

# Building a Community to Support HS CS Teachers: the Disciplinary Commons for Computing Educators

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## ABSTRACT

In this paper, we describe our experience in supporting high school CS teachers by building a local community through the Disciplinary Commons for Computing Educators (DCCE) project. The DCCE project is an effort to explore ways of supporting these CS teachers through the creation of a local community and by promoting teacher reflection. DCCE achieved this goal through an academic-year-long program where a cohort of CS teachers engaged in collaborative portfolio creation and peer observation of classroom teaching. We describe the design of the DCCE activities and present preliminary results from initial evaluations. Our short-term evaluations indicate that this project was successful in creating a supportive community, promoting teacher reflection, and advancing change in teaching practices among a group of computing educators.

## Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computer and Information Science Education—*computer science education*.

## General Terms

Design, Experimentation, Theory.

## Keywords

CS Teacher, Community, Reflection.

## 1. INTRODUCTION

Computer science education is important in both secondary and post-secondary systems, because it can contribute to the intellectual development of students, the innovation potential of

other scientific disciplines, as well as the economic well being of countries [5, 15]. However, computer science (CS) is a relatively new and small discipline in K-12 education. We are facing many challenges in growing high school computing education, including issues related to teacher development. The Computer Science Teachers Association (CSTA) National Secondary Computer Science Survey reports the top three greatest challenges in teaching secondary CS as rapidly changing technology, lack of staff support, and lack of curriculum resources [3]. All three of these challenges in sum point to the need for learning opportunities and continual support for current CS teachers.

Most current efforts aimed at growing high school (HS) or secondary school CS teachers in the United States focus on preparing new teachers through workshops and similar short-term professional development [4, 6, 8], which are important for creating enough new teachers with the appropriate skills to teach CS courses. However, teacher turnover rate is high, and beginning teacher attrition is a serious problem in secondary education [10, 11]. To grow secondary school computing education, we need to support those trained teachers so that they stay and develop into high-quality CS teachers.

As there are still very few HS CS teachers, these in-service teachers are especially isolated. Often there are no other CS teachers in their schools to whom they can ask for CS teaching support. HS CS teachers are often heard saying: "I'm the only [CS] teacher in my school." This suggests that in-service CS teachers are in great need of a community for continual support and professional development opportunities.

The teacher education literature [2, 9, 13] suggests that there are many ways of supporting teacher learning, and offering continued collegial opportunities to develop a professional community is a key to teacher development and teacher retention. The CSTA National Secondary Computer Science Survey results point out that the top two most effective methods identified for delivering professional development to CS teachers are workshops/seminars and networking with others [3]. The current isolation of HS CS teachers further indicates the need for supporting these teachers in making connections with other CS teachers to learn from and to support each other.

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This paper describes our experience in providing longer-term support for in-service HS CS teachers by creating a local community of CS teachers and promoting teacher learning through reflection on teaching practices. We ran a cohort of teachers currently teaching introductory computing through the Disciplinary Commons for Computing Educators (DCCE) project over the past year. Although our focus is on supporting the HS teachers, who were teaching the Advanced Placement (AP) course, we invited college computing faculty to join this community. Since few HS CS teachers have taken collegiate level CS courses, the college faculty offered insights about undergraduate CS courses and how to best prepare students for college. In our cohort of HS and undergraduate teachers, we adopted three main strategies from the Disciplinary Commons project [7, 16]: collaborative course portfolio creation, peer-observation of classroom teaching and focusing on a specific discipline (CS). These strategies are used to promote teacher reflection and build a community of peer CS teachers. Our initial evaluations for the DCCE project show that this type of long term outreach effort is effective in supporting a sense of community among HS CS teachers and promotes reflection on their teaching practices.

## 2. DCCE: CREATING A COMMUNITY OF CS TEACHERS

### 2.1 DCCE Design

To address the issue of teacher isolation and the need for peer support, our DCCE project was intended to create a supportive local community, where HS CS teachers were comfortable in exchanging resources and ideas, as well as to provide emotional support among peer CS teachers. More importantly, this teacher cohort was intended to provide professional development for HS CS teachers, where they were motivated to improve their own teaching and acquire skills to develop into more effective teachers. Promoting teacher reflection is critical for fostering good teachers, who can continue learning and become better teachers through reflective practices [14].

#### 2.1.1 The Disciplinary Commons

Fincher and Tenenberg [7, 16] created the Disciplinary Commons project<sup>1</sup>, which invites a group of computing educators within the same discipline to meet monthly during an academic year in order to share, reflect upon, and document their teaching. Participants in the Disciplinary Commons project prepare a course portfolio that describes their own teaching of a particular course, critique each other's portfolios, and visit each other's classrooms. The course portfolio typically includes a course's learning objectives, contents and structure, rationales for course design, the course's role in a larger context, evaluations of student work and the type and quantity of feedback the students are receiving. Further, its focus on student work can lead to insights into how this course might be taught differently in the future [7, 16]. As identified in the Disciplinary Commons project, the course portfolio can serve a number of purposes, such as providing a structure for the meetings and keeping individual reflection and group discussion grounded in teachers' teaching experiences [16].

The Disciplinary Commons project has been repeated in several institutions internationally<sup>1</sup>. Through participation and reification

within a community of practice [17], the college faculty participants in the past Disciplinary Commons projects found values in the project including opportunities to systematically reflect on teaching practices and learn skills that apply directly to their teaching practices [16]. The Disciplinary Commons project offers a model of "building a community of scholars who can engage with and support each others' practice" [16]. Our project, the DCCE, adopted the course portfolio model including its peer-review and peer-observation mechanism to structure our meetings around teacher reflection and community building.

#### 2.1.2 Bringing CS Faculty into the HS CS Teacher Community

The DCCE project invited college faculty who were teaching introductory CS to join with high school AP CS teachers. These teachers naturally shared a common interest in both the knowledge of and approaches to teaching introductory computing concepts and skills. Our approach of combining college and HS teachers is similar to the idea of teachers' vertical teaming used in K-12 education [12], and is unique among the Disciplinary Commons efforts. Related work on vertical teaming shows that, in addition to enhancing communication on curriculum standards and how different teachers interpret and teach the standards at each grade level, the collaboration and networking in a vertical team provides a support system that reduces teachers' feelings of isolation and promotes greater enthusiasm for their teaching [1, 12]. In the DCCE project, we attempted to offer cross-level communication opportunities with computing faculty to help HS teachers further their understanding of the computing field and computing education. In this paper, we are focusing our analysis on the impact the DCCE project had on the HS teachers, and explicit analysis of the interactions between college and high school faculty will be left for future work.

### 2.2 DCCE Agenda

We had eight teachers in the 2009-2010 cohort: four HS AP CS teachers and four college computing faculty participating in nine monthly sessions over one year. These eight teachers came from different institutions in Georgia. Meanwhile, we invited one HS teacher and one college faculty from the first year pilot DCCE to work as peer leaders to help plan and run the meetings.

**Table 1 DCCE Meeting Agenda**

Dates	Topics
Oct 24, 2009	Building the Commons Institutional Context
Nov 14	Course Context
Dec 12	Course Content
Jan 16, 2010	Teaching Methods Introducing Peer-observation
Feb 20	Teaching Philosophy
Mar 6	Evidence of Student Learning (Assessment)
Apr 24	Course Delivery: Debriefing Peer Observations
May 15	Feedback to Students
June 12	Portfolio Presentations
Dec, 2010	Reunion

In the 2009-2010 teacher cohort, each of the teachers created a course portfolio for the introductory CS course they were

<sup>1</sup> <http://www.disciplinarycommons.org/>.

teaching. The portfolios were individually written and peer-reviewed. The participants all conducted a peer observation, visiting another participant's classroom. The meetings were organized around the elements of the course portfolio as showed in Table 1, which were modeled after the Disciplinary Commons project. We merged and adjusted the order of the topics based on our participants' needs.

### **3. OUTCOMES**

#### **3.1 Data Sources**

We conducted both formative and summative evaluation of the DCCE activities. These evaluations were conducted by both an external evaluator on the project and the internal research team.

For formative evaluation, the external evaluator of this project gathered feedback after each meeting to ensure the quality of the meetings. For the summative evaluation, the external evaluator administered a post-DCCE Survey to gather information about the participants' experience in this project. The survey included a set of Likert scale questions and open-ended questions. This survey was administered at the conclusion of the last meeting session. In total, seven (four high school teachers and three college faculty) of the eight participants completed this survey. In addition, the first author conducted interviews with the four HS teacher participants to collect further information about their participation experience and the impact the DCCE project had on them. While a small sample, the in-depth interviews provided a detailed view of the DCCE project which permits an investigation and understanding of the issues that matter to the HS CS teachers. Transcripts from the interviews were coded using thematic analysis, noting ideas mentioned by at least two participants. These common ideas clustered into three themes: creating a local community, promoting teacher reflection, and promoting change in teaching practices.

In the next section, we summarize the results from the formative survey evaluations and the post-DCCE survey (Section 3.2). We then discuss the three major outcomes of the DCCE project identified as repeated themes by the HS teacher participants (Sections 3.3-3.5).

#### **3.2 Overall Outcomes**

The overall feedback from the evaluation surveys gathered at the end of each meeting on the effectiveness of the meeting's events was positive. The participants were asked to rate (on a scale from 1 (low) to 4 (high)) how informative, engaging, and useful they found each agenda item was. The overall average rating for all meetings was 3.5 on a 4 point scale, indicating that the participants were satisfied with the overall quality of the meetings. Each meeting had specific, defined learning objectives, and the participants also evaluated the degree to which they perceived these learning objectives were met for each meeting. As with the agenda items, we asked each participant to rate the degree to which the meeting addressed each learning objective on a semantic differential scale from 1 (Not at all) to 4 (To a great extent). Overall, the feedback was positive, with an overall average rating of 3.5 for all meetings.

While the feedback collected after each meeting was focused on the effectiveness of the meetings, the post-DCCE survey measured participants' experiences over the course of all the meetings.

Among the seven responses of the post-DCCE survey, all participants reported that they enjoyed the DCCE experience. They all believed that the decision to take part in the DCCE was a good one and that their participation was a good use of time. The participants rated the overall organization of the DCCE as either "good" (1 of 7), "Very Good" (5 of 7), or "Excellent" (1 of 7). However, three participants recommended that there needed to be greater organization around the peer review process outside of the meetings. One participant reported that, although he benefited from reading others' portfolios, he did not always receive timely feedback from others on his portfolio.

All participants reported that they came to a better understanding about their teaching philosophy and saw connections between their teaching philosophy and teaching practices. Moreover, all of them agreed that they had a better understanding of why they taught their course the way they did.

Through open-ended questions, the participants reported they saw the primary benefit of the course portfolios as aiding in reflection. Furthermore, in terms of how often they would engage in reflecting on their teaching practices in the coming year, all the participants indicated they would reflect either several times (3 of 7) or many times (4 of 7) during each term. In addition based upon their reflective practices, all of them expected to try a new teaching practice.

Overall, participants reported that they gained new ideas for teaching, and they adopted teaching practices from other participants. Furthermore, most participants (6 of 7) reported that they had made definite plans to change their teaching the next time they taught the same course.

In terms of creating a local community of CS teachers, the participants rated small group discussion and peer observation as the most valuable interactions with other community members. Also, they all agreed that they were better able to provide feedback to colleagues on their teaching after attending the DCCE meetings. All the survey respondents planned on staying in touch with their DCCE colleagues. They also reported they would contact members of the DCCE cohort in the future for three main purposes: sharing resources, collaboration (e.g., for unit design), and gaining motivation and inspiration from their peers.

In the next section, we discuss the reported outcomes from the interviews with the HS teachers, through three main themes: creating a local community of CS teachers, promoting teacher reflection, and change in teaching practices.

#### **3.3 Creating a Local Community**

One of the main goals of the DCCE project was to create a local community of CS teachers to support the HS CS teachers who were often isolated. After attending the DCCE project over the past year, the HS CS teachers reported that they were able to build a sense of belonging to a community of CS teachers. Participation in a variety of community activities helped to validate what they already did well and built confidence in themselves as HS CS teachers. The participants also saw the values of a local community specifically for CS teachers.

##### *3.3.1 Belonging to a Community of CS Teachers*

All the HS teacher participants reported that attending the DCCE teacher cohort helped them to find a community to join, which did

not exist for them before their participation in the DCCE project. For example, all the HS teacher participants made comments like this one:

[P2]: “I felt like I didn’t belong to a community at all of CS teachers until DCCE. But now I have a lot of teachers that I would feel fine about either calling up or emailing. That did not exist before. That’s one reason I think it’s so important that we have things like DCCE, because CS teachers are usually pretty isolated in high schools. That has now been changed because now I know a lot of people that do what I do.”

The participants further pointed out the value of this community and its activities with its disciplinary focus on Computer Science.

[P1]: “It’s nice to go into a classroom and watch somebody teach what you teach, because you don’t get that in CS. I can go into 13 different people’s rooms and watch a Math classroom, but I can’t go into anybody’s classroom and watch what I do three periods a day. So, it’s nice to go in and it’s reassuring to go in and say, ‘Hey, you know what? This does kind of look like my classroom.’”

### 3.3.2 *Feeling Confident and Affirmed in Teaching CS*

The HS CS teachers reported that participating in a CS specific community allowed them to see the similarities of their teaching, which helps them to feel more confident as CS teachers.

[P1]: I think we all have a lot of things that are similar. When I watched [another teacher], I think he and I had some similar styles, similar ways to approach things. It’s reassuring to watch him because it makes me feel like, ‘Yeah. I’m doing it right.’ I’m more confident hearing other people are doing it similarly. That gives you confidence when you don’t teach it in a vacuum.”

Another participant further identified that some of the community activities (e.g., peer observation and peer review) as enabling the members to validate what they already did well and to incorporate what they learned from other members.

[P4]: “I guess I was very surprised at how excited [another teacher] was about his observation of my class. I didn’t feel it was that exceptional a job. But somehow the questioning process and brainstorming discussions seemed to really be inspiring to him. I realized it’s something I need to focus on more than I already do, because it has a potential. I guess I felt affirmed in a way I had never felt before. I felt that there’s a place for my approach and I could incorporate some of those strengths that other teachers were bringing. I felt affirmed for having some of the ideas I had. So, I did leave with more confidence than when I came in.”

### 3.3.3 *Seeing the Value of Sustained Community with Other CS Teachers*

After their participation in DCCE over the past year, the participants were able to see the values of having regular communication with other CS teachers.

[P4]: “The other thing I learned that needs to be done is having a sustained professional dialogue with other

teachers of CS. So, that’s directly from DCCE, even though it’s something we’ve always known. You know, our Deans of academics tell us, ‘You need to go talk to the other teachers. You need to work together in the school more.’ This is the first experience that really has underscored how fruitful it could be.”

Furthermore, one of the participants reported that her DCCE experience motivated her to join the local CSTA chapter and even became a leader of it, as an extension of her participation in the local community of CS teachers—DCCE.

[P1]: “I joined CSTA and became a leader because of the DCCE. I don’t want to lose contact. I want to be able to still have a purpose to meet every couple of months, and to learn new things, and learn from each other. What the DCCE gave us was the ability to talk with other people and to see how they’re doing things. That’s what we’re hoping CSTA kind of continues to do is to facilitate a community of people teaching the same thing.”

## 3.4 Promoting Reflection

After the year-long project, our HS teacher participants were able to see the primary benefit of the portfolios in aiding reflection on their own teaching. They found that the portfolios served a useful forcing function for reflection and provided a structure for guiding reflection. Teachers reported that completing the portfolio also enabled self-reflection after the DCCE project.

First, the process of producing course portfolios provided a venue that forced teachers to reflect on their own teaching.

[P2]: “I think all of these things [pieces of portfolios] just help teachers think more about what they do when they teach, and why they teach. I think that’s something a lot of teachers don’t really have the time to do unless they’re forced to.”

Furthermore, the course portfolio also provided a structure for guiding reflection. The structure of the course portfolio with well-designed guiding questions allowed teachers to see the structure of their course and examine the rationales and ways of improving the teaching of that course.

[P1]: “[What I Learned] through creating the course portfolio is reflection on my teaching. I learned a ton. It helped me to examine my own structure of the course. It made me question the order that I teach things in when I looked at the order that other people taught things in, my instructional presentation of it. I mean, it’s just kind of nice to be reflective and to put those kinds of things on paper and to say, ‘Okay. This really is truly how I do it.’ Then to kind of ask yourself, ‘Is it working the way that I do it, or is something that somebody else is doing working better?’ So, I love those processes where they get you thinking about what you’re doing and how you can improve.”

Similar to what was reported in the post-DCCE survey, the HS teachers pointed out that their experience of creating a course portfolio enabled them to conduct self-reflection after the DCCE project.

[P3]: “As future plans for professional growth, I think [I would] just take time to sit down and reflect on what I’ve done, which DCCE has helped me do.”

### 3.5 Promoting Pull Transfer and Change in Teaching Practices

*Pull transfer* is a phrase used to describe a bottom-up model of teacher change, where teachers change their practices, adopting ideas and materials from direct, personal contact with other practitioners as and when they need [7]. In pull transfer, the transfer of ideas or practices is achieved directly from practitioner to practitioner rather than pushed from researcher to practitioner. Previously, the Disciplinary Commons project showed that pull transfer happened among their participants [7, 16]. Although we did not explicitly design the DCCE to facilitate pull transfer, we did observe some plans for changes in teaching practices among the HS teacher participants.

#### 3.5.1 Motivation to Change

In the post-DCCE survey, all respondents reported that they would continue applying what they learned from their DCCE experience. In the interviews, the HS teachers reported their DCCE experience motivated them to make changes, in particular, through seeing and learning what other teachers did in their teaching practices.

[P2]: “After seeing [another teacher] teach, I realized that there were definitely a lot of things I could do in my own teaching to improve. It really inspired me a lot and made me realize I’ve got a lot of room for improvement... I definitely have a lot of plans of how I will do things differently. I think a lot of them are a direct result of [the DCCE]. A lot of them directly come from conversations I had with teachers at DCCE.”

#### 3.5.2 Changes and Plans to Change

Through interactions with other participants, the HS teachers identified ways of improving their teaching by changing what they were currently doing. One participant had already made some changes during his participation in the DCCE cohort and planned to extend those changes in the future.

[P2]: “As far as the sessions go, I’ll probably give students a lot more free responses, and I’ll use rubrics that [the HS teacher leader] wanted to. ...That actually affected this past year of teaching. I created about eight rubrics. .... So, I will use those for next year, and I plan on creating more of them that are simulated to look just like the AP exam graders, how they grade their AP exams.”

Participants also reported different ideas to improve their teaching next year, such changing their pedagogy to have more focus on problem-solving, to implement more discovery learning, and to introduce an IDE earlier.

[P1]: “There are a lot of ideas that were shared that I will implement next year, you know, doing more hands-on things, some more discovery things like [one

participant] had mentioned, doing tests more like GridWorld<sup>2</sup> test that [another participant] had shared. He shared a great one that’s just less multiple-choice and more short answer. Then [I] have to do more problem-solving that way.”

[P3]: “I definitely would make changes the next year for two reasons. One, going through it the first time. But number two, listening and reflecting back, you know, on things...GridWorld is being taught because it’s an application we can dump into this class. It’s done. It’s proven. And I can teach them about how to declare an object, and how to give some methods to it, and how to, therefore, extend a class. This application can do that for us. So, as a tool, let’s introduce early. So, that’s a change definitely that I will make.”

## 4. SUMMARY AND DISCUSSION

### 4.1 Reflection on Outcomes

By the current evaluations conducted, we believe that the DCCE project has achieved its main goal: to support HS CS teachers by building a local community of CS teachers, where teachers can share, reflect on and improve their own teaching. Our initial evaluations indicate that the participation in this discipline-specific teacher cohort led to an increased sense of community and increased teacher reflection for high school teachers. These outcomes also led to reported plans for changing teaching practices.

First, working with teachers who were passionate about teaching and were teaching the same level of course enabled the HS CS teachers to see the common ground in their developing community. The interaction with other teachers helped them identify the similarities in the course and practices which helped them build a sense of belonging as a group of CS teachers. Now the often isolated HS CS teachers could connect with and support each other. Our participants reported they valued this community and felt a sense of belonging to it. They also felt more confident about themselves as CS teachers.

Second, the collaborative process of portfolio creation offered opportunities that forced the HS CS teachers to reflect on their practices. It also provided a structure to guide them in effective reflection on their own teaching. The portfolio thereby led teachers to better understand their own teaching and identify ways to improve. Our HS teacher participants even reported reflecting in a similar way on their practices after leaving the DCCE project.

Third, the peer review and peer observation activities allowed these HS teachers to understand and learn from each other’s teaching. These activities provided opportunities for them to validate what they were already doing well and to identify places where innovation and change were desirable.

In summary, three major strategies enabled the project to achieve the outcomes of an increased sense of community and teacher reflection and pull transfer to enable changes in teaching practices for HS teachers: course portfolio creation, peer-observation of classroom teaching and focusing on a specific domain, introductory computing.

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<sup>2</sup> GridWorld is a component of the current AP CS course.

## 4.2 Teacher Leaders and Scaffolding

In addition to the three strategies we adopted in this project, we also recognize the important roles the two teacher leaders played in achieving our goals of this project.

First of all, our experience working with the two teacher leaders was very valuable. The leaders volunteered to help the project researchers organize the meetings based on their own experience with us in a pilot DCCE cohort in 2008-2009. They brought enormous insights to this project with their passion for teaching CS and for connecting with other teachers. They offered first-hand experience in organizing the DCCE activities and communicated with the other CS teachers in "teacher language." The leaders and researchers met weekly to plan meetings, review feedback reports from each meeting, discuss issues identified, and brainstorm ways of improving the meetings. In particular, the leaders developed a set of structured guidelines for creating and reviewing portfolios, peer-observing classroom teaching, as well as reflecting on the teaching of specific concepts for the participants. As peer teachers, the leaders understood many teachers were not familiar with course portfolio creation and peer review, nor were they in the habit of reflecting on their teaching. These activities proved to be powerful tools for teacher learning, but their effective implementation required scaffolding provided by our teacher leaders.

Moreover, the leaders' work as facilitators was greatly appreciated by the participants. All the participants rated the facilitators' contributions to the DCCE as good. The leaders were perceived as open and inviting. Moreover, the HS teacher participants also commented on the many roles of leaders played, such as moderating discussions, guiding portfolio writing, suggesting additional resources, and providing insights.

## 4.3 Future Plans

Our initial evaluations indicate that the DCCE teacher cohort was a rewarding experience for the participants and successfully achieved its goal of creating a support community for HS CS teachers. However, a longitudinal evaluation will be needed to determine the extent to which the project is ultimately successful. We are currently organizing follow-up meetings with participants to share changes in their teaching practices and planning additional evaluations. We plan to conduct follow-up interviews with the participants to track their status and analyze the development of the sense of community through a social network analysis. Given the on-going process of evaluation, the results reported in this paper should be regarded as preliminary. In addition, we also plan to offer a HS CS teacher cohort in the 2010-2011 academic year, incorporating our findings and expanding our efforts to new participants.

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