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Journal

Teachers College Record The Voice of Scholarship in Education, 121(5)

ISSN

0161-4681

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Publication Date

2019-05-01

DOI

10.1177/016146811912100509

Peer reviewed

Teachers College Record
The Voice of Scholarship in Education

Pursuing Deep Equity in "Blended" Classrooms: Exploring the In-Person Teacher Role in Supporting Low-Income Youth Through Computer-Based Learning

by Mica Pollock, Susan Yonezawa, Hilary Gay & Lilia Rodriguez - 2019

Background/Context: *Efforts to increase low-income, underrepresented students' access to coursework increasingly tap computer-based course materials. Yet as we turn increasingly to computers for instruction, what might the in-person teacher still be needed to do? This paper presents seven in-person "teacher roles" that precollege low-income youth and their teachers deemed necessary for supporting students as they used computer-based materials. Data were collected across two years in 19 summer school classrooms where 400 high school students took computer-based college-preparatory courses supported in person by teachers and teachers' assistants (TAs). We offer an empirically informed conceptual framework supporting next research on (and innovation of) equity-minded "blended" classroom practice. We define "equity" effort as active effort to meet the needs of each student and all groups of students; here, the effort was to sufficiently prepare each and all students for college.*

Purpose/Objective/Research Question/Focus of Study: *We used focus groups, classroom observations, and interviews to study the roles that teachers embraced and students valued. We asked two research questions: (1) How do in-class teachers (teachers and TAs) support students as students access material online? (2) According to student and adult participants, which teacher supports are key to student success in the courses?*

Research Design: *Researchers observed classrooms to capture patterns of frequently repeated adult-student and peer interaction. Through informal and semistructured ethnographic interviews and focus groups, we invited participants to comment on needed supports for classrooms and on the supports they saw as particularly valuable (or not). We conducted approximately 46 hours of interviews and focus groups and 500 hours of observation.*

Conclusions/Recommendations: *We describe three in-person teacher roles that participants said assisted students in achieving basic equity with computer materials—that is, precollege content access and course credit otherwise denied. We explore four in-person teacher roles that participants called particularly necessary for deep equity—to support students' individual and collective comprehension of the online materials, often through dialogue. We conclude that the teacher's overarching role for achieving equity in these blended classrooms was to continually adjust pedagogy as needed to ensure each and all students both accessed and understood the precollege content. This suggests that adding technology to classrooms to support all students fundamentally requires teachers.*

> *If you're just confused, thank God! She's right around the corner, you can just go ask her. -*
> *Student describing teacher, summer 2013*

Efforts to increase low-income, underrepresented students' access to coursework increasingly tap computer-based course materials. Some schools use computer-based courses, programs, or supplemental materials to provide access to content, instruction, or credit not otherwise available. Some system leaders believe computers might save costs on instruction by replacing teachers altogether (Means, Toyama, Murphy, & Bakia, 2013). The promise of greater or more efficient access to learning opportunities makes expanding computer-based education attractive, particularly in resource-starved educational environments. Yet as educators move to grow such programs, these efforts also raise a core research question for our field. As we turn increasingly to computers for instruction, what might the in-person teacher still be needed to do?

The question is particularly important as many educational systems expand use of computer-based course materials to replace face-to-face classrooms, not just supplement them (Means et al., 2013). Classrooms that explicitly "blend" in-person teaching with computer coursework provide a useful context to study the roles taken by in-person instructors as students *use* computer-based instructional materials (Bingham, 2016). Although many "blending" face-to-face and online instruction today seek to supplement in-person courses with online tools (Means et al., 2013; Patrick, Kennedy, & Powell, 2013; e.g., Roschelle et al., 2016), this study looked at the reverse: teachers supplementing computer-based courses with their own in-person supports.

This study contributes to a larger conversation about equity and technology use in education. We define "equity" effort overall as "a commitment to ensure that every student receives what he or she needs to succeed" (Blankstein & Noguera, 2015, p. 3) and as effort to develop the full human talents of each student and all "groups" by offering necessary opportunities and resources (Pollock, 2017, p. 12). In this study, we defined active "equity" effort more specifically as effort to fully prepare for college low-income, first-generation students of color too often denied that opportunity.

We see our work on *technology use* and equity as building on studies by other researchers who critically examine the "digital divide" (inequity in basic access to hardware, software, Internet, and technology skill, along class and race lines; Rainie, 2017); who research the need for essential access to content, instruction, and credit among low-income students often lacking such access (Carter & Welner, 2013; Darling-Hammond, 2010); and who explore existing forms of school-based technology use by low-income students, who are disproportionately left alone on more passive tools (Reich, Murnane, & Willett, 2012), dropping out of online learning experiences at higher rates (Bakia, Anderson, Heying, Keating, & Mislevy, 2011; Reich et al., 2016; Veletsianos, Collier, & Schneider, 2015), or experiencing classrooms where decision makers "add tech" without asking why or how to do so (Bingham, 2016; Ertmer, 1999). Most important, we are responding to prior researchers' call for close attention to teachers' efforts to design "productive" uses of technology in their own classrooms (Mishra & Koehler, 2006), particularly with low-income students often denied high-quality opportunities to learn (Pollock, 2016). This study sought to examine how teachers *using* technology strove to provide low-income, first generation college-bound students with necessary access to precollege opportunity.

In this article, we offer a taxonomy of seven in-person "teacher roles" that precollege low-income youth and their teachers deemed necessary for supporting students' computer-based learning. These roles were named important across 19 summer classrooms where 400 students took computer-based college-preparatory courses supported in person by a teacher and several teachers' assistants (TAs). All students were on a quest to improve their high school transcripts toward college. Students received a full year of high school credit for coursework completed over six full weeks of seven-hour days.

We studied these classrooms in the summers of 2013 and 2014 not as ideal use cases but as real-world efforts at using computer-based materials to support the college preparation of low-income students of color too often denied access to college-preparatory opportunities (Darling-Hammond, 2010; Mehan, 2012). We also considered these classrooms more generally as examples of an increasingly typical form of learning, where students share physical classrooms but access foundational instruction and information from computer-based tools. We asked two research questions: (1) How do in-class teachers (teachers and teaching assistants) support students as students access material online? (2) According to student and adult participants, which teacher supports are key to student success in the courses?

We argue that these courses attempted the equity effort of college preparation at two levels of intensity. First, the courses attempted to provide basic access to college-preparatory curriculum and credit otherwise unavailable to these low-income students, an effort we call *basic equity*. Many scholars call for improving such basic course access to close "opportunity gaps" nationally (Carter & Welner, 2013); in our state and nationally, only some young people have access to a wide range of essential courses to prepare for college (Betts, Rueben, & Danenberg, 2000), and the computer-based courses used here were created to expand such access. However, scholars also make clear that beyond course access, the deeper equity goal is to ensure high-quality teaching and learning *in* such courses (Darling-Hammond, 2010; Mehan, 2012) to support students in mastering the material (Hattie & Timperley, 2007). The classrooms studied here also attempted to support such comprehension for course success, what we here call *deep equity* effort. Ertmer (1999) might call these first and second "order" efforts to achieve equity with technology—that is, not just to access "more" tech-based information in classrooms, but to test technology's use for pedagogically successful efforts to support student learning (see also Mishra & Koehler, 2006).

In this study, participants (both adults and students) described three in-person teacher roles that assisted students in achieving basic equity (content access and course credit) and four in-person roles they deemed particularly necessary for deep equity (to support students' comprehension of the online materials, often through dialogue). They suggested that the teachers' overarching role for achieving equity in these "blended" classrooms was to continually adjust pedagogy as needed to support students' learning and comprehension—indicating that adding technology to classrooms to support all students fundamentally requires teachers. Other scholars have found such teacher innovation of "the relationship between technology and pedagogy" to be core to teaching that *productively* incorporates technology to support student learning and success (Mishra & Koehler, 2006, p. 1040). Our study delved into the teacher pedagogical roles that teachers and students themselves found particularly necessary in real time. Our goal here is to offer an empirically informed conceptual framework supporting next research on (and innovation of) equity-minded blended classroom practice.

BRIEF OVERVIEW: THE EQUITY INTENTIONS BEHIND THE "BLENDED" COURSES STUDIED

Nationally, and in California, low-income students of color are often stymied by college-preparatory courses that are insufficient in quantity, variety, and quality (Betts et al., 2000; Darling-Hammond, 2010), even as baseline eligibility for coveted university spots relies on taking and completing such courses. In California, improving access to college-prep courses is foundational to college eligibility. To access a University of California (UC) or California State University (CSU) campus, students must access and pass the "a-g," a sequence of required courses that UC system reviewers have deemed sufficiently college preparatory. Further, to become *competitively* eligible for a slot at the most in-demand UC campuses, high school students typically must take (and succeed in) honors or Advanced Placement (AP) courses. Schools serving low-income students of color typically offer fewer of these courses than school that serve upper income schools, thereby fundamentally disadvantaging young people on the road to college (Orfield, Siegel-Hawley, & Kucsera, 2011). Such inequity in course access remains a fundamental problem even though admissions decisions sometimes take into account the context and course offerings at students' high schools (University of California, 2018).

In response to a statewide need for more universal access to college-prep courses, in 1999, the University of California created UC College Prep (UCCP), an initiative to offer any student low-cost access to preapproved, credit-bearing a-g and AP/honors courses online. As of 2013, UCCP was rebranded "Scout from University of California" and housed at UC Santa Cruz Extension in Silicon Valley. By 2014, 10 College Board-approved Scout AP courses and 11 preapproved a-g and honors courses were available online.[1]

Our campus's Early Academic Outreach Program (EAOP), a UC-funded outreach program preparing low-income students for college, was an early adopter of these courses. More than 15 years ago, EAOP started offering UC's credit-bearing, available-anytime honors and AP courses to our region's low-income students in the summer. EAOP students accessed content and credit not typically available in their schools and used the summer's flexible hours to fill transcript gaps. Scout courses came preapproved, allowing schools to avoid time-consuming approval glitches. For 11 initial years, EAOP partnered with local high schools to offer UCCP (now Scout) courses in the summer to improve nearly 1,200 low-income students' college eligibility. In summer 2013 (beginning a multiyear implementation), the UC Office of the President scaled our campus's EAOP model statewide to offer Scout Algebra II to 200 more low-income students in order to address the particular Achilles heel of Algebra II in UC eligibility.

The idea of an "online course" for some prompts visions of students alone in front of glowing screens while automated programs teach them, test them, and verify their grades. Indeed, in Scout courses, the computer can be a primary instructor and assessor; Means and colleagues (2013) called this "expository instruction," where "digital devices transmit knowledge" (p. 3). Students using Scout math courses during our study, for example, read and viewed explanatory material, then accessed short online interactive tests of understanding (what Means et al., 2013, called slightly more "active" individual online learning), and took online quizzes and exams, typically multiple-choice assessments that were then graded automatically (Figures 1 and 2).

Figure 1. Feedback for incorrect answer, UC Scout Algebra I course (newer Scout course, used summer 2014)

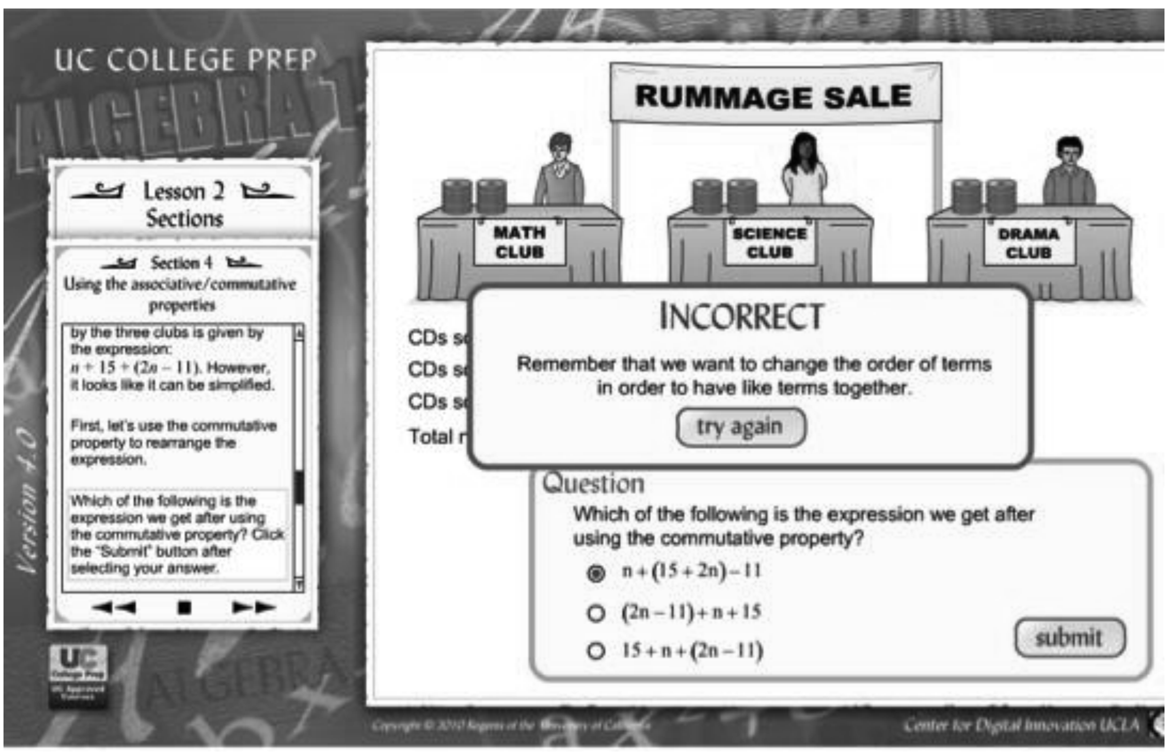
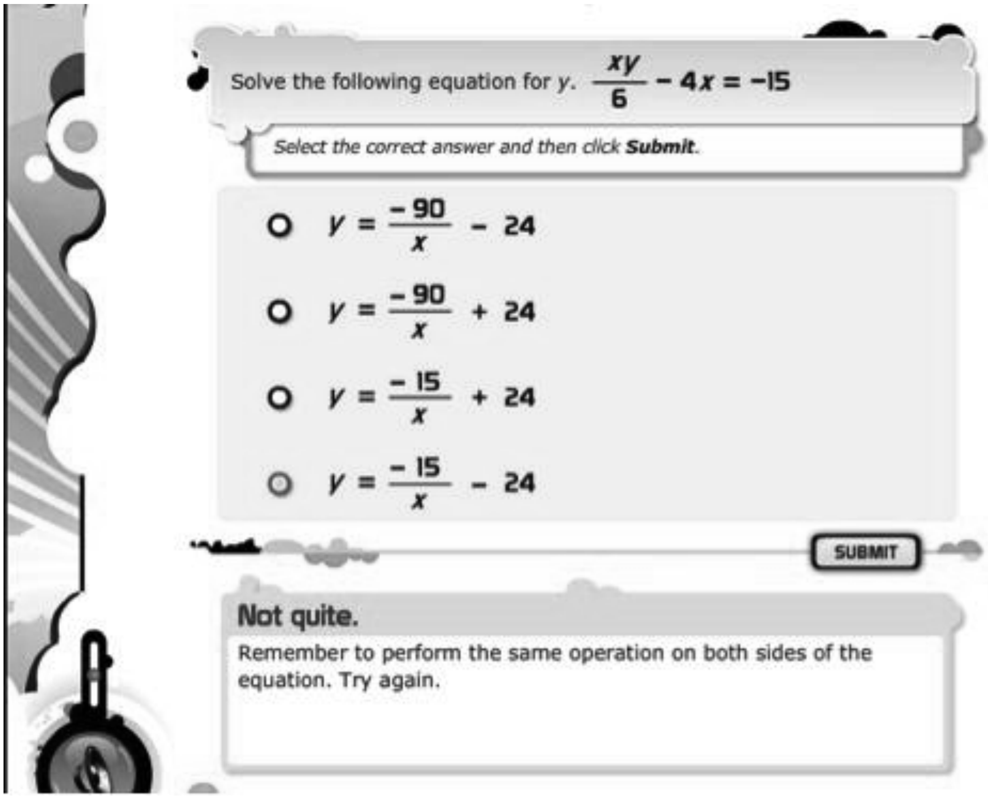


Figure 2. Feedback hint, UC Scout Algebra II (newer Scout course, used summer 2014)



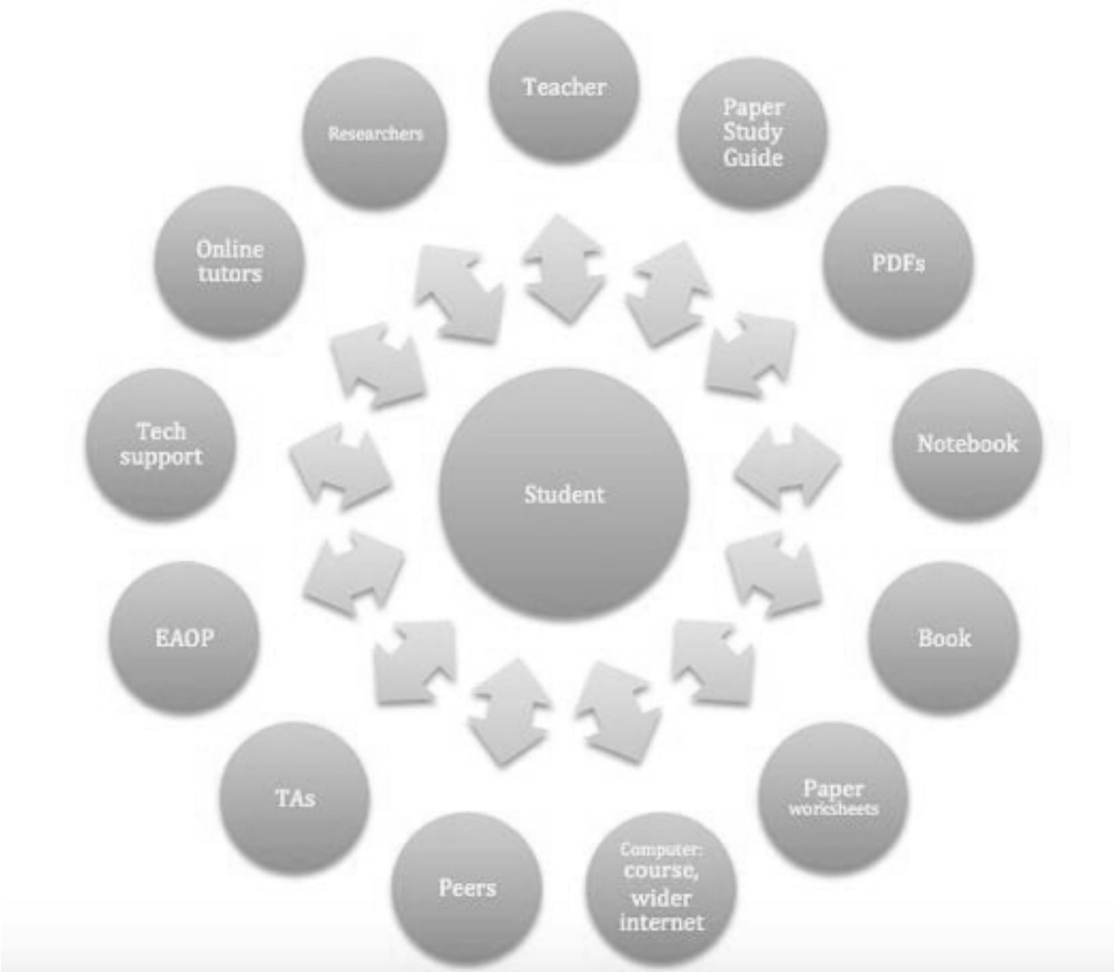
Still, Scout was not designed to be fully teacher-free. For students to get credit for Scout courses, district regulations have required that schools hire credentialed teachers to monitor students' completion of Scout course materials. These teachers have been remote or local; at the time of this study, Scout offered credentialed remote teachers for hire as one option, or a school provided its own teacher for the course. At minimum, these teachers validated students' assignment/assessment completion (including grading some short essay questions in AP courses) and conferred grades. Beyond this basic monitoring, teachers hired by schools interacted with students as much—or as little—as teachers chose or schools required. During the years studied, Scout said it encouraged remote teachers to interact with students; yet, its courses did not require fully "interactive" online learning, such as online dialogue activities and collaboration assignments (Means et al., 2013). By UC's rules, Scout a-g science courses with lab components required some face-to-face lab activities with instructors, and Scout provided a list of required labs to schools.

In its decade-long pilot of UC's online courses, however, EAOP had become committed to a blended implementation: the need for *in-person* teachers and tutors with subject matter expertise to support youth through the online material. Early on, EAOP staff found that students did not log on to the computer courses when taking them alone at home. And, when counselors (not teachers) monitored in-person classrooms, students requested help from EAOP staff with subject expertise. In response, EAOP developed a blended model with roughly 30–40 students sharing a summer school classroom; the students accessed the computer-based materials using individual computers alongside an experienced teacher and teaching assistants. In the model we studied, in-person teacher supports occurred exclusively: No online teacher was hired, and no online interaction occurred. Although peers huddled and talked together in most classrooms, our goal was to understand the support offered by adult instructors (teacher and TAs) while students accessed the computer coursework. We came to call this the "teacher role." We now briefly review prior literature that conceptualizes that role.

PRIOR LITERATURE: CONCEPTUALIZING AND DEBATING THE TEACHER ROLE IN BLENDED LEARNING

Blended learning can be defined most simply as a combination of face-to-face and online learning, or more specifically, as follows: "a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace, and, at least in part, at a supervised brick-and-mortar location away from home" (Staker & Horn, 2012, p. 3). The classrooms we studied all adhered to the working definition of blended learning offered by Means et al. (2013), "in which 25% or more, but not all, of the instruction on the content to be assessed occurred online" (p. 6). They could be classified as "rotation" experiences (Staker & Horn 2012, p. 8): Each classroom came to rotate in some way between online learning and face-to-face instruction at teachers' discretion. As in other blended classrooms, each teacher often moved among "large-group instruction, small-group instruction, and independent work, much of which was technology-led or technology-facilitated" (Pane, Steiner, Baird, & Hamilton, 2015, p. 19). On some days, in some rooms, the classrooms studied might also have been classified as "flex" classrooms, in which students individually accessed instruction largely via the computer course and on-site adults just answered questions (Staker & Horn, 2012, p. 12). But these real-world classrooms, like any classrooms, proceeded idiosyncratically in their use of online materials from day to day and moment to moment, as each teacher rotated among being an individualized tutor, leading whole-class dialogue or lecture, or completing grading or prep work as students worked online (Bingham, 2016). Indeed, research indicates that the in-person teacher role in blended learning is defined anew in every classroom implementation, making the blend *of* in-class interaction and computerized coursework the black box requiring analysis (Enyedy, 2014; Lack, 2013; Means, Bakia, & Murphy, 2014; Patrick et al., 2013; Taylor et al., 2016) (see Figure 3).

Figure 3. Possible supports in the blended learning environments studied



Although public calls to add online courses to school rosters often imply that students will click through such courses alone (Kolowich, 2013), many implementations blend teacher support, peer interaction, and solo learning—and little research thus far supports students learning fully alone online. Prior research on both online and blended courses has indicated the general importance of teachers' support interactions with students, as well as peers', in a "community of inquiry."[2] For example, researchers have found that fully remote learners (Bjork, Dunlosky, & Kornell, 2013; Muilenburg & Berge, 2005) are less likely to submit assignments (Mentzer, Cryan, & Teclehaimanot, 2007) and more likely to drop the class (Xu & Jaggars, 2011), procrastinate, and lose motivation (Lim, 2002; Lim & Kim, 2003), often because of a sense of isolation (Reich et al., 2016). Research suggests that in fully online courses, "students value and benefit from interaction with other students and the instructor" online (Wallace, 2003, p. 250), because learning most subjects often requires some "discussion, feedback, encouragement, or explanation from or with a knowledgeable other" (Wallace, 2003, p. 242; see also Michaels & O'Connor, 2012; Rosé, Goldman, Sherer, & Resnick, 2015). Online, as in person, researchers find, teachers support students through "learning assistance interactions" where teachers reexplain content (Offir, Barth, Lev, & Schteinbok, 2003) and respond to concerns about student welfare (Ream, Lewis, Echeverria,

& Page, 2014). Means, Toyama, Murphy, Bakia, and Jones (2010) indicated that online learning ideally offers “the capability to support real-time and asynchronous communication between instructors and learners as well as among different learners” and to support a community of learners (p. 1). Zhao, Lei, Chun Lai, and Tan (2005) concluded bluntly in a meta analysis that “live human instructors are needed in distance education” to “answer student questions and facilitate discussions” (pp. 1862–1863). “More socially supportive” online courses thus embed tools for discussion, collaboration, and bonding with both instructors and peers so students don’t feel they are posting “into the air” (Rosé et al., 2015).

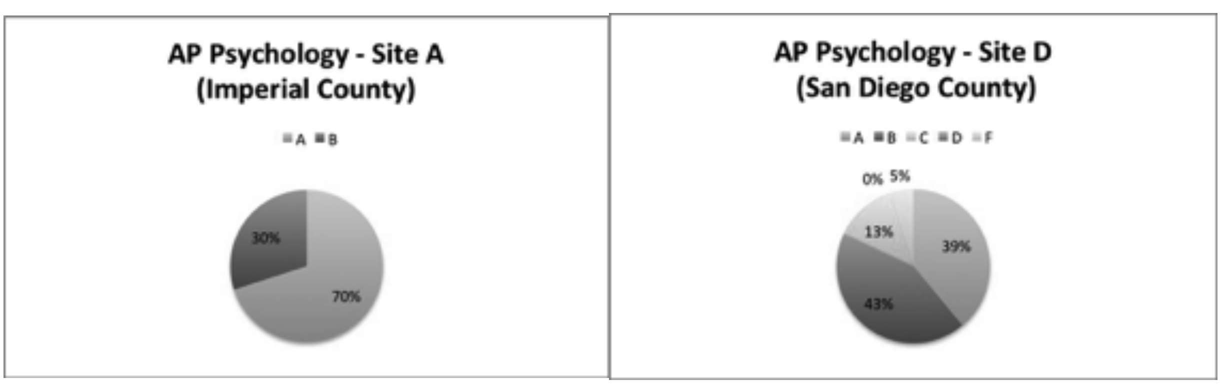
To facilitate more social learning, course designers and instructors increasingly are also supplementing online content access with some forms of *in-person* interaction and dialogue. Some are adding in-person sessions with facilitators to supplement online video lectures (Reich et al., 2014). Others are providing roving tutors or “lab facilitators” to support students as needed in classrooms where students work on online content (National Center for Academic Transformation, n.d.), sometimes also with remote teachers (Bakia et al., 2011). Yet each facilitator, tutor, or teacher might offer different in-person support in such blended environments: Taylor et al. (2016) found that in-person, math-certified adult mentors who *actively* answered questions from ninth graders taking online repeater algebra courses supported more credit recovery than in-person adult supporters who were less subject trained and interacted less. Taylor et al. (2016) thus called for “instructionally supportive” in-person instructors in blended environments, suggesting that “students who are at-risk may need additional instructional support from an in-person teacher” and that “online credit recovery courses with little to no face-to-face support may not meet their needs” (p. 9).

Conversely, as face-to-face courses increasingly blend in technology, research suggests that instructors doing so successfully are increasing, not decreasing, their overall pedagogical supports. Means and colleagues’ (2013) meta-analysis, which found blended classrooms to be preferable to both fully online and traditional (e.g., lecture-based) face-to-face courses, noted that teachers in the blended courses offered *increased student support* versus preexisting classrooms. In many studies, as Means et al. (2010) argued, “blended conditions often included additional learning time and instructional elements not received by students in control conditions” (p. ix).

Thus, researchers seem to be questioning nonsocial online (and face-to-face) learning, and pedagogical efforts to blend in-person pedagogical “support” with online learning are growing (Murphy et al., 2014; National Center on Time and Learning, n.d.; Powell, Rabbit, & Kennedy, 2014). Yet research *closely analyzing* teacher support roles and actions *in* the infinite varieties of blended classrooms is limited—particularly in K–12 settings rather than higher education classrooms (Enyedy, 2014; Means et al., 2010). As recently as 2016, Bingham still argued that “few studies have investigated blended learning in the K–12 context” (p. 2), particularly qualitatively, resulting often in K–12 implementations of blended learning without serious planning for teacher roles or practices. Researchers have called for more research on real-time experiences in blended classrooms (see also Reich et al., 2016), for study of “how students and teachers interact with each other” in real time (Wallace, 2003, p. 244), for studies of “how the technology is used” (Mishra & Koehler, 2006, p. 1018), and for analysis of the “ongoing relationship between online and offline learning activities” (Means et al., 2014, p. 189)—at times with a particular attention to the demographics of students and schools (Reich et al., 2012).

In this study, then, we add to existing literature by offering low-income students’ and teachers’ voices on the support roles taken by teachers in blended classroom environments. We used a variety of qualitative methods to prioritize students’ and teachers’ insights about supports that helped students’ ongoing learning and to understand participants’ “ongoing efforts to make technology ‘work’ in their individual classrooms” (Ertmer, 1999, p. 49). Most of the students who started the courses stayed in the courses, and almost everyone who stayed in the courses passed them with As or Bs (Figure 4). We focus here on students’ and teachers’ takes on the teacher roles that supported both content access and understanding—equity both basic and deep.

Figure 4. Final grades for UC SCOUT courses



DATA SOURCES AND METHODS

During the summers of 2013 and 2014, we studied 19 blended offerings of UCCP/Scout courses in our region and statewide. In 2013, we examined classrooms at four high school sites in our region that offered six AP and honors courses in psychology, sociology, and environmental science, and two algebra courses, primarily for repeaters (Table 1). In 2014, we studied 11 classrooms statewide offering Scout Algebra II as a key college-preparatory requirement. Several of those classrooms served high school graduates who were slated to take Algebra II—now a remedial math course—as their first course in community college.

Table 1. EAOP Summer 2013 Online Course Offerings

Rural *N* = 118	**Urban *N* = 34**
Site A	**Site C**
Honors Sociology *AP Psychology* *AP Environmental Science*	*Algebra I* *Algebra II*
Site B	**Site D**
Honors Sociology *AP Environmental Science*	*AP Psychology*

Given EAOP's demographic focus, all the students in the 19 classrooms studied attended Title I schools with a student body that was 70%–90% economically disadvantaged and where students were typically the first in their families to attend college. EAOP staff recruited all participating students and teachers. The research team—a group of faculty (first two authors), graduate students (third and fourth authors), and undergraduate researchers—invited all teachers, tutors, and students to volunteer for the study. We further recruited participants through in-person presentations to answer questions and secure consent.

As researchers, we were not involved in decisions about course pedagogy (Penuel, Fishman, Cheng, & Sabelli, 2011). Instead, we captured *teachers'* quests to figure out how to use online materials effectively by documenting and discussing teachers' decision-making and in-class activity. Per EAOP and Scout, teachers had discretion as to how to use the online course materials; they received an initial training focused primarily on how to use the computer program and then could contact Scout personally as desired for assistance. The research team observed classrooms to capture patterns of frequently repeated adult-student and peer interaction. In field notes, we documented moments when adults and students talked to one another and/or interacted physically over course materials (leaning repeatedly together over computers, responding to raised hands, pointing or scribbling on paper notes). We noted when students responded to support seemingly positively (an exclamation ["oh!"], a smiling return to a seat). We prioritized observation and interview data in which students and adults explicitly named a support as helpful. Through informal and semistructured ethnographic interviews and semistructured focus groups before and after classes, we invited EAOP staff, teachers, and students to comment throughout each summer on improving the Scout courses themselves (as a UC product), on needed supports for classrooms, and on the supports they saw as particularly valuable (or not). In sum, we conducted approximately 46 hours of interviews and focus groups and 500 hours of observation over a span of 12 weeks over two summers (Table 2).

Table 2. Data Collection Methods

Data Collection Methods	
Formal and Informal Interviews	*Conducted with teachers and TAs throughout the study*
Classroom Observations	*Multiple classroom observations each week*
Audio Recordings	*Recorded interactions of students and teachers/tutors*
Focus Groups	*Separate group interviews for students, and for teachers/TAs*

DATA ANALYSIS

Amid the classrooms' variation in blends, we sought patterns of in-person adult support from teachers and teaching assistants—support forms repeatedly observed by researchers and named by participants. As a team, we reviewed interview, observation, and focus group data in regular meetings during data collection; after data collection was complete, we wrote analytic memos synthesizing data on forms of "help." We spent multiple meetings agreeing on a coding practice allowing us to review all forms of data for *moments of in-person support* witnessed or named by participants, gradually looking for a short list of *versions* of teacher helping named repeatedly by participants or observed in classrooms. In this ethnographic effort to name a taxonomy of helping forms (Emerson, Fretz, & Shaw, 1995; Lofland & Lofland, 1995), we coded both the aspects of helping observed in field notes (e.g., an explanation in response to raised hands) and the supports described explicitly by participants. Before classifying a form of observed support as actually helpful, we also verified that participants said they valued the support form. As we narrowed types of support to seven teacher "roles" to conclude the first seven-week summer, we only included a role in our conceptual taxonomy if it arose consistently enough in the data across the classrooms that the research team of six could all recognize it as pervasive rather than rare or classroom specific. In the second summer of studying math classrooms only, our research team (now of three) reviewed all observed and stated helping examples to see whether the teacher roles found in year 1 were present the following year. They were. Even as each classroom developed its own specific blend of teacher support for use of Scout, that is, every room tapped its teachers (teachers and TAs) in some shared ways. Across both years, we did not find discrepant roles that we chose to exclude from our discussion. We also did not find discrepancies between the support forms emphasized by adults versus students. Each key role was agreed on by participants of all ages.

FINDINGS: SEVEN TEACHER ROLES IN SUPPORTING COMPUTER-BASED LEARNING IN PERSON

Seven teacher roles were both commonly observed and named as valuable by participants across 19 classrooms over two years. Three were ways that on-site adults supported students in accessing online content for course completion and credit that would not otherwise have been available (what we came to call basic equity). Four were roles helping students to comprehend the subject matter (deep equity). Sometimes, a single role heavily characterized a classroom. Nevertheless, each role was found across all classrooms. Participants framed each form of support as necessary to student success:

<u>Roles for in-class teacher support</u>

Basic equity roles (enabling content and credit access)

1. **Teacher as fixer/explainer of technology**
2. **Teacher as monitor of student behavior**
3. **Teacher as highlighter of necessary content**

Deep equity roles (supporting content comprehension)

4. **Teacher as explainer of the content provided**
5. **Teacher as extender and applier of ideas**
6. **Teacher as provider of feedback and assessment**
7. **Teacher as caretaker of student well being**

We explore each role in turn in the section that follows, purposefully offering brief descriptions of the three basic equity roles enabling basic content/credit access and more qualitative detail on the four deep equity roles participants said were key for supporting student understanding. In conclusion, we suggest that the teacher's overarching role was to continually adjust pedagogy as needed to ensure that students both accessed and understood the precollege content.

TEACHER AS FIXER/EXPLAINER OF TECHNOLOGY

On any given class day, tech glitches occurred that on-site teachers had to fix in order to provide course access. Links broke or froze (e.g., a census website that loaded slowly), or videos and animations failed to load on all or some computers. When asked, students described reaching out to the teacher, TAs, or other students for tech help, reporting programs that crashed, tests that didn't accept answers, or occasional questions about the computer's tasks (e.g., "I needed help knowing if I had to submit my answers on one page before going on to the next on my quiz today. A tutor helped me.").

Classrooms in these predominantly low-income schools lacked equipment, and participants struggled with hardware problems (see also Bakia et al., 2011); participants also encountered school firewalls and tech incompatibility (one class had to relocate when computers were unable to load the Algebra II videos). Online tests sometimes refused to accept students' correct answers, a glitch in the course's developing design that had to be fixed at the UC Santa Cruz "home base."

Other tech glitches had to be addressed with in-house solutions. EAOP purchased headphones so that students could listen to computer lessons after realizing that many lacked them. Some teachers created and printed their own assessments or assignments when online assessments froze or failed to load. Other tech problems required quick fixes by a tech-knowledgeable TA or teacher.

Throughout the summers, participants noted teachers' important role in making the online material literally accessible, echoing a role of teacher as tech "troubleshooter" in a blended classroom (Bingham, 2016). Yet participants also noted that productive technology *use* in teaching was about far more than getting hardware and software to function: "merely knowing how to use technology is not the same as knowing how to teach with it" (Mishra & Koehler 2006, p. 1033). Participants described various ways that teachers usefully adjusted use of the online materials in class. As we describe next, teachers helped to regulate who accessed which online material when.

TEACHER AS MONITOR OF STUDENT BEHAVIOR

Participants noted that in a course that quickly covered a lot of material during long summer days, teacher-regulated pacing of daily, required work was a basic support mechanism. As one teacher put it bluntly, "My goal is to finish." As a monitor of course completion, participants noted, each teacher decided which online material to focus on and which to skip, pacing each summer day to make sure material was sufficiently covered. Adults in all classrooms also regulated transitions between activities to keep students on the teacher's basic timeline (e.g., starting class, guiding everyone to an expected lesson on the site, wrapping up activities at appointed times). Adults also enforced when students should complete exams and monitored in-class student chatter during screen time.

In other blended classrooms, teachers have been seen managing a lot of "off-task" tech use (Bingham, 2016). Our classrooms did not exhibit much such behavior, perhaps because students had volunteered to take the courses (or in math, sought last chances to become college eligible), and also because of the blistering pace needed to finish. Teachers instead called pacing decisions critical to course completion given the summer speed. In interviews and focus groups, many students agreed that they would never complete such a course if they had to do it "at home alone"; teacher monitoring buoyed students forward. Students also indicated that teacher monitoring of student pacing helped classrooms be "less, like, distracting than a regular classroom." One student noted that adult monitoring of time, in combination with student self-"management," helped students "finish":

> They give you a set amount of work that has to be done by the end of the day, you have to finish by the end of the day. You have to manage your time — so that you are able to finish it in time. And it's a very nice experience that you get to do that.

As monitors of students' need "to finish," adults also took student attendance, a key requirement for securing credit. One teacher repeatedly spoke one-on-one with both students and parents to alert them to motivation issues or shaky class performance. Another TA said that adult monitoring of student behavior and classroom time was particularly necessary for students with nascent "study skills," who would "fall behind, because you wouldn't be able to catch up."

Teachers' monitoring of overall student pace in order to finish meant that in many classrooms, the experience was minimally personalized or individually tailored to students' own pace or competency development as idealized by blended learning proponents (Patrick et al., 2013). In another study of blended classrooms, Pane et al. (2015) found similarly that educators "reported that students can work at their own pace 'to a point' but described setting a minimum pace to ensure that there was time to work through all of the required content. The result was a limit on the time students could take to master material" (p. 21). In the classrooms we studied, each student had to complete the same computer sections in order to move on; we rarely saw students who were more than a day or two ahead in the online curriculum. Often, the entire class of students was asked to proceed at a fairly even gait, a finding also replicated even in schools considered fully "personalized" (Pane et al., 2015). Sometimes (particularly in mathematics, as noted later), teachers asked students to repeat material until they could move on with a decent grade, a kind of semi-"competency based" personalized approach. Still, a more typical form of regulated personalization witnessed was simply giving students extended individual time on computers when students could work at their own pace on the day's prescribed material and ask questions of a roaming teacher or TAs (see also Pane et al., 2015). Teachers thus monitored both individual and collective finishing.

Observation also indicated potential risks of overmonitoring student pacing. One more extreme version was a teacher who made students read large quantities of the day's material together aloud, a strategy that the observer sensed dulled student enthusiasm. And although teachers successfully regulated pacing to ensure completion and coverage by most students in the courses, the ability to go to some degree at one's own pace through each day's online material was an aspect of the summer courses that both students and teachers said they appreciated. Students and adults also lauded the ability to slow down on a given lesson as needed (to rewind and repeat material) or to speed through something already understood. Participants thus praised the fact that there was some ability for students to "manage your [own] time" each day, even while suggesting that adults' monitoring and group pacing of the day, week, and summer session was a needed teacher role. As one algebra teacher put it, it would be impossible to address common confusions or needs when "everyone is missing a certain thing" if every student truly was at completely "different stages of the program."

In sum, participants overall deemed adult monitoring of student behavior (and pacing specifically) to be a teacher role that, in moderation, enabled course completion by individuals and the group—and so, the basic equity of necessary credit for college eligibility.

TEACHER AS HIGHLIGHTER OF NECESSARY CONTENT

Scout curriculum was already succinct: Subject matter was typically digested into short text, images, videos, and animations (Figures 1, 2, 5, 6, and 7). But adults also highlighted material of particular importance to upcoming assessments or anticipated which concepts students would particularly need in later high school or even college coursework. When prepping for class, one teacher said, “I’ll go in the computer . . . review which sections are gonna be important or pertinent to read . . . have those ready.” Another mathematics teacher focused on “previewing” key concepts she knew students would need for the following lesson in the math sequence. The AP Psychology TAs, undergraduate psychology majors themselves, pulled out concepts that had been emphasized in their own college courses. We termed this “highlighting” a form of basic equity assistance focused on ensuring every student’s access to essential content access and course completion.

Figure 5: Image from AP Environmental Science (older UCCP course, used Summer 2013)

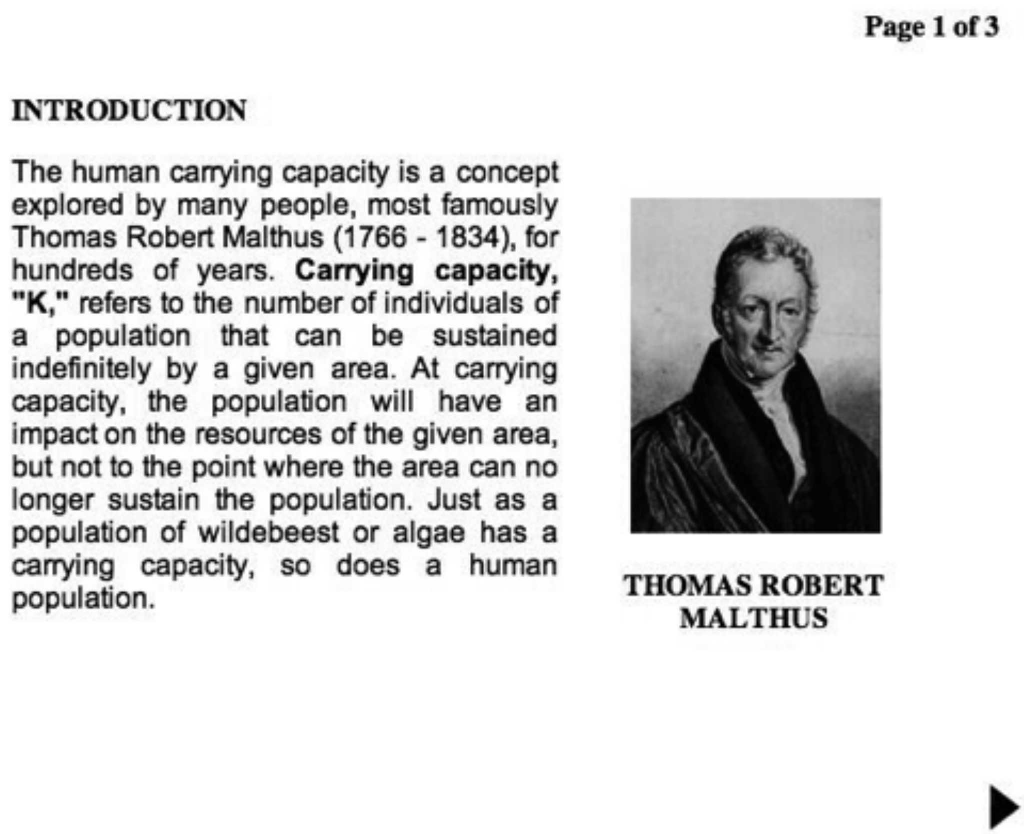


Figure 6: Still from animation explaining “carrying capacity” from AP Environmental Science (older UCCP course, used Summer 2013)

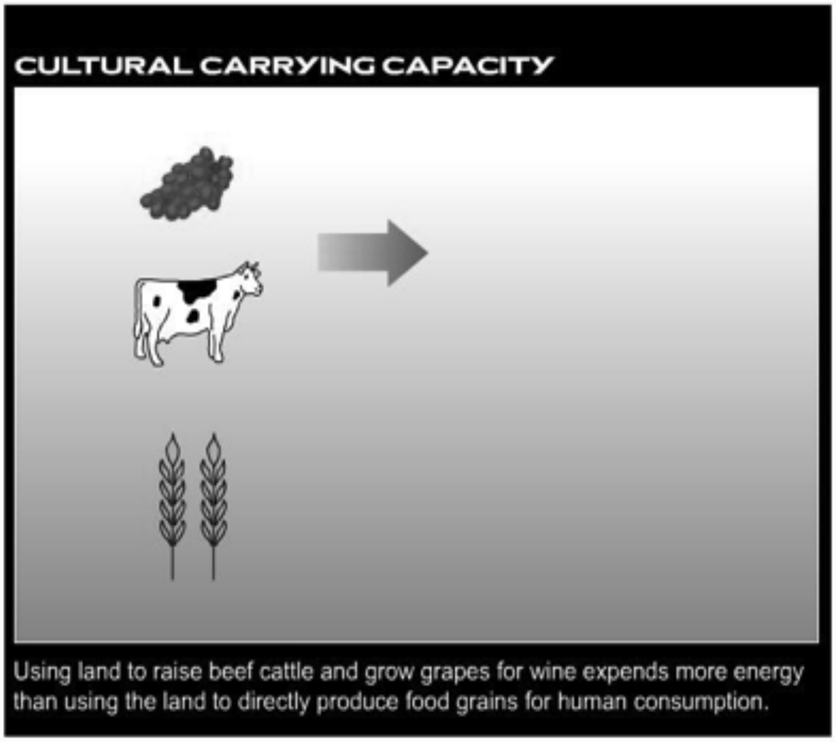
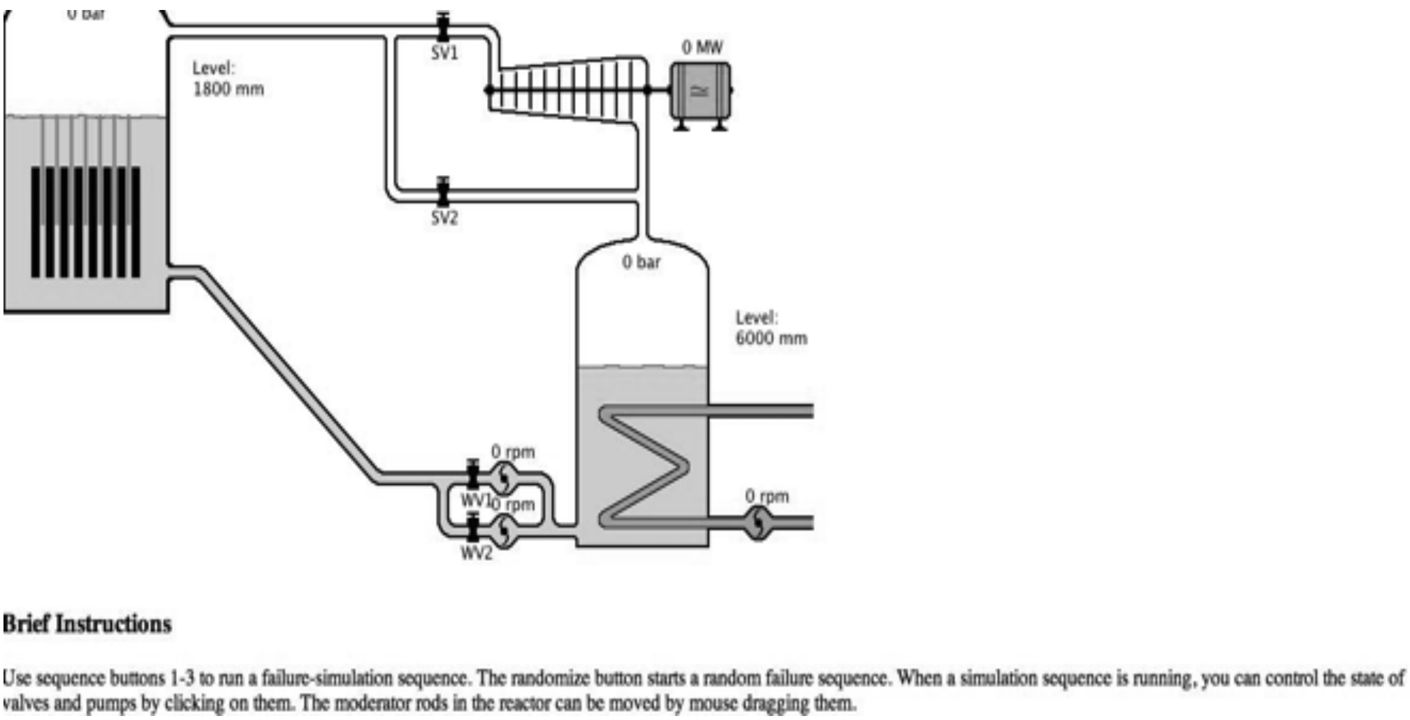
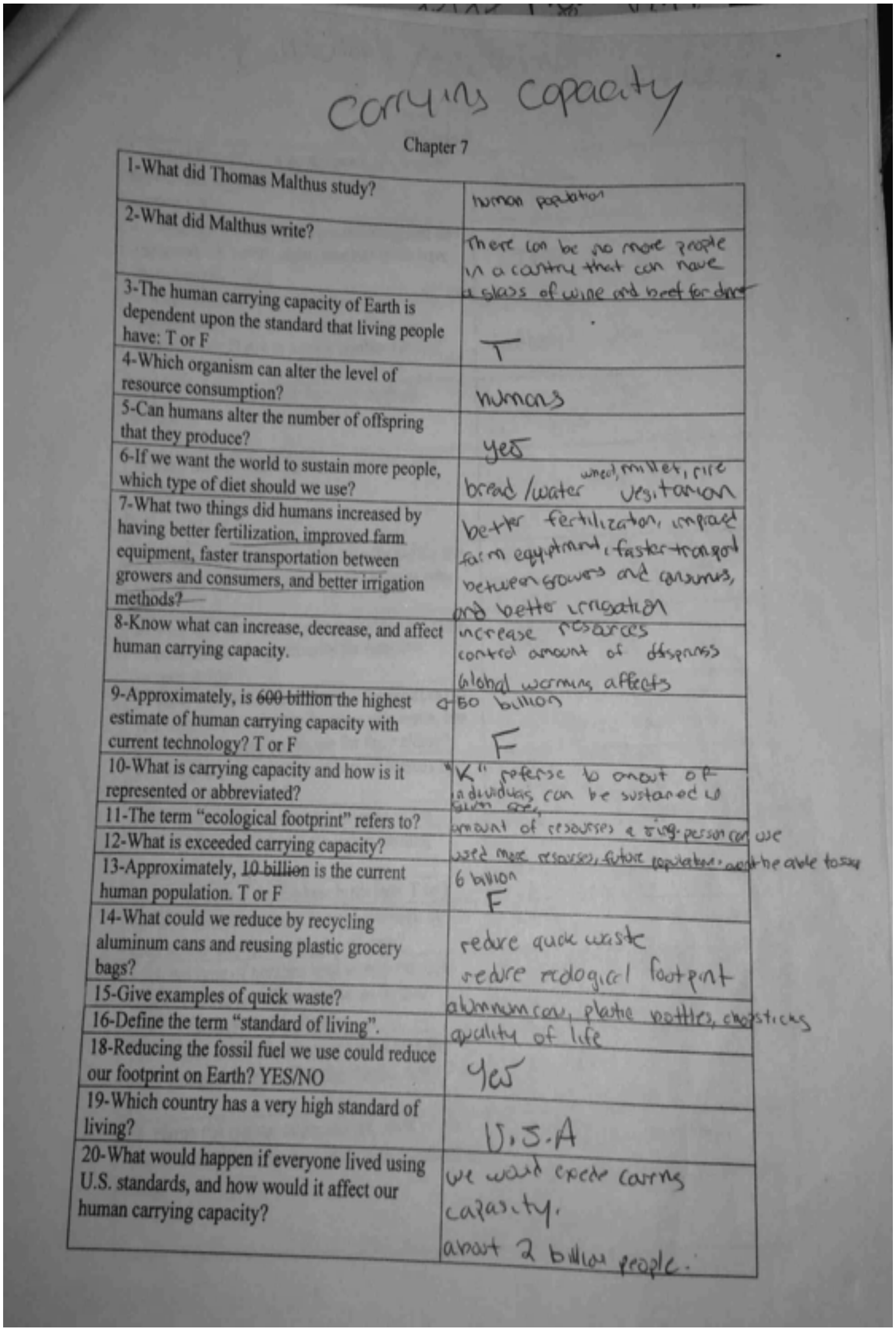


Figure 7: Still from simulation from AP Environmental Science (older UCCP course, used Summer 2013)



As teachers verbally highlighted key content that students needed to prioritize, they also often helped students digest the course content. For example, they provided key vocabulary or concepts in paper study guides to help students prepare for the computer-based tests; (see Figure 8 for a guide adapted by students). In those classes, students explicitly said they appreciated the study guides' assistance in marking key concepts. One student in AP Environmental Science commented that study guides clarified "what to focus on for the test," while another added, "When I did the study guide, I'd understand . . . it helped me to click it, like, to connect together." An AP Psychology student noted bluntly, "If you studied the study guide then you did good on the test," enabling good grades and course credit. Highlighting focused on ensuring that students would pass courses with sufficient grades and so gain credits critical for college eligibility.

Figure 8. Study guide for AP Environmental Science


carrying capacity

Chapter 7

1-What did Thomas Malthus study?	human population
2-What did Malthus write?	There can be no more people in a country that can have a glass of wine and beef for dinner
3-The human carrying capacity of Earth is dependent upon the standard that living people have: T or F	T
4-Which organism can alter the level of resource consumption?	humans
5-Can humans alter the number of offspring that they produce?	yes
6-If we want the world to sustain more people, which type of diet should we use?	bread /water wheat, millet, rice vegitarian
7-What two things did humans increased by having better fertilization, improved farm equipment, faster transportation between growers and consumers, and better irrigation methods?	better fertilization, improved farm equipment, faster transport between growers and consumers, and better irrigation
8-Know what can increase, decrease, and affect human carrying capacity.	increase resources control amount of offsprings global warming affects
9-Approximately, is ~~600 billion~~ the highest estimate of human carrying capacity with current technology? T or F	50 billion F
10-What is carrying capacity and how is it represented or abbreviated?	"K" referse to amout of individuals can be sustained in given area
11-The term "ecological footprint" refers to?	amount of resourses a sing. person can we
12-What is exceeded carrying capacity?	used more resourses, future population won't be able to sus
13-Approximately, ~~10 billion~~ is the current human population. T or F	6 billion F
14-What could we reduce by recycling aluminum cans and reusing plastic grocery bags?	reduce quick waste reduce ecological footprint
15-Give examples of quick waste?	aluminum can, plastic bottles, chopsticks
16-Define the term "standard of living".	quality of life
18-Reducing the fossil fuel we use could reduce our footprint on Earth? YES/NO	yes
19-Which country has a very high standard of living?	U.S.A
20-What would happen if everyone lived using U.S. standards, and how would it affect our human carrying capacity?	we would exceed carring capacity. about 2 billion people.

Students also noted when teacher highlighting of key content risked making learning almost too easy. In an AP Psychology class where the teacher made study guides, reviewed the study guides verbally, and prepared a PowerPoint presentation with questions and answers for review before the final, students noted that they had to study just "for one minute" for exams. ("Don't tell her because she'll make it harder," one smiled.) Concerned that such help could be excessive, one AP Environmental Science teacher explicitly did not review guides with students and offered no credit for using them. Instead, she would gently suggest where students could look for study guide answers ("look at X animation" or "think about the phosphorus cycle"), highlighting but never offering the answers directly.

While advising against *too much* highlighting of necessary content, then, both adults and students called it helpful when adults supported students to focus on the most important information, concepts, and vocabulary in a course or subject area. When adults highlighted particularly necessary precollege material, students could answer specific questions accurately when tested, enabling basic course success and thus college eligibility.

As we explore next, however, students said it was when adults went *beyond* the online content to explain and discuss material in more depth that they began to actually understand the material and retain it for tests. Four roles going further beyond the computer's instruction emerged as particularly critical forms of in-person support, according to participants. Three of the roles hinged on teacher-student dialogue that supplemented the more one-way, didactic computer experience that provided basic digital access to material. The last, the teacher as caretaker of well-being, fueled the others: It offered the will to adjust pedagogically and engage material until students "got it." Each deep equity role thus actively sought to ensure students' individual and collective comprehension of material rather than just access to it.

TEACHER AS EXPLAINER OF THE CONTENT PROVIDED

Across the courses, students said that teachers and TAs played critical roles in explaining content beyond that provided online. Students and teachers praised some of the computer courses' explanations and engaging animations, but students routinely said they were "confused" by particular online material. Students said that teachers played a key support role by responding to student questions. Teachers were the key reason students said they would not take the online course "at home alone":

> S1: In psychology, you have to have a lot of questions to understand what we're learning about.
> S2: And I think if I just went along with the website I wouldn't understand it because some of the questions and examples they use are irrelevant or are just confusing.

Beyond course-specific critiques, students also noted that whereas a computer could only "talk" without taking questions, a teacher could be asked new questions or queried in the middle of any confusing explanation. When stuck and unable to answer questions or solve problems on the computer, students actively sought teachers to "show," "tell," and explain concepts or procedures; teachers would respond individually, in small groups, or to the full class. Two students explained why they preferred teachers' explanations to those of the computer:

> S1: I don't like learning on the computer. I'd rather have like a person show me how to do it.
> S2: Same here. My eyes get really tired on the computer easily and start crying, so then I have to try to get back into the problem. And it's kind of difficult because I was so used to the teacher [as main source of explanation], and now I have to use the computer.
> S1: Yeah. It's, I don't know, I just don't understand it as well as I would with a person.
> S2: Yeah, like how a person would explain it. I can tell them what I don't understand and then they would tell me.

Asked what, if anything, he would change about the computer aspect of the course, S2 laughed and summed up, "Ask questions and they'll reply."

Repeatedly, students indicated that their ability to ask questions and get answers was key. Many in the math courses noted that during the school year, one-way, unstoppable teacher lecture had characterized their experience in math, contributing to their need to repeat the material. Some noted that prerecorded "lectures" would be no different: One instructor considering his blended course versus a "flipped" classroom (where students might watch prerecorded lectures online outside of class) argued that the critical thing for teaching and learning was allowing students the ability to stop, talk to, and question other people *while* they talked. The key to learning, he said, was to engage speakers in discussing how they got "from A to B":

> T: Just the ability to stop and raise your hand and say, "How did you get from A to B?" I mean you could certainly pause it and rewind [a recording] and just hear the exact same thing over again, but not having the ability to say, "Can we please have another example?" or "Can you please tell me?" Taking that away from the student is taking away from that learning.

As another student put it, teachers also didn't have to be the *first* ones to "explain." In math, for example, adults ready to stop and supplement a computer's explanation sometimes added up to sufficient help on "the steps":

> "I like the program because on the computer it shows you step-by-step how to get the answers for the problem. And if you still need more help there are TAs to help you."

Time taken for teacher explanation increased over the summer in almost all classrooms. Several teachers who started students working alone on their computers soon became swamped by student questions and implemented classwide mini-lessons and discussions, often returning to seemingly "traditional, teacher-centric practices" (Bingham, 2016, p. 15). Yet in comparison to Bingham's 2016 study, this study's teachers turned to more teacher-centric practices not to handle student misbehavior but almost exclusively to proactively ensure student comprehension. Two students explained:

> S1: Yeah it's Algebra 1 stuff the first week but then as you keep on going it's harder and harder. Without her working on the board and giving us handouts. . .
> S2: I think we'd all be lost.

Students noted in AP Psychology how they often "flagged down" teaching assistants for on-demand "help":

> Today, I didn't get the concepts of daydreams and illusions. But for the illusions, a friend helped me and for daydreams, Ms. [TA] helped me.
> I didn't understand this concept of classical conditioning and [TA] showed me a visual diagram to understand the concept.

Often, students said, they asked questions of peers or looked up answers in textbooks or from other online sources. But in most classes, qualitative data indicated that students asked the teacher and TAs to assist with their questions as they worked online, and typically they noted leaving such interactions satisfied. Notably, students noted that adult helpers more familiar with the subject matter could answer questions most helpfully; such adults "actually know what they are talking about" and could describe a concept "in a different way." In AP Psychology, for example, the two TAs, both psychology majors, supported students through lengthy one-on-one explanations requiring disciplinary knowledge. In one representative example, a TA sat for nearly 15 minutes with a student to talk through dominant and recessive genes.

Adults also decided when to provide fewer explanations. Worrying at one point that students were becoming "dependent on us" after weeks of proactive explanations of key concepts, the psychology TAs shifted to a strategy of waiting to be asked for help, noting, "They need to realize that if you need help, you need to actively go and seek it rather than waiting for us to walk around so you can get help." In an ongoing quest to ensure student comprehension, adults thus decided which explanations to offer preemptively or reactively (or not) in response to common confusions, and how much to engage students themselves in dialogue. As we describe next, they also decided when to push learning far beyond the computer's concepts in an effort to more fully prepare students for the rigors of college.

TEACHER AS EXTENDER AND APPLIER OF IDEAS, BEYOND WHAT COMPUTER PROVIDES

Many teachers supplemented the online courses with additional assignments, activities, lectures, and dialogues to further engage particular concepts they regarded as critical for students' precollege learning. One teacher created additional writing prompts and took time to write responses to them. Another AP Environmental Science teacher guided her students in analyzing and discussing data in paper science notebooks to demonstrate the scientific process; she also assigned essays to "train them on how to write for science." In addition, she created additional hands-on labs to supplement her course, an extension she considered critical to college preparation. "Imagine going to your first lab class" in college without ever using lab instruments, she said. She continued,

> I think it's important for students that are being prepared to go to college to be able to use . . . scientific instruments. I want them to be able to use a scale, to be able to use all the instruments of measurements we prescribe here, the cylinders. It's a science class, it needs labs. You know like work labs, real labs. . . . So they need to have the experience, a lot of experience. And we take some kids to college without ever using [lab materials].

Most often, adults extended the computer-based learning by leading small-group or whole-class discussions designed to extend and deepen understanding of particular concepts, including by encouraging students to make deliberate connections between their lived experiences and the concepts taught from the online coursework. Students framed such teacher-led discussion as key to supporting real-world student comprehension and engagement.

One sociology teacher in particular demonstrated this role in action. His sociology classroom often used the computer as an online textbook, to read initial lessons (sometimes aloud or as a group), or to watch video links related to a topic then taken up in verbal discussion. While he engaged the computer material through verbal vocabulary practice and short essay responses (with many supplemental questions that he wrote), he particularly extended the curriculum via lengthy full-class discussions.

Often, the teacher invited students to share a personal example connected to an online question or added examples from his life to flesh out the text first read on the screen—as in a discussion of sociological “gender roles” in which the teacher invited students to reconsider the typically “female” role of “teacher.” The teacher prodded students to define terms like *gender stratification* or *feminism* through gentle teacher questions like, “Think also about how many male nurses you’ve seen?” or “So can you think of any ‘institution that forces gender’?” As one student put it, “What better example is there than a personal one to make it real?”

This teacher would also organize discussions to explore the meaning of vocabulary from the screen. In interviews, he explained, “If they’re [students] going to be reading something, they need to know what the words mean, you know.” Without discussion, he noted, “reading doesn’t give them [students] the concept”; he added, “They read the definition; they don’t know what it means. Like to actually APPLY it. . . . That’s why we do the vocabulary, to apply it and say this is what this means, this is what that means.”

We observed that in discussions, students could at times repeat definitions from the computer but not be able to explain the word. In focus groups, students said such discussions indeed helped them more deeply understand new words. One student confessed, “I could read a definition and still not understand the meaning of it [pause], so he is really good at showing examples.”

The teacher also walked around to engage in quiet 1-1 discussions reacting to online material and then invited some students to share their thoughts with the class (“Now I’m going to call on [Student], because she has a very interesting connection to this history. Please tell the class what you told me.”). In separate focus groups, students shared that this interaction pattern developed understanding through group attention to a concept:

> [The teacher] usually has us talk to our partner and then after talking to our partner for like two or three minutes he brings it up as a whole class discussion. He calls [on] people, like “What did you and your partner talk about?” and so everyone ends up knowing everything.

Small- and full-class dialogue, as a student added, meant that eventually “somebody” would solidify one’s comprehension: “If you don’t understand then you can talk to your partner and then that helps. If they don’t understand it or something then the whole class will talk about it and somebody will help you understand.” Students argued that the discussions also helped them to engage multiple perspectives on fraught social issues like racial profiling or gender roles (“When you have discussions you see what other kids can say about it or other people’s experiences and it’s kinda like, *oh*”), and to make personal connections to sociology topics, aiding memory for assessments as well. As one student put it,

> He always asks for our opinion, and that’s usually when we express what we think. And then like he could relate what we think to what we’re supposed to understand, and… that becomes a reference later on when we are taking a quiz or something like that.

Students also noted that the fact that *they* were allowed to spark such dialogue showed the teacher’s commitment to “our understanding”:

> If you ask him questions about it he doesn’t mind he’s not gonna be like “hurry up and finish the work.” He cares about our understanding for it.

The psychology TAs explained similarly that dialogue for “applying” knowledge was critical, based on their own university-level experience with the subject:

> Psychology is collaborative and you get so much more out of it if you hear other people’s opinions. You can’t just be in front of a computer screen watching videos all the time, you need to go out there and apply it.

Although students clarified that they did not always “need” discussion to repeat material toward success on multiple-choice assessments, many did say they needed discussion for deeper “understanding” and application of concepts. Some such dialogue required the in-person interactions of teachers overhearing side conversations or wandering the classroom to invite deeper 1-1 explanations. As we explain next, teachers’ efforts to assess and provide feedback on student comprehension also often hinged on the ability to listen and dialogue. We noticed this support role particularly in mathematics.

TEACHER AS PROVIDER OF FEEDBACK AND ASSESSMENT

Researchers of “math talk” argue that dialogue with students is important for several reasons: because it lets students articulate and so work through their own understanding (Daro, 2014), and also because it helps a math teacher “diagnose like a doctor does” (O. Soto, personal conversation, n.d.). That is, through listening to or reading examples of students’ thinking, teachers can better focus their instruction strategically to help plug gaps in comprehension. Such feedback loops are key to “data use for equity” strategies in education (Datnow & Park, 2015; Datnow, Park, & Wohlstetter, 2007) and, many argue, to successful teaching, period (Hattie & Timperley, 2007).

Automated versions of immediate feedback from a computer are what make many people most excited about tech-based personalized learning without teachers (Pane et al., 2015). However, such automated feedback does not necessarily enable the dialogue for understanding that we saw in the blended classrooms studied.

During both summers, we observed adults and youth gesturing on screens or scribbling and erasing on paper in rapid back and forth, as adults strove to understand and respond to students' comprehension needs. One TA bent over two girls working on a problem set and paused as a student articulated her thinking about a problem posed by the computer. The interaction then pinpointed a confusion:

> TA leaning over 2 girls; she has been standing over one girl's shoulder a certain amount today. Peer at next desk is working on her own paper, pointing at girl's paper. Girl is factoring using the diamond trick. Peer points out that a 1 should be a negative 1. "You do know why, right?" says the TA. Girl looks up at her. "Because. . ." (stops) TA herself then explains by pointing to one side of the diamond, "When you multiply them it's [pauses waiting for the student to respond]?" S: "1." TA: "When you add them it's [pauses again]?" S: "-2." Girl starts writing, and then says, "OOOOOHHHH. I get it, thank you." Now both girls return to their own screens and TA walks away.

As here, much of the math talk we heard across classrooms was not the deep conceptual talk about mathematics idealized by researchers. Students and adults often dialogued about procedures and computational tasks, of "flipping it" and other "steps" necessary to finish problems correctly. But even in such moments, teachers demonstrated how they often were needed to talk through student thinking in progress in order to clarify both procedural errors and conceptual misconceptions that the computer could not find.

For one, the computer program only provided feedback after a student had clicked "submit" on his or her final answer. In contrast, in-person adults checked student comprehension as students *thought* about mathematics and drafted possible answers; teachers could tell students that they were on the right track before students submitted an answer. Often, adults roaming the room spotted and then discussed student confusions as students wrote on paper:

> T: I love this choice. I love this. Why are you erasing?
> S: Because I got negative one.
> T: What's wrong with that?
> S: (inaudible)
> T: I'm loving what's happening right now, because you (inaudible). . . . You can get negative one.

Teachers could proactively approach students to check on their understanding. In focus groups, students noted that the teacher and TAs would approach them if they looked confused, even if the students did not verbally ask for help. As one put it, "I guess they knew we needed help, because they would be like, 'Oh you know, let me see that problem' [laughs] and then they would go through it with you."

Fully intelligent or adaptive computer programs can adjust instruction individually based on student answers, such as making test questions harder the more students get right. Means et al. (2010) argued that research shows benefits to such "online learning environments with the capacity to individualize instruction to a learner's specific needs" (p. 52). The courses studied did not have this "adaptive" capability; instead, teachers themselves pinpointed individuals' confusions to support students on particular concepts or procedures. While several teachers used supplemental computer programs (e.g., "IXL," http://www.ixl.com/math/) to enforce targeted practice on needed concepts, teachers also diagnosed misunderstandings by asking students to explain concepts aloud to a neighbor or to write answers on individualized whiteboards, paper, or plastic projector slides for teachers' review—what Bingham (2016) called "low-tech" or "no-tech" strategies used in blended classrooms. Such strategies inviting student talk or writing also helped teachers pinpoint shared confusions across the group. One teacher explained his process of determining from handmade worksheets what to address as a full class:

> Then every single day, maybe 15 minutes before class starts, I meet with the TAs and I say, "How did yesterday's presentation work? How did the worksheets go?" Then if the students have a lot of questions about yesterday's lecture, the first thing I do is I put that question up on the board and I say, "Okay, everyone did this one, and I hear there was a question about this particular problem." So before I move on I have some knowledge about where they were struggling, so that allows me an opportunity to kind of address it before I go onto the new topic.

Teachers and TAs also proactively created extra assessments to check for student understanding and routinely invited students to verbally explain the mathematics to adults, sparking extended dialogue about misconceptions. Teachers and TAs regularly approached students with prompts like, "What are you thinking?" One teacher explained that he coached his TAs to approach students proactively:

> I really force the TAs to just kind of get in their face. Even the ones that are quiet and aren't asking—they're [the TAs] bugging them. That's what I want them to do . . . saying, "I know you don't have any questions but I have a question for you: How did you get that answer? Explain it to me."

In contrast to teachers' capacity to creatively diagnose student struggles, the computer courses had multiple-choice options programmed to anticipate and then briefly describe common misunderstandings (Figure 2). Yet such preprogrammed reactions offered a fixed set of responses. In contrast, teachers could respond creatively to an endless stream of student misunderstandings. We saw that teachers also could anticipate and recognize a broader range of student mistakes than could the computer. For example, teachers could proactively ask students about common misunderstandings from far earlier levels of mathematics than the computer anticipated, such as fractions, basic division, greater-than and less-than signs, or rules of exponents. As one professor put it in an interview, he had realized his class of new community college entrants was struggling with "fractions," "working with negative numbers," and other "simple mathematical issues" that the computer could not recognize but that he had to address: "Making mistakes substituting numbers, [they] keep writing the negative signs in front of some numbers throughout the steps . . . some of them are simple mathematical mistakes. Some of them know what to do, they just do not know when to use it, and sometimes how."

Adults also checked more thoroughly than a computer could for complete verification of student understanding. As many teachers noted, even if the computer deemed an online response "incorrect" and prompted students to try again, students could click random answers until the computer gave them the correct one (Figure 1). Essentially, the computer accepted students' answers as sufficient for moving on far more readily than teachers did.

A telling example occurred during one mathematics course. Students had been receiving high scores on the online assignments but had scored poorly on a teacher-made algebra quiz. After talking with a few students, the teacher decided that students' online scores did not reflect their actual mastery of the content. In response, the teacher and TAs added supplemental practice exercises (on paper) to their daily routine, and they started going over problem sets with students verbally after submission to discuss the type of problems that the students missed. The teacher and TAs also asked students to show what they knew in writing or through verbal explanation when they claimed to understand a problem set. Other teachers started to require verbal explanation of concepts in order to pass through sections of the computer course, or approached students individually to ask them to "prove" their understanding:

> OK, so prove it. Draw me a picture. . . [student draws in her notebook as teacher looks on] Good. Much better.

This ongoing insistence on ensuring students' comprehension exemplified the final teacher role in our taxonomy: the teacher as caretaker of student well-being. Basically, teachers would not rest until they were convinced students were "good" on course material.

TEACHER AS CARETAKER OF STUDENT WELL-BEING

Teachers and TAs across the classrooms—all of whom had proactively chosen the job of teaching summer school—expressed a sense of urgency as they provided support to young people. One 2014 teacher called preparing students for college eligibility in the make-or-break, last-chance summer course of Algebra II "the scariest thing I'd ever done, because it was so important." Some stayed late to help individual students or called them early to insist they return to class. In classrooms, all used humor, smiles, or tough-love tactics to cajole students forward through long summer days. In this example, two adults encouraged a student to keep working on a test instead of turning it in before it was "right":

> TA: S, come on.
> T: ((to S)) If you feel good about it. Then you feel good about it.
> TA: ((to S)) Come on, stay and get it right. (then something in Spanish)
> S: ((to TA)) Yo no hablo español. (smiles)
> T: ((to S)) (inaudible)
> S: (smiles, takes his test back and sits down again to keep working)

One TA described his individualized encouragement to persist:

> I try to relate to them. I'll tell them, like, "Yeah, man, I used to not like these problems," or like "It used to be really hard for me too, but once you like (inaudible), it's really easy." I think . . . you seem more human and, like, friendly to them.

Although extended relationship-building time often did not seem possible in quick summer courses, “human” caretaking routinely involved gentle, dogged encouragement of students to strive for full comprehension of course content. One teacher helped an Algebra II student go over an assignment:

> T: I think mostly they’re little mistakes. The problem is with order of operations you need to be careful.
> S: I was careful.
> T: We’re not—it’s ok. I see why you wrote that, but if you’re not a positive but negative, what kind of number are you?
> S: Irrational
> T: And?
> S: Rational?
> T: You’re either rational or irrational.
> S: I didn’t think I was doing it wrong. . .
> T: It’s okay. We’re learning.

Tellingly, adults often said their supports were geared toward gradually growing students’ confidence to tackle more of the work themselves with *less* adult help. One community college course instructor spoke at the end of the summer about how he felt he had lifted students’ confidence to fuel them through their community college careers. “The confidence thing just totally blind-sided me,” he confessed, adding, “I had no idea that I was going to have that much of a challenge.” Proudly, he described coaching them through a particular weak spot with “radicals and rational exponents,” warning them, “Now, I want you guys to eat your Wheaties tomorrow because we are really going to do this!”:

> T: Instead of them saying, “I don’t even know where to start,” it’s like, “Okay, you know where to start. Let’s look at your notes. What is it that they’re asking? Okay, write down *what you know*.” You kind of have to walk them through that process. And now it’s not so much. Now it’s like, “Okay, Mr. X, I’ve gotten this far. I [just] don’t know what to do next.”

He added with a smile, “I got them all geared up.”

We came to see each of the teacher roles listed here as fueled by this human energy for “gearing up” for success young people typically underrepresented in college (Nieto, 2008; Ream et al., 2014). Basic equity efforts required an insistence on getting students access to opportunities to learn; deep equity efforts required insistence on ensuring comprehension. While computers were by design tireless teachers, only human teachers could support students to persist by adjusting pedagogical use of computers until students were successful. We were humbled throughout by adults and students willing to engage with difficult material, often with few breaks, through long summer days. Indeed, we were awed by adults and students writing, talking, reading, and clicking, literally for hours, in pursuit of greater educational opportunities and better lives.

DISCUSSION

EAOP’s implementation of Scout offered a critical opportunity to explore students’ and teachers’ take on the role of the in-person teacher in supporting students accessing core precollege material online. To us as researchers, such analysis felt particularly critical with low-income students often denied access to foundational learning opportunities in their schools.

In rapid courses that used computerized curriculum without substantial planning time, the_teachers we studied could have defaulted fully to “more teacher-centric, low-tech practices” as simply “the pedagogical roles and practices with which they were most comfortable” (Bingham, 2016, p. 12). Yet both teachers and students continued to creatively adjust use of the computer materials, explaining explicitly that adults ratcheted up specific human supports because they saw them as important for student success.

This study fleshed out participant experiences corroborating prior researchers’ conclusion that teacher interaction is valued by students taking online courses, beyond “mere presentation of material” online (Wallace 2003, p. 261). Our study also attempted to detail what about teacher interaction seemed most necessary to participants. Studies often do not analyze in detail the types of support “communication options available to online learners” (Means et al., 2010, p. 17), nor the details of the real-time, in-person supports offered in blended environments using online tools—“the right mixture of human and technology [that] seems most beneficial” to participants (Zhao et al., 2005, p. 1863). We set forth to capture these data because across the country, real educators deciding when, whether, and how to supplement face-to-face offerings with computer-based materials for any students also need to decide when, whether, and how to supplement computer-based offerings with teacher supports.

Which of the support interactions that participants deemed necessary could have occurred remotely is a key question for next research. Some of the dialogues that participants deemed helpful could potentially have occurred online. Other interactions, like a tutor proactively riffling through a frustrated student’s crumpled notes or the other teacher diagnoses, cajoling, and invitations chronicled here, seemed to rely on in-person interaction. In-person teachers cajoled ongoing learning through spontaneously offering a personal experience to clarify a whispered question, or gently pointing, with a finger, to a correct concept erased in frustration. In addition, peers in both summers huddled around computers together or leaned over to one another to ask and answer questions, making in-person peer support a critical focus for future study.

The in-person teacher help needed (or not) in any blended learning experience also depends, of course, on both the learners and the design of the online tool. How computer courses themselves can be developed to invite the kinds of person-to-person interactions that participants here deemed necessary will remain a key a question for additional researchers, teachers, and technologists, who will also need to examine how teacher roles differ when computer-based materials are themselves more interactive. The particular course materials studied might be characterized as “textbook-like information delivered over the Web” (Means et al., 2010, p. 3; see Figures 5–7), in comparison with intelligent systems that adapt as students answer questions or more deeply interactive or gamelike tools. Still, research suggests that it is more typical for low-income students to access relatively passive online materials in their schools, making it critical to study such tools in use (Reich et al., 2012).

Further, in describing most teacher roles, participants clarified that not all teachers would inherently be effective helpers. In these classrooms, as in any classroom pursuing equity via rigorous instruction (Darling-Hammond, 2010), skilled adults who were knowledgeable about subject matter and committed to student success were the supporters students said they needed.

Finally, in several cases, participants also cautioned when teachers should not help too much. Indeed, far from requiring handholding at all times, these low-income students also clarified they did not always need or want teachers to supplement the computer. That is, if education opportunity was primarily about accessing foundational information, and if the computer was explaining that information well enough for students to get the right answers on a test, students often didn’t need additional teacher help at all. However, students said they needed adults to step in if the premade computer explanation was unclear; if more exploration, dialogue, or application was necessary to fully understand the content; or if they needed goading to complete tasks in a timely fashion. And if deep equity in learning opportunity is about engaging ideas, participants said, students wanted teachers even more. Deeper engagement was also particularly necessary if the ultimate goal was not just for students to pass a test to earn a credit, but also for students to succeed in later courses in college.

Participants deemed teachers most needed alongside students grappling with essential content; for checking in proactively on student understanding and diagnosing students’ specific struggles; and for explaining material in additional innovative ways to students who remained confused. The content-knowledgeable and committed teacher was, above all, an *infinitely creative innovator of content and pedagogy,* shifting instructional practices in response to students’ ongoing (often previously unanticipated) learning needs with the goal of student comprehension (Richtel & Doughtery, 2015). It was when teachers spontaneously seized personal examples to make their points, supplemented curriculum overnight or on the spot to provide new explanations, and talked through concepts beyond the computer’s preset material that students said their learning was maximized. Through the various “talk moves” key to any committed teaching (“say more”; “explain your thinking to me”; “connect that to what we learned before”) (Michaels & O’Connor, 2012), teachers creatively invited student participation. And, as participants noted, it was in these creative, as-needed conversations between teachers and students that young people themselves got to speak about what they were learning—and, be heard.

CONCLUSION

In the blended classrooms studied, participants deemed in-person teachers necessary for seven key roles supporting students using computer courses: three for providing access to content and credit otherwise not available (basic equity), and four for supporting comprehension of content (deep equity). Throughout both summers, participants across subject areas argued that teachers as *tech supporters* were key to making the course function at specific moments. Teachers *highlighting* computer content for exams helped students pass fast-paced courses. Teachers *monitoring* the learning experience helped pace each day or week so students might finish in a limited amount of time. These forms of in-person teacher help enabled basic course and content access to improve low-income students’ basic college eligibility.

However, both adult and student participants noted that students just clicking through to submit answers acceptable to the computer could accomplish completion and credit but not necessarily comprehension. Participants thus named other teacher roles as particularly necessary to *deep* equity: the teacher as *explainer of content,* as *extender and applier of content* beyond the computer’s offering, and as *provider of feedback and assessment* on student learning. Each role focused on deeper comprehension was fueled by the teacher’s personal commitment to being a *caretaker of student well-being.*

Teachers’ ongoing, committed “adjustment” of technology use to support student learning (Ertmer, 1999) seemed the key to equity effort both basic and deep. Throughout the courses, adults *creatively innovated pedagogically* both with and without the computer until students indicated they understood key concepts, both individually and as a group. They pursued comprehension particularly through committed dialogue, written and verbal, with and sometimes sparked by students. As pedagogical decision-makers, teachers in each classroom worked each day to develop productive uses *of* technology for student support. As one teacher put it, “You can’t ignore the technology that’s coming and you can’t take away the instructor. It has to be both.” Figuring out the optimal blend of both was teachers' ultimate job.

Teachers innovating tech use with equity in mind will continue to solve an ongoing puzzle for education. At first blush, classrooms using computer-based courses seem to raise doubt about the role of teachers, period. But as educators add online coursework to classroom life and classroom life to online coursework, teachers will remain essential to innovating pedagogy for equity—that is, until it meets each and all students' needs.

Notes

1. Formerly known as the University of California College Prep (UCCP) initiative, the "Scout" program was housed at UC Santa Cruz Extension at the time of this study (www.ucscout.org). In 2012, after open access to online UCCP courses had stymied efforts to track usage and effectiveness, Scout had consolidated into a single new learning management system and began a process of updating all course materials, including efforts to align online materials with new Common Core State Standards. Scout was under ongoing design, with new courses under various states of development and some courses sunsetting. Our goal in this study was not to evaluate Scout itself but instead to consider the in-person teacher role in offering it for credit in real settings with low-income students preparing for college.

2. https://coi.athabascau.ca/coi-model/an-interactive-coi-model/.

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Cite This Article as: *Teachers College Record* Volume 121 Number 5, 2019, p. -
http://www.tcrecord.org ID Number: 22628, Date Accessed: 3/1/2019 2:14:01 PM