and Social Studies	1

elementary teachers with little prior CS experience evaluate a CS curriculum. This approach was informed by related work in the field of teacher education looking at how teacher-focused supports can shape teacher knowledge, behavior, and outcomes (e.g., Star & Strickland, 2008). The goal of this two-phase design is to provide insight into how the introduction of the TEC Rubric changed teachers' evaluations.

Participants

Seventeen in-service teachers (15 female, 2 male) participated in this research. The teachers taught grades ranging from kindergarten to 8th grade and varied disciplinary subjects (Tables 1 & 2). Participating teachers worked in different schools across the same district in a metropolitan area. All participants were enrolled in a course titled "Learning with Technology", which is taught as part of a Master's of Education in Teacher Leadership at a large, public university in the Mid-Atlantic region of the United States. None of the teachers had prior experience teaching CS or have been trained as a CS teacher.

Study context

The teachers completed their evaluations as part of an assignment in the third and fourth weeks of the Learning with Technology course, which was taught by an author of this paper. The assignments were motivated by larger discussions around CS and computational thinking integration, technology curricula, and technology integration within the classroom.

Table 3. Assignment prompt and evaluation survey questions given to teachers.

Assignment prompt for both phases	
A colleague of yours has been asked to teach a new Introduction to Computer Science course for 4th graders. Knowing that you are an expert in teaching with technology and teaching about technology, this colleague has asked for your professional opinion on the first 2 units (10 lessons) of SFUSD's Creative Computing curriculum. The goal of the course is to introduce students to computer science in a fun and engaging way. Desired learning outcomes are for students to (1) learn some basic ideas of programming and (2) become more interested in programming and the field of computer science. The teacher is particularly interested in making sure the curriculum is appropriate and accessible to all students, including special needs students, English Language Learners, and students from historically underrepresented populations in computing (female, African American, Latinx, etc). Finally, the teacher is new to computer science so does not have much prior experience in programming to draw from, making her a little nervous about the new curriculum.	
Evaluation Survey	
Phase 1 – Without the TEC Rubric	Phase 2 – With the TEC Rubric
Curriculum Review:	Curriculum Review:
(1) What do you see as the strengths of this curriculum?	(1) What do you see as the strengths of this curriculum?
(2) What do you see as the weaknesses of this curriculum?	(2) What do you see as the weaknesses of this curriculum?
(3) Would you recommend your colleague use this curriculum? Why or Why not?	(3) Would you recommend your colleague use this curriculum? Why or Why not?
(4) On a scale of 1–5, how confident are you in your evaluation of the curriculum? (5 point Likert scale)	(4) On a scale of 1–5, how confident are you in your evaluation of the curriculum? (5-point Likert scale)Reflection
	(1) What was the difference between evaluating the curriculum with the rubric as opposed to without it?
	(2) Did you find the rubric to be useful for evaluating the curriculum? If so, why?
	(3) Were there any categories in the rubric you found confusing or difficult to apply?
	(4) Were there any topics or curricular dimensions you think were missing from the rubric?
	(5) How often do you think you would use this rubric when evaluating technology-related curricula? (5-point Likert scale)
	(6) How easy was it to use the rubric to evaluate the curriculum? (5-point Likert scale)
	(7) Any final thoughts about this assignment or the rubric you would like to share?

Study procedure

The teachers evaluated a CS curriculum first without and then with the TEC Rubric. Teachers were given the same assignment prompt (Table 3) at the beginning of each phase. The prompt took the form of a scenario where they were being asked by a colleague to evaluate a CS curriculum while paying attention to important aspects of the curriculum such as learning outcomes, appropriateness and accessibility to all students, and accessibility to a teacher new to teaching programming.

In both phases, teachers were given one week to complete a short, free response survey online after reviewing the materials to identify strengths and weaknesses of the curriculum. This survey was composed of a set of four evaluation questions (Table 3). In the second phase, teachers were given the TEC Rubric as a scaffold to guide their evaluation. Teachers completed the full TEC Rubric as instructed and then completed the same survey as in phase 1. After the second evaluation, the teachers were also prompted to reflect on how the rubric impacted their experience evaluating the materials using a series of evaluation questions. No instruction related to CS or discussion of the assignment took place in class between the two assignments.

In both phases, the teachers evaluated the Green Book of the San Francisco Unified School District's 3–5th grade Creative Curriculum (San Fransisco Unified School District (SFUSD) Computer Science Team, 2018). This curriculum, based on the Creative Computing Curriculum (Brennan et al., 2014), introduces CS as a creative, collaborative, and engaging field to elementary school students. It is broken down into five units with 15–20 lessons implemented in 45 to 60-min periods approximately once per week. Students explore a range of CS topics from algorithms and programming to the greater impacts of computing. While using the same curricular unit in both phases of this research increases certain threats to validity (Gay, 1987), this design was chosen so as to control for differences between curricula while also serving a more direct way to understand the role of the TEC Rubric in shaping how educators new to CS evaluated the materials. Whether teachers repeated any of their comments in their evaluations between phase 1 and phase 2 varied by teacher and all text was analyzed in the same manner, whether parts were repeated between the two phases or not. Further limitations of these methods are included in the discussion.

Data analysis

The data were separately analyzed in three parts: 1) Curriculum Review portion of the Evaluation Survey, 2) Teacher-Completed TEC Rubrics, and 3) Phase 2 Rubric Use Reflection.

We first examined the responses to the four curriculum review survey prompts in phase 1 and phase 2 to identify the main topics discussed by teachers within their evaluations. In a preliminary coding stage, the survey responses were inductively open coded for patterns (Saldaña, 2015) by three researchers to identify emergent themes from the data. Each researcher reviewed the survey responses from both phases and compiled a list of potential themes. The researchers then met to compare the emergent themes, to consolidate redundant themes, and drop less frequent ones. The comparison and consolidation process resulted in 10 final themes: instructional design, student scaffolds and supports, teacher supports and ease of teacher use, exploration, collaboration, reflection and feedback, language (ELL or ESOL), exceptionalities, culture and identity, and youth culture and student interest (Table 4). These themes were then codified into a coding manual and were used to analyze teacher responses relating to the curriculum. The coding manual, along with examples of each code can be found in Table 4. Teacher evaluations that referred to multiple codes were assigned all codes that applied.

Using these codes, all three researchers coded the phase 1 and phase 2 curriculum review portion of the evaluation surveys. To ensure reliability, the three coders met following coding and all discrepancies were discussed to reach 100% agreement. Each coded text segment was entered into a spreadsheet along with the associated codes and whether the segment discussed the code positively or negatively. Each code was analyzed based on the number of times the code was referenced within teacher evaluations and the number of teachers referencing the codes to determine both the most frequent codes and changes in teacher analysis of the curriculum. Following coding, the inductive codes were categorized according to their alignment with the themes of the TEC Rubric (Teacher Accessibility, Equity, and Content).

Table 4. The coding manual developed to analyze teacher responses to the four survey prompts, grouped by how they align with dimensions of the TEC Rubric.

Code and definition	Code example
Teacher Accessibility	
Teacher Supports and Ease of Teacher Use Aids put into the curriculum to assist a teacher in the presentation of content. This can include comments about how easy (or difficult) the curriculum is to use and the ability for teachers to use the curriculum without extensive computer science expertise, training, or experience. It also includes resources, descriptions, scaffolds, and vocabulary provided in the service of teachers.	*There are many scaffolds incorporated in the curriculum that would help teachers feel confident implementing the lessons regardless of how much experience they have with programming.*
Equity	
Language (ELL or ESOL) All discussions of how the curriculum will be used by and effect English language learning populations (commonly referred to as ELL, ESL, or ESOL). Discussions of the supports given specifically for English language learners and the language used to present the materials.	*The teachers provide sentence starters to students for communication. This is very helpful for students learning the language.*
Exceptionalities Discussion of all students who are considered to be exceptional within the schooling environment. This includes students who are in special education or have disabilities as well as those who are advanced, accelerated, or gifted. This does not have to be a documented ability or disability. It can include discussions of students who work faster or slower than others, students with varying computer access or computer literacy, providing extensions, providing additional supports, differentiation, and accessibility to "all learners."	*Students that have IEP's may struggle with all of the readings in each lesson.* *It would also be advantageous to include enrichment or acceleration ideas.*
Culture & Identity Culture is defined as a group of people that someone is a part of due to commonalities, whether ethnic or gender. The culture category includes discussions of including or excluding students' cultural perspectives and connecting to students' homes, neighborhoods, and heritage or gender culture. This can include discussions of students seeing themselves or their culture represented within the curriculum or the curriculum being attractive due to cultural characteristics.	*Not really diverse in 'exceptionalities' category, wondering how this can be infused more with students' homes, neighborhood, etc.*
Youth Culture and Student Interest Youth culture and student interest includes the things that students are interested in or would relate to with regards to their personal interests and youth culture. This can include discussion of concepts that are familiar to students.	*By allowing students to develop a program about themselves, they are able to show and use their interests.*
Content	
Instructional Design Those practices generally considered by the education field to be best practices in writing lesson plans such as activating background knowledge, identifying objectives, providing opportunities for student practice, appropriate pacing, and assessment of student learning. This code does not include mentions of scaffolding, student supports, or teacher supports as those are coded separately in other categories.	*Each lesson plan has a clear objective, and a suggested timeframe for each step.*

(*Continued*)

Table 4. (Continued).

Code and definition	Code example
Student Scaffolds and Supports Design aspects specifically for the support of students through scaffolding and other means. These might include, but are not limited to: reviewing vocabulary, teacher modeling, discussions to aid understanding, gradual release and scaffolds, and student resources such as student guides.	*The student workbook is also another useful scaffold build into each lesson.*
Exploration Allowing students to explore the content/platform. This includes discussions of giving time to explore, learning through exploration, students getting to "play around" with the program, discovery learning, and experimentation.	*Students have the opportunity to try and play with the newly learned concepts and tools.*
Collaboration Times when students are working together or assisting each other. This includes discussion of paired programming, peer teachings, students sharing ideas, working with peers in various groupings, and students learning together.	*Students work in pairs in each lesson to learn and play with the learning skills and learn from one another.*
Reflection and Feedback Students having the opportunity to reflect on their learning and projects and give feedback to other students. This includes class wide debriefs of lessons and reviewing the work of others.	*Time set aside for self-reflecting at the end of each lesson because this helps students assess their own learning.*

Following the curriculum review evaluation survey coding, the teacher-completed TEC Rubrics were examined with a focus on how teachers used the rubric and how it shaped their evaluations. Due to a technical issue with uploading the rubric to the submission portal, for one teacher we only have the Equity category of the TEC Rubric. For all other teachers, all three dimensions were analyzed. A researcher analyzed the completed rubrics along the two dimensions: count-based analysis of utilization of rubric features (checkboxes to mark criteria met and open-ended responses to Evidence and Reasoning and Suggestions for Feedback) and a qualitative analysis of information provided within open-response areas (Evidence and Reasoning and Suggestions for Feedback). This analysis was performed with the overall goal of understanding how the teachers used the rubric. Since the goal of this analysis was not to evaluate the curriculum, focus was paid to the rubric use rather than the specific evaluative content of the responses. The researcher generated summaries of the information provided by each teacher in the open-ended responses. Salient quotes from teachers regarding their evidence or suggestions were also noted throughout the analysis process. These data were examined to determine if and how use of the rubric encouraged teachers to provide suggestions to align the curriculum to their teaching environment and further examine the specific nature of those comments.

Finally, teacher reflections to using the rubric from the phase 2 survey were coded to understand how teachers felt about using the TEC rubric and how the rubric was both useful to the teachers and the difficulties of using it. Initially, all three researchers examined the reflection portions of the free-response survey data to determine a coding procedure. Based on the differences between the reflection questions and the curriculum review evaluation questions, a second coding scheme was developed for the reflection questions. The three researchers shared initial themes developed through an

initial inductive open-coding (Saldaña, 2015). One researcher refined the emergent themes into seven codes: focus on specific or new areas, depth, teacher confidence, idea organization, time, ease or difficulty of use, and equity noticing. These codes were applied to the reflection data with the goal of understanding teachers' overall evaluations of using the TEC Rubric and the ways the rubric did and did not support their evaluations.

Results

In the remaining portion of the paper, we discuss teachers' evaluation of the CS curriculum based on the curriculum review portion of the evaluation survey and the teacher responses on the TEC rubric. We begin by presenting an analysis of teachers' responses to the survey prompts without and then with the TEC Rubric. Then, we explore how these evaluations changed between the two phases, including an overall discussion of instructional design and broader focus on culture and equity when using the rubric for evaluation. We conclude this section with an analysis of the teachers' impressions of the rubric and their overall feedback regarding its use.

Phase 1: without the TEC Rubric

Prior to being introduced to the TEC Rubric, the teachers were asked to evaluate the curriculum based on their knowledge and experiences as classroom teachers. The scenario of the assignment asked teachers to attend to some specific aspects of the materials that aligned to dimensions of the TEC Rubric (e.g., computing content, accessibility to all students, accessible to inexperienced teachers). This was done to help bootstrap the teachers on what was admittingly a difficult assignment given their lack of prior experience with CS. The extent to which teachers discussed these topics and their initial evaluations of the rubric are explored below, organized according to the categories of the TEC Rubric: Teacher Accessibility, Equity, and Content.

We first analyzed responses to the three open response questions in the curriculum review portion of the evaluation survey: strengths and weaknesses of the curriculum and whether teachers would recommend the curriculum to a peer (Table 3). This analysis resulted in a total of 225 uses of the analysis codes from all 17 teachers (Table 5).

Table 5. Without the TEC Rubric analysis by inductive codes and Rubric categories.

Category/Code	Code count	%	# of teachers
Teacher Accessibility	**23**	**10.22%**	**13**
Teacher Supports and Ease of Teacher Use	23	10.22%	13
Equity	**36**	**16.00%**	**12**
Language (ELL)	10	4.44%	8
Exceptionalities	22	9.78%	10
Culture & Identity	1	0.44%	1
Youth Culture/Student Interest	3	1.33%	3
Content	**166**	**73.78%**	**17**
Instructional Design	59	26.22%	16
Student Scaffolds and Supports	42	18.67%	16
Exploration	19	8.44%	12
Collaboration	28	12.44%	14
Reflection and Feedback	18	8.00%	11

Teacher accessibility

Within the analysis codes, teacher accessibility was represented by the code **teacher supports and ease of teacher use**. This code was the fourth most prevalent idea in Phase 1 (10.22%) and was mentioned by 13 of the 17 teachers. These comments both applauded the curriculum and noted areas for improved teacher support. One teacher noted that the curriculum *gives teacher guidance and support for implementation, making it a little less scary for teachers that feel technologically challenged* (101) and another noted that *teachers would find that the videos, tutorials, and workbooks are easy to follow and that the site has many supports in place to answer any questions or solve any problems* (107). Alternately, a teacher described that *some teachers may be overwhelmed* (109) by the curriculum. As one teacher highlighted, this could be due to the need for teachers to *put in many hours on their own to play around and understand* (101).

Equity

Equity was captured through four of the analysis codes: **language (English Language Learners), exceptionalities, culture & identity**, and **youth culture/student interest** (Figure 6). In Phase 1, 12 of the 17 teachers attended to some aspect of equity, resulting in 16.00% of the total codes. Teachers focused their writing on **language (ELL)** and **exceptionalities** when discussing equity. Specifically, the **language** category captures references to ELL populations including the supports given for language use, representation of various languages in the materials, and vocabulary when it was mentioned as a support specifically for ELL populations. Generally, teachers commented on manners through which to improve the curriculum for students with regard to language. One teacher recommended that *the guiding sheets could be in a few common languages (Spanish, Portuguese, Russian) to help support these students* (101). In the **exceptionalities** category, teachers discussed both the supports and extensions for learners. For example, one teacher commented that *it would also be advantageous to include enrichment or acceleration ideas [and] differentiation for students with special needs or students who require extra support* (107). Another teacher added that the curriculum *could provide more strategies for eager learners who will discover tools/block before they are introduced* (115). When evaluating the curriculum without the TEC Rubric, only one teacher commented on **culture and identity**, saying the lesson was *very beneficial for female students and students from different backgrounds because they are able to work with other students and it doesn't feel competitive because they can work with another person and safely share ideas* (108). Only three comments were made about **youth culture/student interest** in Phase 1, each from a different teacher.

Content

Lesson content was the most discussed topic within Phase 1 (73.78%) with all 17 teachers attending to at least one dimension of content. This included teachers mentioning **instructional design, student scaffolds and supports**, and opportunities for **collaboration, reflection and feedback**, and **exploration** (Figure 7). Instructional design was the facet of the curriculum most mentioned by teachers. This included teachers discussing activating background knowledge, making connections to prior lessons, clear and measurable objectives and standards, lesson pacing, and assessing student learning. This was followed by comments coded as **student scaffolds and supports**, where teachers

discussed the student materials. Teachers noted that the curricular design elements included support for students. For example, one teacher highlighted the *step by step instructions for students to learn and understand a new concept* (106) and another noted the *scaffolding/gradual release throughout the lesson sequence* (104). In attending to content, teachers were also critical of the materials and made suggestions for their improvement. One teacher stated that the *time expected for each activity isn't realistic* (111) and another suggested, *I feel that this could be a more cohesive curriculum if the teacher introduces the project in the beginning of the introduction lesson* (117). Opportunities for **collaboration** were highlighted by students working together and the promotion of pair and partnered work. Teachers recognized the opportunities for **exploration** with one teacher noting *flexibility for what the student wants to try out* (105) and another mentioning *opportunities to . . . play with newly learned concepts* (108). Finally, **reflection and feedback** was discussed as an aid to teachers and students. A teacher indicated the lesson *give [sic] time for the teacher to discuss and debrief with the students* (102), while another teacher appreciated the *time set aside for self-reflecting at the end of each lesson because this helps students assess their own learning* (107).

Phase 2: with the TEC Rubric

As with the last section, our exploration of the second phase, evaluation with the TEC Rubric, is divided according to the three sections of the TEC Rubric. In each section, we first explore teachers' responses to the curriculum review portion of the evaluation survey taken in the second phase of the study (Table 3). Then, we consider their responses on the TEC Rubric.

Analysis of the curriculum review portion of the evaluation survey from Phase 2 resulted in 195 uses of the analysis codes (Table 6). We also sought to understand how teachers used the rubric and the various rubric elements (i.e., checkboxes, open ended responses). Teachers used each part of the rubric and utilized their criteria rankings to provide suggestions for improvement. This took the form of all teachers using the checkboxes to mark whether criteria were present and including notes in the Evidence of Reasoning section of the TEC Rubric. Most teachers also included Suggestions for Improvement section of the rubric.

Table 6. With the TEC Rubric analysis by inductive codes and Rubric categories.

Category/Code	Code count	%	# of teachers
Teacher Accessibility	**32**	**16.16%**	**15**
Teacher Supports and Ease of Teacher Use	32	16.16%	15
Equity	**39**	**19.70%**	**15**
Language (ELL)	5	2.53%	5
Exceptionalities	17	8.59%	10
Culture & Identity	9	4.55%	8
Youth Culture/Student Interest	8	4.04%	6
Content	**124**	**62.63%**	**17**
Instructional Design	50	25.25%	16
Student Scaffolds and Supports	36	18.18%	16
Exploration	8	4.04%	6
Collaboration	18	9.09%	7
Reflection and Feedback	12	6.06%	6

Teacher accessibility

During Phase 2, the **teacher supports and ease of teacher use** code, that aligns with Teacher Accessibility, was the third most utilized code (16.16%). It was commented on by 15 of the 17 teachers. Teacher comments remained mixed with regards to the overall accessibility of the curriculum. While one teacher noted that *these lessons were well planned and a teacher is able to follow the plan and … materials are available and easy to access* (108), another noted that rubrics for *teachers to evaluate seem to [sic] vague* (112), and a third stated, *there is no clear way for a teacher to know when/if/how they need to move faster or slower through the curriculum* (105).

Equity

Equity comprised 19.70% of the total codes in the Phase 2 curriculum review portion of the evaluation survey with 15 of the 17 teachers attending to equity in their survey responses. In this phase of the study, teachers continued to focus on students with **exceptionalities** as the most used equity code. This was followed by the codes **culture & identity** and **youth culture/ student interest**. The focus on these codes expanded teachers' discussions with one teacher *wondering how this can be infused more with students' homes, neighborhood, etc* (111) and another remarking that students have *several opportunities to make the lessons relevant to them [the students] by creating projects that are unique to their culture and interests* (105). It also led a mixture of critiques and positive comments toward opportunities for students to express their culture and interests. One teacher critiqued that *most of the lessons give students a specific task to accomplish without giving students opportunities to relate it to their own life and make a stronger connection to the topic* (103), while another noted that the projects are occasionally *an opportunity for them [the students] to express themselves* (117). In Phase 2, **language (ELL)** became the least frequent equity code, with only 5 of the 17 teachers attending to it in their responses.

Content

During Phase 2, teachers continued to spend the greatest amount of their writing discussing Content (62.63%). All 17 teachers once again attended to Content in their responses. Particularly, teachers continued to focus on **instructional design** and **student scaffolds and supports** with less focus on opportunities for **collaboration, exploration**, and **reflection and feedback**. The salient aspects of the instructional design and student support remained the same between the two phases with both positive and negative comments toward the lesson plan content. One teacher noted that *the lessons were well designed and have the potential of getting all students actively engaged and learning to program* (108). Alternately, another teacher brought up the need to align the content with *core standards* … [and] *other content areas* (104). Various teachers also noted supports for students such as *user friendly vocabulary* (113), *the gradual release [scaffolding]* (114), and *ideas were provided to help students* (107).

Evidence and reasoning and suggestions for improvement

For each criterion within the TEC Rubric, the evaluator is provided a chance to add evidence and reasoning as well as suggestions for improvement. Overall, 16 of the 17 teachers utilized this section to provide evidence and reasoning for their criterion markings and 15 of the 17 teachers utilized this section to provide suggestions about the curriculum (Table 7). The suggestions included specific changes that could improve the

Table 7. Teacher use of suggestions for improvement.

	Evidence and reasoning		Suggestions for improvement	
Rubric Section	Number of Teachers	% of Teachers	Number of Teachers	% of Teachers
Teacher Accessibility	**15**	**93.75%**	**12**	**75.00%**
Teacher Support	15	93.75%	8	50.00%
Supplemental materials	14	87.50%	9	56.25%
Equity	**16**	**94.12%**	**13**	**76.47%**
Culture (Community Level)	15	88.24%	10	58.82%
Identity (Individual Level)	15	88.24%	8	47.06%
Exceptionalities	14	82.35%	11	64.71%
Content	**15**	**93.75%**	**13**	**81.25%**
Computer Science Content	13	81.25%	6	37.50%
Instructional Design – Pedagogical Practices	14	87.50%	7	43.75%
Instructional Design – Content	15	93.75%	10	62.50%
Theme	8	50.00%	6	37.50%
Assessment	13	81.25%	10	62.50%

Note: Percentages for Teacher Accessibility and Content are out of 16 available rubrics and those for Equity are out of 17 available rubrics.

curriculum for a teachers' individual context. Some of the suggestions teachers supplied would need to be carried out by the curriculum developers or CS experts. This included one teacher's suggestion that *questioning could be more explicit and listed within the lessons so that teachers are provided with good examples of higher order thinking questions* (104) and another teacher's note that *it would be helpful if the lessons offered ideas about what misconceptions might come up* (107). Other teacher suggestions pointed directly to teacher moves that teachers using the curriculum could perform. For example, one teacher suggests that a *teacher could encourage students to talk about their culture and cultural heritage … students could think about the country where they born [sic] or come from* (106) Another noted, *a suggestion would be to have the option of recording their reflections digitally with a Talk to Text tool or some other recording app* (107). Through these suggestions, teachers noted the changes the curriculum would need to fit into their unique environment and meet the needs of their students. They utilize the rubric, as the authors hoped, to specifically indicate changes to be made to align the curriculum with their setting.

Twelve of the 16 available rubrics identified Suggestions for Improvement related to Teacher Accessibility. In this section, teachers mostly identified materials that would be helpful to them such as the addition of small check-in assessments. Most of these suggestions could be created either as part of the curriculum development process or by the teachers as they implemented the curriculum. When examining the curriculum for Teacher Accessibility, 15 of the 16 available rubrics utilize the evidence and reasoning section of the rubric. Teachers tended to use this section to provide examples aligning to each criterion.

In the Equity section of the rubric, 13 of the 17 available rubrics included Suggestions for Improvement. Most of the suggestions offered sought to introduce opportunities for their students to share culture through concrete activities. Sixteen of the 17 teachers provided reasoning for their equity ratings. They especially emphasized the open-ended tasks where students create their own project as being key to students expressing their culture when other areas of the curriculum did not allow this.

Finally, on the Content portion of the TEC Rubric, 13 of the 16 rubrics offered Suggestions for Improvement and 15 of the 16 rubrics offered Evidence and Reasoning. Teachers focused on providing evidence of the criterion being met and rephrasing the criteria found in the lesson plan. Generally, they did so using one concrete example, such as the discussion of paired programming for the criterion focused on collaboration. It appears that having equity and teacher accessibility before unit content within the TEC Rubric might have directed some teachers' attention toward equity and accessibility when making unit content suggestions. Of the 13 teachers who offered suggestions for content improvement, three specifically mentioned exceptional populations in their suggestions and others noted suggestions that would support all students, but especially students with exceptionalities. For example, one teacher focused on the needs of students with exceptionalities saying, *add some more guidance to some of the exploring activities for SpEd students so they can be focused on the given skill* (103)

Comparison and value of the TEC Rubric

Guided by the structure of the TEC Rubric and the language of the survey prompts, teachers discussed many of the same elements in the two phases of the study. However, there are some ways the nature of the teachers' responses changed after using the TEC Rubric in their evaluation. In this section, we explore these changes in teachers' evaluation of the curriculum. Then, we present teacher reflections to using the TEC Rubric based on the additional questions on the phase 2 survey (Table 3).

Teacher accessibility

Overall, the participating teachers discussed Teacher Accessibility more in Phase 2, with the TEC Rubric, than in the previous phase (Figure 5). They referenced **teacher supports and ease of use** nine more times in Phase 2 than they had in Phase 1 (32 references and 23 references, respectively) with 2 more teachers attending to this dimension in the set of responses generated with the support of the TEC Rubric. While the teachers were already attentive to the level of teacher support the curriculum offered before being introduced

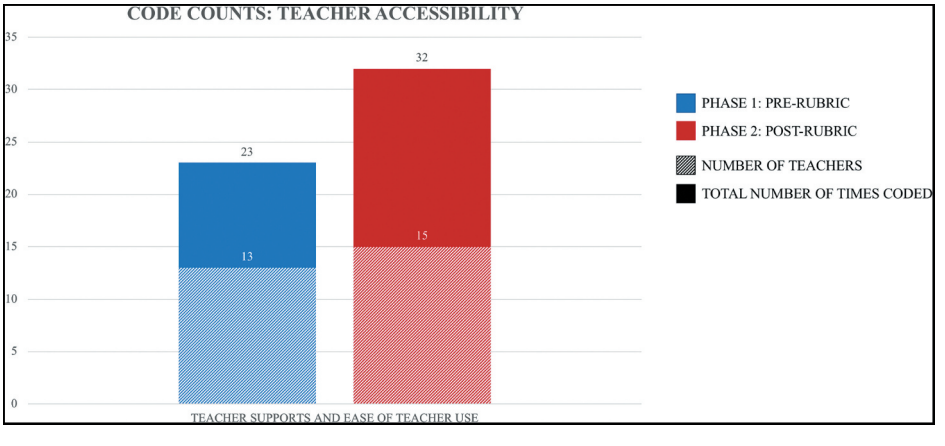

Figure 5. Teacher accessibility code counts.

to the TEC Rubric, the increase in frequency of comments coded as **teacher supports and ease of use** suggest that the rubric helped teachers become even more aware of the supports offered, and the types of supports that could be offered.

Equity

Between the first and second analyses of the curriculum, we see a change in both the quantity and composition of comments attending to the Equity category. Although the increase in total identification of equity codes between the two phases was slight (36 instances of the Equity code in Phase 1 and 39 in Phase 2), teachers were more likely to mention students' culture (1 mention in Phase 1, 9 mentions in phase 2) and their interests (3 mentions in phase 1, 8 in phase 2) when guided by the structure of the rubric than they were in Phase 1 when just guided by the prompt (Figure 6, columns 3 and 4). We also see a growth in the number of teachers attending to these dimensions. In Phase 1, only 3 teachers commented on either the **culture and identity** or **youth culture** dimensions, compared with nine different teachers in Phase 2. The rubric appears to have helped to illuminate equity issues related to students' various cultures and interests. The broader set of ways that teachers wrote about equity in Phase 2 may allow teachers to make curricula more relevant to students.

Content

In all, teachers were most concerned with topics relating to the content of curricula when evaluating them for use within their classroom. In both phase 1 and phase 2, the Content category was where the majority of teachers comments were focus (73.78% of comments in Phase 1 and 62.63% of comments in phase 2). It was also the only category commented on by all 17 teachers in both phases. **Instructional design** and **student scaffolds and supports** were the two most used codes in both phases. However, some of the codes relating to content, specifically opportunities for **exploration, collaboration**, and **reflection and feedback**, were discussed less frequently in the second phase than the first (Figure 7). Comments coded as **Exploration** decreased from being mentioned 19 times by 12 teachers to being mentioned only 8 times by 6 teachers in phase 2. Likewise,

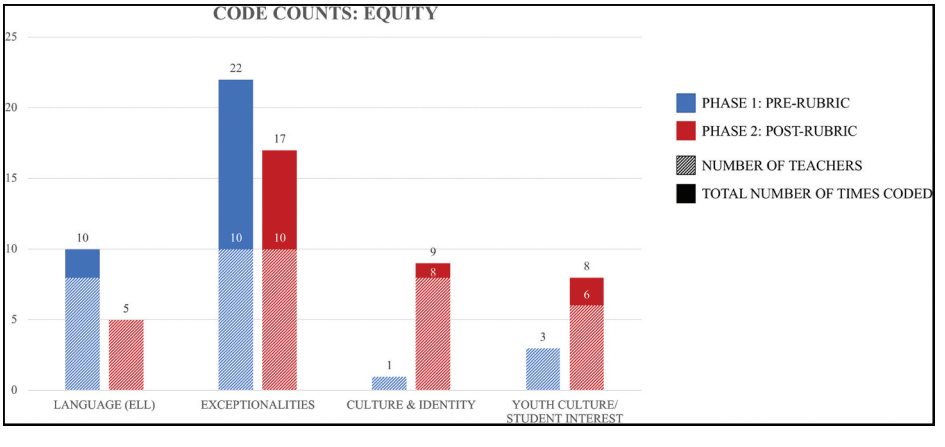

Figure 6. Equity code counts.

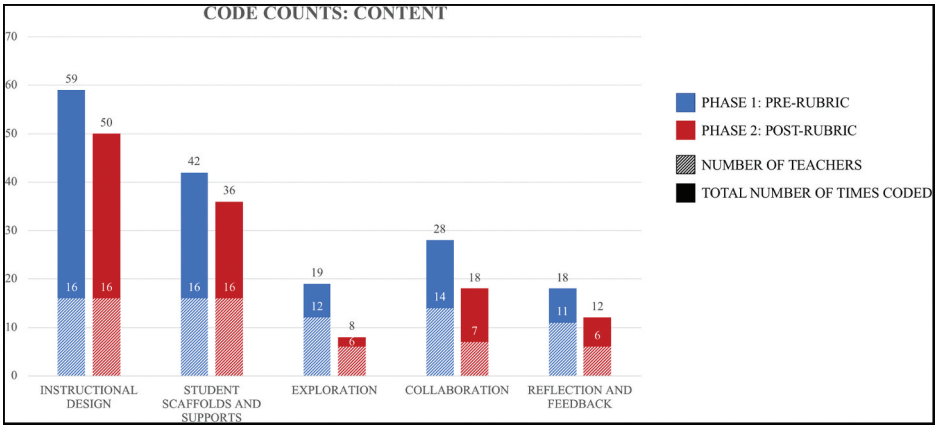

Figure 7. Content Code Counts.

comments coded as **collaboration** dropped from 28 to 18 with half as many teachers attending to it in phase 2 (7 compared to 14 in phase 1). Finally, comments coded as **reflection and feedback** went from 18 from 11 teachers in phase 1 to 12 comments from 6 teachers in phase 2. One way to explain this drop in frequency between the two phases is by shifting attention to dimensions of the curriculum, as can be seen in the increase in comments in other dimensions of the rubric.

Confidence in evaluations

Supported by the TEC Rubric, teacher confidence in their evaluations of the curricula increased slightly (Figure 8). On a scale of from 1 (not very confident) to 5 (very confident), without the TEC Rubric teachers had an average confidence of 3.59 (SD = 0.71). With the TEC Rubric, the average teacher confidence increased to 3.94 (SD = 0.66). While not a huge increase, this nevertheless suggests that having a scaffold such as the TEC Rubric helped teachers to feel more confident in their ability to evaluate CS curricula.

Experiences using the Rubric

After completing their evaluation of the curriculum with the TEC Rubric, teachers were asked to reflect on the experience and comment on if and how the rubric helped them in

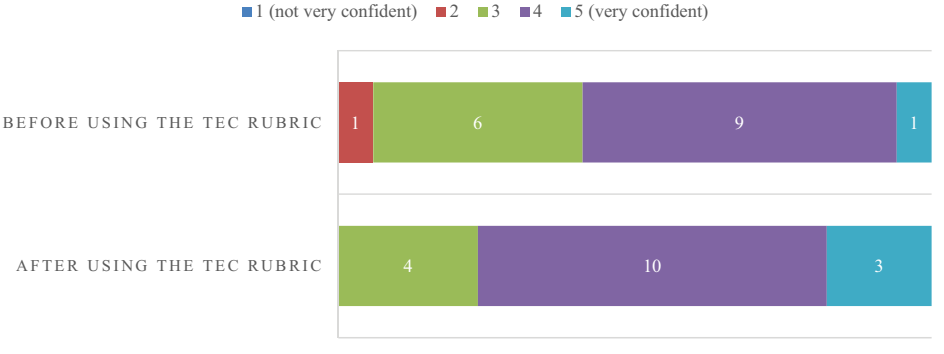

Figure 8. Teacher confidence in evaluations before and after using the TEC rubric.

their evaluations. Overall, teachers were positive about their experiences using the TEC Rubric and highlighted how the rubric changed their focus, depth, confidence, and noticing of equity. While we acknowledge that this might be affected by their evaluation being part of a class assignment and the knowledge that their instructor was involved in the creation of the rubric, their comments nevertheless provide insight into the role the rubric played in their evaluating the CS materials. The most common response from the teachers about using the rubric was how the rubric changed their focus. Eleven of the 17 teachers mentioned how the TEC Rubric helped attune their attention to specific features of the curriculum. For example, one teacher noted that the rubric helped her be *more focused on specific areas . . . instead of just making general observations about the curriculum* (101). A second teacher discuss the benefit of the rubric *giving more details on what to look for in good lesson plans* (108). As a third teacher described, *I was going back and looking for specific things with the rubric more than just evaluating without it . . . it guides what you should be look for when evaluating the curriculum instead of just evaluating based on my own feelings for it* (103). Other teachers emphasized the importance of shared focus when working with curricular evaluation committees. For example, a teacher indicated that the rubric *gives a committee common ground for curriculum expectations . . . [and] helps keep conversations grounded so decisions can be made without external bias* (109). Prior to using the TEC Rubric, teachers noted being unsure of their ratings with one teacher documenting being *apprehensive about my own evaluation of the curriculum* (105) prior to using the rubric. When using the rubric, a teacher remarked, *I got much deeper into the curriculum* (104) and another highlighted the ability to *analyze the curriculum on a more intricate level* (113).

Teachers noted the rubric encouraged them to place attention on new areas. One teacher explained, *I took more time to think about equitable practices and accessibility for teachers* (117). As we found above, in teacher responses after using the rubric, the teachers discussed a broader set of categories related to equity. This might be, in part, because, as one teacher notes, previously the teacher *didn't even think about how it [the curriculum] related to culture until it was laid out in the rubric* (103). When using the rubric another teacher described having *looked more specifically for equitable practices, because even though I know I like to plan and incorporate these practices into my own lessons, I don't always consider it when I read lesson plans and activities* (117). Given how one of the central goals of the TEC Rubric is to assist evaluators in highlighting equity and equitable teaching practices, these comments, in conjunction with our findings, demonstrate how the TEC Rubric is achieving this goal.

While the rubric allowed teachers to explore the curriculum with greater depth and signaled additional criteria for teachers to evaluate, the depth has another side. For example, one teacher commented, *I found the rubric to be overwhelming* (112). The average ease of use rating given by the teachers was 3.19 (*SD* 0.98) on a 5-point scale. Because of the number of criteria, one teacher commented that *the rubric was lengthy and time-consuming making it difficult to see myself using it for potential technologies in the classroom* (110). In contrast, another teacher stated *it was time consuming to think of the curriculum like this, but* ***well worth it to determine the value of how it is being taught*** *[emphasis in original text]* (101). Given this, it will be important for teachers and districts using the rubric to balance the effort needed to use the rubric with the positive results it can produce.

Discussion

As seen in phase 1 of the study, when unsupported by an evaluation instrument such as a rubric, teachers asked to evaluate materials beyond their own discipline focused on the "nuts and bolts" of a curriculum. The teachers in our study attended to topics including teaching practices, sequencing, and information provided within the lesson plans such as standards and objectives. Teachers also paid attention to the supports that are offered to them by the curricula and, especially, noted how the curriculum supports their students. While these elements of curricular design are important, this approach can overlook dimensions of the curriculum related to equity, especially with respect to how the students are represented within the curricula and are given the opportunity to represent themselves. Attending to equity is particularly important when it comes to CS given persistent issues with underrepresentation in the field. Use of the TEC Rubric helped direct teachers' attention towards equity-related aspects of curriculum and led teachers to discuss equity in a broader sense. When not supported by the TEC Rubric, teachers discussed equity with respect to students with disabilities and accessibility to English Language Learners. Evaluating the same curriculum with the TEC Rubric, teachers were attuned not only to students with these exceptionalities but also to the culture and identity of students and the inclusion of youth culture and student interest in the materials. In some ways, this is not surprising given their inclusion in the TEC Rubric but nevertheless, it shows how the rubric helped teachers attend to overlooked, yet important, aspects of equity. With this heightened awareness, teachers can better adapt the curricula for their own classroom and add elements that they consider to be missing from the curriculum to meet the needs of their individual students. With goals of broadening the participation of women and individuals from minoritized races in CS fields, classes starting in early grades need to help students from these groups to see themselves within the curriculum (Scott et al., 2015). Increased teacher focus on equity heeds calls from the field for true inclusion of *all* students within the CS for All movement (Ladner & Israel, 2016) and could lead to a more diverse CS field.

While discussion of equity increased slightly with use of the TEC Rubric (36 mentions to 39 mentions), teachers decreased their discussions of offering opportunities for student exploration, collaboration, and reflection when guided by the TEC Rubric. But, despite teachers discussing these specific concepts less in their written narratives following their use of the rubric, the TEC Rubric includes criteria specifically about each of these concepts. Therefore, these ideas are not lost when teachers use the rubric, rather teachers can see if they are present based on the criteria and elect to make exploration, collaboration, and reflection focal points if desired or focus on concepts considered to be more salient. The TEC Rubric covers the items that were important to teachers prior to using the rubric, even if with the TEC Rubric these points are less prominent in their evaluations.

Limitations

While we think this study sheds light on the potential for rubrics to structure and attune teachers in their evaluation of curricular materials, it is not without its limitations. One set of limitations of this study stem from the teacher population who participated. The teachers who participated in this study were all part of a self-selected cohort of teachers

in a leadership program. Since they are all teacher leaders, this could affect how they look at curricula and their overall evaluations. A second limitation of this study is that while the TEC Rubric was designed for a range of educational decision makers, this study only included teachers; thus, we do not know whether similar patterns of use would be observed in other educational decision makers (e.g., administrators).

Another set of limitations are related to the context in which the study was conducted, and the design of data collection. First, the study took place in a classroom where the instructor was one of the authors of the instrument being discussed. As such, it is possible that teachers were hesitant to be overly critical of the rubric for fear of class repercussions. While we have no reason to believe this was the case, it is nevertheless a possibility. Second, the activity was given for course credit. The student responses themselves were not graded on quality (just credit for turning it in), but this also may have shaped the way teachers engaged with the activity and used the rubric. Finally, the fact that the teachers were asked to evaluate the same curriculum twice may have impacted what was included in the second review. For example, due to having already examined the curriculum, teachers may have already known what to look for the second time around or been looking for different things to comment on during phase 2. Again, the instructions of the activity and the addition of the TEC Rubric in the second phase of the study were designed to prevent this, but it nevertheless may have impacted the data collected.

There are also limitations related to the nature of the data collected. Given that the analysis is dependent on written evaluations turned in, we do not have insight into the specific motivations of the teachers or how they felt beyond what they wrote. While we think this a limitation, we also think this is an authentic task as it is common for such evaluations to result in a written document detailing the results of the evaluation. Finally, the curriculum that was chosen for evaluation in this activity was exemplary and included many best-practices from CS education research. Future work could examine the use of the TEC Rubric with a set of materials with ranging attention to equity issues.

Conclusion

With so many different CS curricula available, it is important that educational decision makers have a way to examine the materials that are available to make the appropriate choice for their specific context. Further, as part of this evaluation, it is important to identify modifications that could be made in order to align instructional materials with the needs of the students within the school. Since no two schools or classrooms are the same, no curriculum can cover the needs of every student, but teachers need resources to assess curricula and identity the modifications that are necessary for their environment. To help with this challenge, the TEC Rubric was designed to serve as a scaffold to assist in evaluating curricular materials to aid educators in making informed curricular decisions. This paper reports on a study designed to understand if and how the TEC Rubric aided teachers in evaluating CS curricula. The results of this study reveal how the TEC Rubric helped teachers to not only feel more confident in their responses but also to be more aware of the needs of all students within their classrooms and methods for meeting those needs. Evaluating a curriculum with the TEC Rubric helps teachers to identify not only the facets of curriculum that are inherently important to them such as the lesson structures but also draws attention to pressing issues related to supporting all students and working

towards the goal of broadening participation in CS fields. In doing so, the TEC Rubric directs teacher focus when evaluating curricula to include Teacher Accessibility, Equity, and Content and can help teachers and schools in continuing to make progress toward the goal of providing effective and accessible CS instruction to all.

Disclosure statement

This paper is of interest to those seeking to promote equity within computing curricula in K-12 educational settings and those interested in the use of rubrics to evaluate curricular materials. This work supports the use of curricular rubrics to evaluate the effectiveness and equitable practices of CS curricula and specifically supports the use of the TEC Rubric to help in the decision-making process of districts, schools, and teachers when choosing curricula for their classrooms.

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