Adapting to Large-Scale Changes in Advanced Placement Biology and Chemistry Curricula and Tests: the Impact of Online Teacher Communities

Running Head: ONLINE TEACHER COMMUNITIES

Adapting to Large-scale Changes in Advanced Placement Biology and Chemistry Curricula and Tests: The Impact of Online Teacher Communities

Qualifying Paper

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Table of Contents

Acknowledgements

Although I am often skeptical of new technologies, I believe in the promise of technology to facilitate, expedite, and deepen collaboration in bold new ways. To combat the isolation that teachers consistently experience in their respective classrooms (and often schools), new technologies can produce new venues for teacher learning and development. This paper is an attempt to explore the intersection of technology, collaboration, and teacher learning and is itself a product of collaboration and learning. As a result, I want to acknowledge my gratitude as follows:

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Introduction

Although Advanced Placement (AP) courses are intended to promote rigorous, college-level instruction for high school students, AP tests have been criticized for privileging breadth over depth. In response to both this criticism and to the 2002 National Research Council (NRC) report on STEM education, AP Biology, Chemistry, and Physics curricula and exams were redesigned in 2013, 2014, and 2015 respectively. These courses now emphasize scientific inquiry and reasoning, as well as depth of understanding for big ideas in science, over fixed, broad content coverage of facts. Subsequent NRC STEM reports (National Research Council 2012, 2011), the Framework for K-12 Science Education, and the Next Generation Science Standards have emphasized the importance of this shift.

These are sweeping changes to a long-standing instructional program. Hundreds of thousands of AP science students – and more than 16,000 teachers – are now challenged to succeed on a high-stakes test about the inquiry process, real-world applications of scientific principles, and synthesis of complex content knowledge. To help teachers learn about the revisions, the College Board and other providers offer a range of professional development options, from weeklong summer workshops to short face-to-face courses, online self-paced courses, downloadable resources, and online peer-learning communities.

This paper is part of a four-year, longitudinal National Science Foundation–funded project in which five research institutions are collaborating to study the relative effectiveness of these various types of professional development in enabling teachers to make significant changes in their practice. Of the many forms of professional development our research has examined thus far, participation in the College Board's online teacher community portal – where teachers can discuss teaching strategies, share resources, and connect with each other – has had the largest positive, direct, and statistically significant association with both teacher self-reported practice and student AP scores (Fishman et al., 2014). The online AP Teacher Communities (APTC) have produced positive gains for teachers and students involved in a national, large-scale change in curricula and assessment. This makes it important to explore how usage in the APTC aids teachers in helping their students succeed on the revised AP tests, as well as how the APTC might be more responsive to teacher self-reported needs. Findings from the experience of AP teachers may be valuable in other large-scale curriculum changes, such as the Next Generation Science Standards (NGSS) or Common Core Standards.

This study examines the following research questions:

1. How do teachers use the APTC? What is the relationship between various types of APTC use and student AP scores?

2. In what ways do these online communities, whose content and processes are driven by bottom-up peer interactions, complement and extend top-down forms of the professional development offered by the College Board?
3. Given knowledge about best practices from other online communities for professional learning, how might the APTC be more responsive to teacher self-reported needs?

In this paper, I will first provide an overview of the literature on professional development, communities of practice and technology, and online learning communities. Next, I will share background information on Advanced Placement curricula and exams and the online APTC and describe my research methods and sources of data. Then, I will report my findings and, finally, I will end with a discussion of implications, scholarly significance, and future research.

Literature Review

Professional Development in the United States

Although there are many possible goals for teacher participation in professional development, my research begins with the premise that the ultimate goal of teacher professional development is to increase student achievement, with interim objectives that involve shifts in instructional practices (Mundry, Spector,

Stiles, & Loucks-Horsley, 1999). Darling-Hammond and colleagues (2009) found that professional development correlated with student gains when it was ongoing, connected to practice, focused on specific academic content, linked to school initiatives, and collaborative. Similarly, Borko, Jacobs, and Koellner (2010) considered the content, process, and structure of high-quality professional development, and concluded that the best professional development offerings were both situated in teachers' practice and focused on students' learning. Borko et al. (2010) found that effective professional development was ongoing and sustainable, integrated with other aspects of change within the school, and focused on modeling preferred instructional strategies by building communities of practice [defined more thoroughly below].

Unfortunately, most teachers in the United States do not have access to professional development "that uniformly meets all these criteria" (Darling-Hammond et al., 2009, p.5). Cohen and Moffitt (2009) argued that one reason professional development does not work in the United States is due to a strong commitment to localism, which precludes national common curricula or exams and a shared instructional context for teachers to collaborate. Mehta (2013) further emphasized that this commitment to localism makes it difficult for centralized authorities to consistently support and produce high-quality schooling and, therefore, results in wide variation in performance levels.

This study examines a kind of national "subsystem" – of Advanced Placement Biology and Chemistry teachers – within an otherwise decentralized American school system. All Advanced Placement teachers across the United States must submit their course syllabi for accreditation review by the College Board to ensure course guidelines and resources are in place, and must prepare their students to take the same national exam. Therefore, the community of AP teachers provides an unusual example of professional development that transcends local school systems. With the challenge of localism removed, this study hopes to extend theory by investigating a professional development community of teachers with shared curricula and assessments.

Communities of Practice and Technology

The term "community of practice" is usually attributed to Lave and Wenger's ground-breaking book on situated learning (Lave & Wenger, 1991), which describes knowledge as a "property" enacted by groups of people over time in shared practices (rather than in the minds of individual learners) (Hoadley, 2012). Over time, the term community of practice has come to be defined as a "group of people who interact, learn together, build relationships, and in the process, develop a sense of belonging and mutual commitment" (Wenger, McDermott, & Snyder, 2002, p.34). In order to build and sustain a community of

practice, Wenger, McDermott, and Snyder (2002) advocate for seven principles: (1) design for evolution, (2) open a dialogue between inside and outside perspectives, (3) invite different levels of participation, (4) develop both public and private community spaces, (5) focus on value, (6) combine familiarity and excitement, and (7) create a rhythm for the community (p.51). These scholars emphasize that the benefit of group learning is not limited to periods of success; collective reflection is preferable to individual reflection because exposure to the mistakes of others catalyzes creative solutions to complex problems (as cited in Noonan, 2014). Practically, Dufour, Dufour, Eaker, and Many (2006) concluded that successful communities of practice are characterized by a shared mission (and values and goals), collaborative focus on learning, collective inquiry, action orientation and experimentation, commitment to continuous improvement, and a results orientation.

Wenger's more recent work with White and Smith (2010) emphasized the role that technology can play in providing a platform for a community of practice. Technology can be used to either support the community (i.e. communication among members) or the practice itself. Typically, scholars have investigated the role of technology in supporting communication rather than practice (Hoadley, 2012). Hoadley and Kilner (2005) identified three ways – *content*, *process*, and *context* – that technology can support practice. Technology allows for the ability

to store, manipulate, and transmit information [*content*] in a variety of formats; for example, in the APTC, teachers share lesson plans, resources, and instructional materials that they use with their students. Technology allows for scaffolding [*process*] of a particular task, activity, or sequence; for example, video links posted within the APTC allow teachers to reflect on and share their implementation of inquiry labs. In addition to content and process, technology enables the user to shift social *context*, by allowing for interactions across distance, location, and time (Hoadley, 2012); for example, by participating in the online APTC, teachers across the country engage in discussion around their shared curricula and assessments.

Online Learning Communities

Communities of practice supported by technology are often referred to as online learning communities. Online learning communities are groups of people who gather in an online space to "learn, interact, and build relationships, and through this process develop a sense of belonging and mutual commitment" (Wenger et al., 2002 in Booth, 2012). Barab, MaKinster, and Scheckler (2003) further defined an online community as "a persistent, sustained social network of individuals who share and develop an overlapping knowledge base, set of beliefs, values, history, and experiences focused on a common practice or mutual

enterprise" (p.238). Specifically, online teacher communities potentially allow educators to learn while they are actively applying new ideas in their own work settings, to provide and receive sustained coaching and feedback, and to cultivate a reflective, collaborative, professional community (Dede, 2006). Based on the supposition that online communities can provide a form of ongoing professional learning for teachers, this study examines how online communities complement and extend other forms of professional development offered by the College Board. While the field has made good progress in understanding the design elements and structure of high-quality professional development (Borko, Jacobs, & Koellner 2010; Darling-Hammond et al., 2009; Desimone, Garet, Birman, Porter, & Yoon, 2003; Garet, Porter, Desimone, Birman, & Yoon, 2001), there have been few opportunities to examine the relative effectiveness of alternative professional development offerings, such as online learning communities related to a specific curriculum (Fishman et al., 2013) and in particular, to explore online learning communities in relation to teacher and student learning, particularly during a large-scale change in curricula and tests. This study strives to extend theory by examining an online community whose teacher participation has been associated with increases in student scores (Fishman et al., 2014).

Context for this Study

The Advancement Placement (AP) program is offered by the College Board as a means of introducing rigorous, college-level material to high school students across a broad range of subject areas (College Board, 2015a). The College Board defines curriculum standards for AP courses and offers corresponding examinations that are administered in centralized locations under controlled conditions and graded centrally for quality control and norming. The examinations are scored with whole numbers on a 1 to 5 scale. Students who earn a 3 or higher, depending on the discretion of their institution of higher education, can use their scores toward college credit, both as a way to reduce the cost of college and as a way to place into advanced courses upon arrival at college. Increasingly, colleges view AP courses and AP exam performance as important information in the admissions process (Geiser & Santelices, 2006). There are no "official" College Board curriculum materials, though in each subject there are a range of well-regarded texts created by third parties, so teachers put together their own curriculum plans that must be reviewed and certified by the College Board before the course can officially be listed as "Advanced Placement" on high school transcripts.

In 2013, 2014, and 2015 respectively, AP Biology, Chemistry, and Physics curricula and exams were redesigned in response to recommendations from the

U.S. National Research Council (National Research Council, 2002). The changes stress scientific inquiry and reasoning, reduce the emphasis on broad content coverage, and focus on depth of understanding, in alignment with both the new National Research Council Framework (2012) and the Next Generation Science Standards (NGSS Lead States, 2013). The major facets of the AP science redesigned curricula include (1) a refining of key concepts and content into Big Ideas, which encompass core scientific principles, theories, and processes, (2) articulated scientific skills that students should know and be able to do, and (3) student-directed inquiry labs, which provide students with "opportunities to take risks, apply inquiry skills, and direct and monitor their own progress" (College Board, 2015a). In order to assess these new components, the three-hour redesigned AP science exams consist of a 90-minute section of multiple-choice questions and a 90-minute section of open-ended, free response questions. Both sections evaluate students' understanding of the Big Ideas and the ways in which this understanding can be applied through science practices, such as the use of modeling and/or mathematical processes to explain scientific principles, the manipulation and interpretation of data, and the making of predictions and justification of phenomena (College Board, 2015b).

Prior research on the various forms of professional development (e.g. weeklong summer workshops, daylong face-to-face courses, online self-paced

courses, and online peer-learning communities) that AP teachers chose to support their transition to the redesigned courses and exams indicated that participation in the online peer-learning community, the AP Teacher Community, has the largest positive, direct, and statistically significant associations with both teacher self-reported practice and student AP scores (Fishman et al., 2014).

The online AP Teacher Community (APTC), a College Board portal where teachers can "discuss teaching strategies, share resources, and connect with each other" (College Board website, 2015), began approximately 15 years ago as an independent, teacher-created listserv and evolved into a College Board-hosted electronic discussion board. In 2013, the College Board upgraded the APTC experience to a web-based platform, which allows for posting, commenting, and sharing resources within each subject-specific online community. Each subject-specific APTC is comprised of six web pages (See Appendix: Figures 1 through 6 for screen shots):

- landing page or *Home* page, which features the latest *Discussion Board* posts and most recent community activity;
- *Discussions Board* page, which features the online community and allows for subscription to certain discussion threads;
- *Resources* page, which features documents that members have uploaded and shared;

- *Curriculum Framework* page, which features the subject-specific AP Big Ideas and Sciences practices;
- *My Library* page to upload personal resources and bookmark resources that others have posted; and
- *Members* page, which lists all of the APTC members.

Also notable is the *keyword search box*, which is featured prominently at the top right on every APTC web page. Although the APTC is most directly accessed by logging into the web portal [https://apcommunity.collegeboard.org/], there is also an option to receive daily and weekly email digests of all discussions, particular topics and threads that a user wants to follow, or updates on when members post new resources and comments.

As of October 2015, the Biology and Chemistry APTCs had 11,585 and 8,867 unique users respectively. However, this number is somewhat deceiving, as only approximately 7.5% and 6.4% of registered users are actively logging into the Biology and Chemistry communities, respectively, on average per week (J. Clewley, College Board, personal communication, October 15, 2015); when disaggregated, those users that are actively logging in are comprised of approximately 75% of returning users and 25% of new users in both the Biology and Chemistry APTCs.

Methods and Data Sources

This study employs a mixed-method approach, using survey and case study data to investigate how APTC usage supports teachers in navigating the AP redesign and in helping their students succeed on the revised AP tests, as well as how the APTC might be more responsive to teacher self-reported needs. Due to the technical structure of the College Board's APTC platform, log data was not available.

The primary quantitative data sources are a web-based survey emailed to all AP Biology and Chemistry teachers (16,609 in total) in late May 2014 and student scores (final AP Biology and Chemistry exam scores, measured on a 1 to 5 whole-number scale), taken by students across the United States in May 2014. The AP Biology survey was sent to 9,511 teachers and received a return rate of 25%, for a total sample of 2,408 AP Biology teachers, of which 1,369 self-reported as users of the APTC. The AP Chemistry survey was sent to 7,098 teachers, was completed by 2,493 AP Chemistry teachers, for a return rate of 35%, and includes 1,296 AP Chemistry teachers who self-reported as users of the APTC.

The survey collects data on demographics, professional development participation, general attitudes toward professional development, characteristics of each teacher's AP science course, instruction, and school context, and levels of concern regarding the mandated curricular reform. Specific survey questions

relating to the online APTC inquire about the frequency of visits to the site, duration of average visiting time, degree to which the community is responsive to teacher needs, degree to which student work was a focus, degree to which teaching was modeled, degree to which there were opportunities to build relationships with colleagues, degree to which there was effective support for teaching the redesigned course, the reasons for participation in the online community, the types of activities teachers do while in the community, and an open-response item on how teachers would improve the online community (See Appendix B for the listing of survey questions relating to the APTC). Standard statistical techniques were used to analyze this data, including correlation, regression, analysis of variance (ANOVA), and multilevel modeling (Raudenbush & Bryk, 2002).

Qualitative data sources include direct observations of the APTC and case study interviews with 34 teachers, who volunteered during the larger survey described above and were selected based on diversity of teaching experience and geographic location (Yin 2014; Stake 1995, 2000). The goal of the case studies was to illuminate experiences noted in survey results. Individual interviews were conducted with 34 AP Biology and Chemistry teachers, in January 2014 and June 2014, to capture teachers' perspectives on preparing for and teaching the redesigned AP curricula. Case study participants included 24 Biology and 10 Chemistry teachers, randomly selected from the survey sample. Table 1 (Appendix

A) summarizes demographic characteristics. These one-hour individual interviews were conducted by telephone and were digitally recorded. During these interviews, case study teachers were asked about their use (or lack thereof) of the APTC, how often they visit the APTC (frequency), how long they spend in the APTC (duration), why they visit, what they do when they visit, the role of the APTC in their adoption of the redesign, their participation in "lurking" or posting within the community, and "pros" and "cons" of the community (See Appendix B for the listing of case study interview questions relating to the APTC).

Qualitative data were analyzed using Atlas.ti software, an iterative process whereby first a sample of transcripts were read and initial codes were generated through an *emic* approach. These codes were then applied, reviewed, refined, and revised. With each round of review, additional transcripts were added to the sample for coding and subsequent analysis. Throughout this process, potential themes emerged and were tested and refined with each round of review and discussion (see Appendix C for the final codebook, developed with support from HGSE master's students Adrienne de Souza and Katherine Dlesk).

Limitations

There are several limitations in this work. Most notably, the College Board does not track demographic data for their overall teacher population, which limits

the understanding of how representative this study's sample is to the overall AP Biology and Chemistry populations. In addition, the College Board does not record individual user behavior (known as log files) on their APTC platform. Therefore, APTC teacher use (e.g. behavior, frequency, and duration) had to be gleaned from survey and case study data based solely on teacher self-report of those who chose to voluntarily participate. Self-report data is inherently characterized by selection bias, which might reduce the overall generalizability of the implications. A final limitation is the result of the staggered AP redesign rollout; data from the 2014 AP science exams captures the first year of implementation for AP Chemistry and the second year of implementation for AP Biology.

Findings

This section reports findings of the three research questions by exploring APTC usage patterns, examining how the APTC complements and extends other forms of professional development, and investigating how the APTC might be more responsive to teacher self-reported needs.

Research Question 1: APTC Usage

The online APTC is primarily comprised of veteran science teachers who are new to the AP curriculum. Of the 2014 AP Biology (N=1,369) and Chemistry

(N=1,296) teachers who responded to the survey and use the APTC, the majority are veteran science teachers who are relatively new to teaching the AP curriculum. While the majority of AP Biology respondents have been teaching science for 11 to 15 years, the majority of these teachers have been teaching AP Biology for 0 to 5 years. The same pattern holds for AP Chemistry, with the majority of teachers having taught science for 11 to 15 years, with an almost equal amount having taught for 6 to 10 years, and AP Chemistry for 0 to 5 years. The graphs of the AP Biology and Chemistry teacher populations look almost identical (see Appendix A: Figures 7 and 8).

Given the prevalence of experienced science teachers, the average age of APTC Biology and Chemistry users is 44 and 45 years respectively, with ranges between 22 and 71 and 21 and 73 years of age respectively. The median age of the Biology and Chemistry APTC respondents is 43 and 45 respectively.

With regard to gender, survey respondents who report using the APTC are predominantly female – 3 to 1 for biology and 1.8 to 1 in chemistry (see Appendix A: Figure 9). As noted previously, the College Board does not keep demographic data on their affiliated teachers, so it is not possible to determine how representative this sample is of the total AP Biology and Chemistry teacher populations.

In terms of usage, the online APTC can be accessed by participants 24 hours a day, 7 days a week and does not have a fixed duration or format. Therefore, participants in this type of professional development do not adhere to identical forms of dosage (how often visits occur) or intensity (how long visits last). According to the 2014 survey data for APTC users, the most common frequency of use is once a month, followed by every few months, and then twice a month (see Appendix A: Figure 10). Once logged in, AP Biology and Chemistry users most frequently reported spending approximately 10 to 20 minutes in the APTC, followed by 20 to 40 minutes in the biology community, and 5 to 10 minutes in the chemistry community.

When APTC frequency use rates are disaggregated by AP teaching experience, users with five or more years of AP teaching experience log on with greater frequency than do APTC users with fewer years of AP experience. Only 4.7% of APTC Biology users and 6.6% of Chemistry users with 4 or fewer years of AP teaching experience log on "almost everyday" versus 11.2% of APTC Biology and 16.7% of Chemistry users with 5 or more years of AP teaching experience.

In testing correlation rates between APTC use and student outcomes, higher average student outcomes were associated with daily teacher APTC use for both biology and chemistry respondents. This trend was first identified by using box

plots (see Appendix A: Figure 11), which visually suggest a difference in average AP scores for students of teachers who reported using the APTC *every day*. This difference was confirmed using an analysis of variance (ANOVA) and Tukey's honest significant difference (Tukey-HSD) tests.

In order to test if these higher student outcomes were the result of more veteran AP teaching experience and/or prior student achievement, a multiple regression model that controlled for teachers' experience teaching AP courses and their students' average performance on the PSAT (data provided by the College Board) was used to confirm the statistical difference between everyday and non-everyday use. Results from both the biology and chemistry groups confirm a positive, statistically significant correlation between everyday teacher use of the APTC and student outcomes on the AP tests with these controls in place. Therefore, regardless of level of AP teaching experience and student prior achievement, everyday APTC use by teachers is associated with higher student AP scores.

There is a notable difference between the AP Biology and Chemistry communities with regard to correlations between daily use and student outcomes. The same multiple regression model for daily chemistry users held true when users indicating weekly APTC use were also added to the sample (though with a smaller coefficient). This indicates that the threshold of weekly use was sufficient for

chemistry teachers in order to show a correlation with improved student outcomes. This same analysis did not hold for the biology community, indicating that only a threshold of daily use showed a statistically significant correlation with improved student outcomes. In sum, the survey data shows that both chemistry and biology communities demonstrate a positive, statistically significant correlation between everyday use and student AP scores. Furthermore, chemistry also shows a similar correlation for weekly use, while biology does not.

Although case study participants report similar patterns of use as survey respondents, case study participants illustrate that consistent use of the APTC is not a given. Only 18% (6 of 34) of case study teachers reported consistent frequency and duration between the first and second interviews.

Case study participants also noted that APTC users are more likely to access the online community on school days, rather than on weekends. Case study participants describe accessing the online community in the evenings, after-school, or on prep periods; case study participants explained:

> "It would be nighttime because we have only got one planning period [during the school day]. [laughing] We are really pushed for time. I am usually looking for resources on my own time in the evening." (Case Study Participant #21)

> "Most of my planning was occurring at night and so I would do it [use the APTC] at night. I was looking just to see what was out there as I was planning." (Case Study Participant #33)

The only notable exception to accessing the APTC on evenings during the school year is that case study participants regularly mention the importance of accessing the APTC once the scores are returned over the summer.

Focus on the AP exam corresponds with direct observation of both the AP Biology and Chemistry communities, which show that the three top-rated threads, based on number of posts and number of views, are all related to the exam. For example, even as of October 2015, in the biology community, the top-rated threads based on number of posts are as follows: *Exam 2013: After Thoughts* with 174 posts, *AP Biology 2013 Scores: A Summary* with 113 posts, and *Answers to the 2013 FRQs* (free response questions) with 96 posts. The top-rated threads based on number of views follows suit: *Exam 2013: After Thoughts* with 7,626 views, *AP Biology 2013 Scores: A Summary* with 5,879 views, and *AP Bio Review Packet* with 4,602 views.

The APTC is defined by contributions of a select few consumed by many. Approximately 10% of survey respondents in the biology and chemistry communities reported posting a new thread, a comment, or a resource to the discussion board. In contrast, approximately 90% of survey respondents engaged in "lurking" – reading posts, comments, and resources posted by others, rather than directly contributing new content. Based on case study data, APTC users cite their most common form of engagement as lurking. Although they may not have

initially planned to lurk, these APTC users attributed their lurking, or lack of posting, to the desired content already being posted. Therefore, APTC users searched for specific items and lurked, rather than posted. Case study participants describe the phenomenon in which plentiful information leads to lurking, rather than posting:

> "I didn't really have to ask [post] a question
> because somebody else had already asked it.
> Or, they'd ask a question I hadn't even thought
> yet to ask so it was really beneficial."
> (Case Study Participant #17)

> "I used it [the APTC] a lot – mostly skimming
> to read what other people had posted, in searching
> for specific topics because I found most stuff I wanted
> was already there."
> (Case Study Participant #5)

When conducting specific searches, case study APTC users most frequently mention that they are seeking lesson support (e.g. resources, answers to questions, advice) and community support (e.g. emotional support, sharing challenges and setbacks). Searching for specific topics and lurking, the most common uses cited by APTC case study teachers, distinguish the APTC from other examined forms of professional development by tailoring the experience to the user. The ability to find plentiful information often leads to lurking, rather than posting.

Research Question 2: *Complementing and Extending Top-Down Forms of Professional Development*

In an effort to support teachers in shifting to the redesigned AP Biology and Chemistry curricula and tests, the College Board offers a range of professional development sessions. Among the mix of face-to-face weeklong workshops, one-day workshops, and online courses, the online APTC is the only College Board offering that is co-constructed by teachers; the other professional development options are top-down professional development sessions delivered by the College Board. Although each APTC has a unique moderator, a current or former AP teacher who is paid modestly by the College Board, the online community functions and is sustained by the original interactions, resources, and momentum of AP teachers. In addition, compared to the other professional development offerings, the APTC is the only option that is continuous throughout the calendar year; the others are finite professional development sessions with a one-day, four-day, five-day, or a multi-week span.

In addition to being "bottom-up" and ongoing, the APTC has the following two primary attributes, based on survey and case study data, that complement and extend top-down forms of professional development: 1) personalization of content and 2) a shared, affective community.

Personalization of Content

All survey participants were asked to rate each identified professional development experience that they engaged in on its responsiveness to participant needs, focus on student work, modeling of teaching practices, opportunities to build relationships with colleagues, and effectiveness in supporting needs with respect to the revised AP course. Of all of the sampled professional development offerings, the APTC rated highest on average for "responsiveness to your needs as a participant," which was defined by the survey as "for example, was the agenda flexible or customizable to accommodate your (and others') varying interests and needs? Or was the agenda fixed and followed rigidly?" The responsiveness of the APTC, as rated by the survey participants, is not surprising given the inherent set-up of the APTC, in which users can search for and find specific discussions and resources of interest. Case study participants articulated the difference between the APTC and other professional development offerings with respect to personalization of content by stating:

> "When you go to a professional development, you're kind of at the mercy of the presenter and you're going to get some ideas but you're also going to get a lot of things that you're really not interested in, so you might sit there for a day or for three days and it might take them a long time to get around to what you actually want to know about. What was nice about the community [APTC] was you can go on there and be looking for a specific thing, and you can find ideas on that specific thing or if you just want to get ideas in general, then you can go out there and just read all the posts. I mean, it's nice

> that if you're in a time crunch and you want to get some practice Hardy-Weinberg problems, you can go on there and find that very quickly. That's what I like about it."
> (Case Study Participant #8)

> "[In the APTC], you get that discussion going back and forth as far as, have you thought about this or what about this or how do you handle it with this kind of special needs student and things like that. Whereas, if you just had a book or at times, if you had a teacher up in front of a classroom giving a presentation, there isn't time to get into those details. It's not that they wouldn't want to. It's just the time isn't there. But with the AP Community, as long as you're willing to put the time in, that discussion can happen."
> (Case Study Participant #23)

In addition to responsiveness, survey participants ranked "to access resources" as the second most popular reason for visiting the APTC. Resources within the APTC can be accessed at any time of day and from any device (computer, tablet, smartphone) with Internet capability. Case study teachers note that the sheer number of participants ensures a variety of rich resources, which are more relevant than those that can be found outside of the community:

> "The vast number of the people that are a part of a group means there are a vast number of resources. So, if you need an activity for a certain concept because the kids aren't getting it, Googling it will get you some things, going on the resource board will get you more and more relevant things that you can use."
> (Case Study Participant #25)

As case study participants noted, sharing resources was particularly useful in the early implementation of the redesign when few exam questions had been formally released.

> "Yeah, I mean, it [the APTC] was honestly the best thing I had last year, you know, see what other people are doing, get advice. When it came time for the test, people were sharing review materials and, you know, questions and, not hints, you know, but like test taking hints, I guess I should say. That sort of stuff was invaluable to my kids because I would then share with them that sort of thing and it was really good, especially at the end of the year, I pretty much lived on that thing."
> (Case Study Participant #8)

The APTC provides personalized access to content in a way that most forms of top-down professional development cannot provide.

A Shared, Affective Community

Connecting with off-site colleagues is important given that most AP Biology and Chemistry teachers are likely the only teacher of that particular curriculum in the school. As described by two case study participants:

> "I am really an island. I am the only AP Biology teacher at my school. There is no connection between AP Biology teachers in the county really. We get together for a 20-minute session once a year and brainstorm, but there is no sharing."
> (Case Study Participant #21)

> "If I limited myself to face to face, I wouldn't have any other AP teachers to talk to. I'm the only one in my district.

> I would have to be branching out across my county and across several counties around me to build up even a small pool of AP Chemistry teachers. And within that pool, I may not have anyone that's teaching in a similar situation as I am – be it numbers-wise or economic factors."
> (Case Study Participant #23)

Although survey respondents rated face-to-face workshops more highly than the APTC in providing "opportunities to build collegial and/or supportive relationships with other teachers," the APTC may serve to foster collegial relationships across distance, which reduces isolation and provides encouragement to teachers. Moreover, the APTC may support an affective community for teachers, as one case study teacher explained:

> "It is very helpful to hear when other people have had the same problems or obstacles as you. Like a lab that does not work out, what are some possible reasons? How do people overcome the problem, so you do not feel so alone."
> (Case Study Participant #21)

> "The other thing though, at times, is the moral support. … seeing that 'Oh, I'm frustrated with this too', … there are other people that are in your situation. You're not the only one… That can be mentally helpful at times as well."
> (Case Study Participant #23)

In particular, when survey respondents were asked to rank the reason(s) why they visit the APTC, the number one ranked response (with approximately 95%) was "to read what other teachers are thinking." This peer-to-peer component of the community seems to be something that distinguishes the APTC from the

other top-down forms of professional development, which usually do not allow time for the sharing of emotions and personal experiences. The following case study participants confirm the importance of the affective component and acknowledge that emotional sharing reduces isolation and provides encouragement:

> "I think in the year leading up to the new exam... it was vital. Just to hear other people's frustration, knowledge, and understanding... to know that okay, other people are having the same challenges or questions that I have... It kind of reduced the sense of isolation." (Case Study Participant #6)

> "For me, it gave me, you know, some reassurance that I'm actually doing what I'm supposed to be doing. Like things that had gone awry, you know, kind of made me feel like oh, did that happen to only me? And that happened to someone else too?…So it gave me, you know, encouragement of how in terms of how I can better do my job, you know, hopefully next year, and how things that I should change..." (Case Study Participant #28)

In complement to more traditional, top-down forms of professional development, the APTC allows for teachers to search peer-shared resources and discussions tailored to their needs, allowing for personalization of content responsive to interests and curiosities. In addition to resources, the peer-to-peer aspect of the APTC creates a space for sharing affective components of teaching, which may not be featured or addressed in top-down forms of professional

development, which are usually more focused on imparting content knowledge. Case study participants who use the APTC report that their isolation is reduced and they are encouraged through these peer exchanges.

Research Question 3: *Making the AP Teacher Community More Effective in Serving Participants*

Although participation in the APTC is correlated with positive student outcomes, a gap exists between what the literature suggests about best practices in effective online communities and what is actually observed within the APTC, with regard to moderation and user interface (a discussion of that literature is contained in the next section). As a result, one of the survey questions queried respondents in an open-ended format – "What, if anything, would improve your experience with the AP Teacher Community?" Interestingly, the majority of survey respondents commented on moderation and on user interface, which specifically comprised search functionality and organization of information. The following paragraphs report on these findings with respect to moderation and user interface.

Survey respondents note that the online community does not always feel safe given the employed moderation techniques (or lack thereof) and/or the domination (or bullying) by a few strong voices.

> "I think that [the moderator] is incredibly responsive and helpful. I do sometimes cringe at harsh replies to

> folks (newbies) who ask questions that are searchable. I wonder if that turns some off from participating or asking. I also know it must be frustrating from [moderator's] standpoint."
>
> "Some individuals, including the moderator, have too strong of a voice. The moderator should moderate, not be the 'know all' of the group. But instead, 2,000 posts later, he is often the end of a thread, ceasing discussion. Given that, he is also an advocate for those that believe in the new course, which is refreshing and much appreciated. But too often, it is a site for bullying or being bullied."

Similarly, some case study teachers note that the APTC feels like an echo chamber of the same voices or an insider's club; these teachers describe, "you'll notice that there is a small core of people really talking" (Case Study Participant #11) and "the forum is generally dominated by lots of strong voices" (Case Study Participant #25). Far fewer survey respondents describe the moderation as successful, with comments such as: "The moderator does an excellent job of keep the group professional, respectful and focused on student learning. Thanks!"

With regard to user interface, survey respondents ask for better search functionality and better organization of information. Respondents repeatedly note that the search engine functionality is less than ideal for locating desired resources and that it is challenging to find one's way back to a particular resource.

> "When you are looking for a specific topic, you often get all sorts of hits from all different areas. For example, if you put in 'photosynthesis' and search for an activity, you might get a couple of photosynthesis, some genetics,

> some ecology... it's annoying."
>
> "It's so vast. Researching resources in the search option can be arduous. A simple search can yield numerous non-related threads and resources. I wish there was a way to streamline everything."
>
> "My experience with the search bar for the AP Teacher Community, I was not able to find the resources I was looking for by typing in a keyword search. Because of the way replies to posts are organized, it was hard to find the starting post that many times contained the resource I was looking for. A redesign of either how the threads are organized or an update of the search function to be able to find posts with resources attached in a more efficient way would be extremely helpful."

There are also specific calls for "live online chat with other users who are online," "shared test question banks," and opportunities to "interact more with teachers on successful teaching strategies".

Delayed response time was not directly mentioned by any of the survey respondents, but it is something that I have observed within the community. Research often points to the importance of receiving a timely response, especially for new users (Frumin & Dede, 2016).

Discussion and Implications

This paper set out to further explore the online AP Biology and Chemistry teacher communities during the large-scale redesign of these courses and arrived at three main findings: (1) the APTC provides a personalized, peer-generated, affective environment which complements and extends top-down forms of professional development; (2) while duration is not of significance, everyday teacher use of the Biology and Chemistry APTC shows correlation with increased student AP test scores (for Chemistry, this is also true of weekly use); and (3) based on teacher self-reported needs, the APTC might be further improved with changes to moderation and user interface.

While professional development is inherently focused on teacher learning, professional development in the face of a redesigned curriculum or assessment (or both) also requires "unlearning" of prior practices, beliefs, and values about the nature of teaching, learning, and/or schooling. According to Dede (2005), unlearning requires higher levels of emotional and social support than traditional forms of professional development that are focused on intellectual and technical dimensions. Dede (2005) also notes that unlearning, ideally, should take place in "distributed learning communities, so that the learning process is consistent with the knowledge and culture to be acquired" (p.15). Therefore, the APTC might complement and extend top-down, multiday, face-to-face professional

development workshops by providing a continuous context, to be accessed when needed, where teachers can collectively unlearn skills and support each other emotionally in re-learning new practices in their respective environments. Survey and case study participants confirmed this when describing that participation in the APTC reduces isolation, provides emotional support, and encourages teaching practice.

In addition, the challenge with the other top-down, face-to-face workshops is that teachers generally are able to attend when they are farthest removed from their classroom contexts during vacation weeks or months. The APTC likely provides a form of unlearning and reflection that is more proximate to teacher practice during the school year. As a result of this proximity to teacher practice, the APTC may complement and extend top-down forms of professional development by being more responsive and personalized to teacher needs in the moment during the school year, as evidenced by survey and case study participants description of the search function to find activities and resources for planning and test-preparation.

The study's second main finding reports on the frequency of teacher participation that correlates with increased student AP test scores. Although duration of time spent in the community is not statistically significant, the frequency with which teachers visit is; daily teacher use of the APTC is associated

with increased student scores in both the biology and chemistry communities. This finding also holds true for weekly participation in the chemistry community. However, it is unclear if the correlation is due to a teacher self-selection bias, as it might hold true that teachers who are trying harder to help their students are the ones logging in daily, not that the resource itself is making the difference.

According to survey participants, the average frequency of visiting the APTC is once a month and the average duration of time spent in the community is 10 to 20 minutes. These averages when taken together do not account for much exposure to the APTC; however, when the statistically significant frequency of everyday teacher use is combined with an average duration of 15 minutes (average between 10 and 20 minutes) over the course of a five-day week throughout the 36-week school year, the APTC exposure time adds up to 45 hours, aligning with professional development literature which states that teachers may need as many as 50 hours of instruction, practice, and coaching before new strategies are mastered and implemented (Gulamhussein, 2013; French, 1997). Further investigation is needed into which activities everyday APTC users engage that contribute to increases in student AP scores.

The third finding from this study focuses on improving moderation and user interface within the APTC. A review of the scholarly literature highlights the importance of moderators in the effective functioning of online learning

communities, in part because of the critical role that moderators play as facilitators of community discussions and champions of member engagement. For example, Booth (2012, p.24) states, "Without the social artistry and guidance of a single leader or a team of leaders, online communities will unlikely reach their full knowledge sharing potential." In order to foster collaboration and knowledge sharing, moderators should employ intentional language to prime the members of the community to the norm of reciprocity. Phrases such as "pay it forward" or "return the favor" can activate members' altruism and promote their development of commitment to the community. To accomplish this, moderators might consider highlighting what benefits certain members have received as well as any opportunities for them to "give back" to the community that supports them.

In addition to altruistic language, moderators also need to pay attention to how the information within an online community is organized. It is critical that members of an online community are able to easily discover where to add their voices to the discussion and what contributions need to be made. A well-organized community will lead to increased contributions by lowering the barrier to participation. In sum, the 2014 APTC survey and case study data illustrate that teachers adapting to a large-scale change in curricula and tests want an ongoing environment in which to share feelings, emerging expertise and experiences, and resources. A well-moderated community ensures emotional and social safety for

all members, and a user-friendly interface and efficient search function ensure effective retrieval of resources.

Conclusion

By examining a professional development community of teachers with shared curricula and assessments, this study explored a unique American "subsystem" – of AP Biology and Chemistry teachers adapting to a large-scale redesign in 2013 and 2014 respectively. While there were many forms of professional development offered to support AP Biology and Chemistry teachers in navigating this monumental shift (toward depth and scientific inquiry, reasoning, and application), the online APTC is the only offering that is ongoing throughout the calendar year, proximate to all stages of teacher learning, and co-constructed by teachers – sustained by their unique participation, resources, and momentum.

In addition to being continuous and "bottom-up," the APTC provides *personalization of content* and a *shared, affective community*. The search function within the APTC allows users to locate specific discussions and resources of interest and therefore to customize their professional development experience. Survey and case study participants also report that the APTC reduces isolation and provides emotional support in navigating curricular changes and possibly in

"unlearning" prior practices and beliefs. According to Dede (2005), unlearning demands higher levels of emotional and social support than traditional forms of professional development that usually target intellectual and technical dimensions. Because the APTC is most commonly accessed by teachers for its capacity for *personalization of content* and a *shared, affective community*, the APTC might be further improved, according to survey respondents, by enhanced search functionality and moderation.

Scholarly Significance and Future Research

This research contributes to knowledge about the support that online learning communities offer to teachers in the context of large-scale mandated curriculum and assessment changes. The ability for teachers to sustain community, access resources, and personalize content seems to be important in professional development. Understanding the contribution of the APTC yields valuable information for both policy and practice as we seek to improve professional development offerings for all teachers who are responding to impending national large-scale changes in curricula and assessments, such as the Common Core state standards and associated tests.

Future research with this data set will examine teacher and school characteristics among APTC users and non-users. Understanding teacher

motivations and behaviors in peer-based online learning will illuminate reasons why teachers may choose to use (or not use) the APTC, which is vital to meeting the professional development needs of teachers. In addition, future research will explore associations between teacher actions within the APTC (e.g. posting a new comment or "lurking" by only reading what others have posted) and student AP scores to gain insight into specific APTC user actions that correlate with increases in student outcomes. While this paper examined the Advanced Placement online communities for biology and chemistry, the largest online teacher community for science teachers in the United States is the National Science Teachers Association (NSTA), with 170,000 users. Further research might compare the APTC and the NSTA communities, as well as online teacher communities in other countries or within multinational communities.

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Appendix A: Tables and Figures

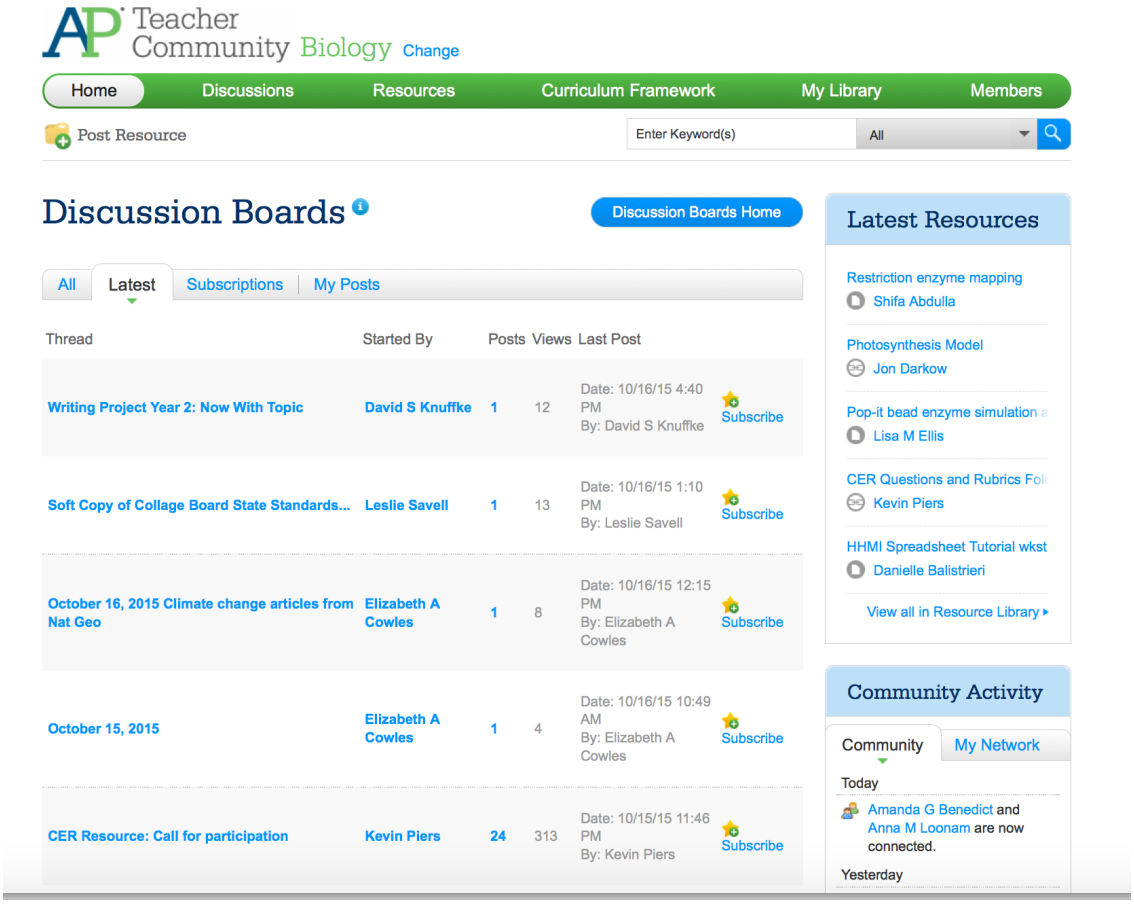


Figure 1. Screen shot of APTC *Home* page

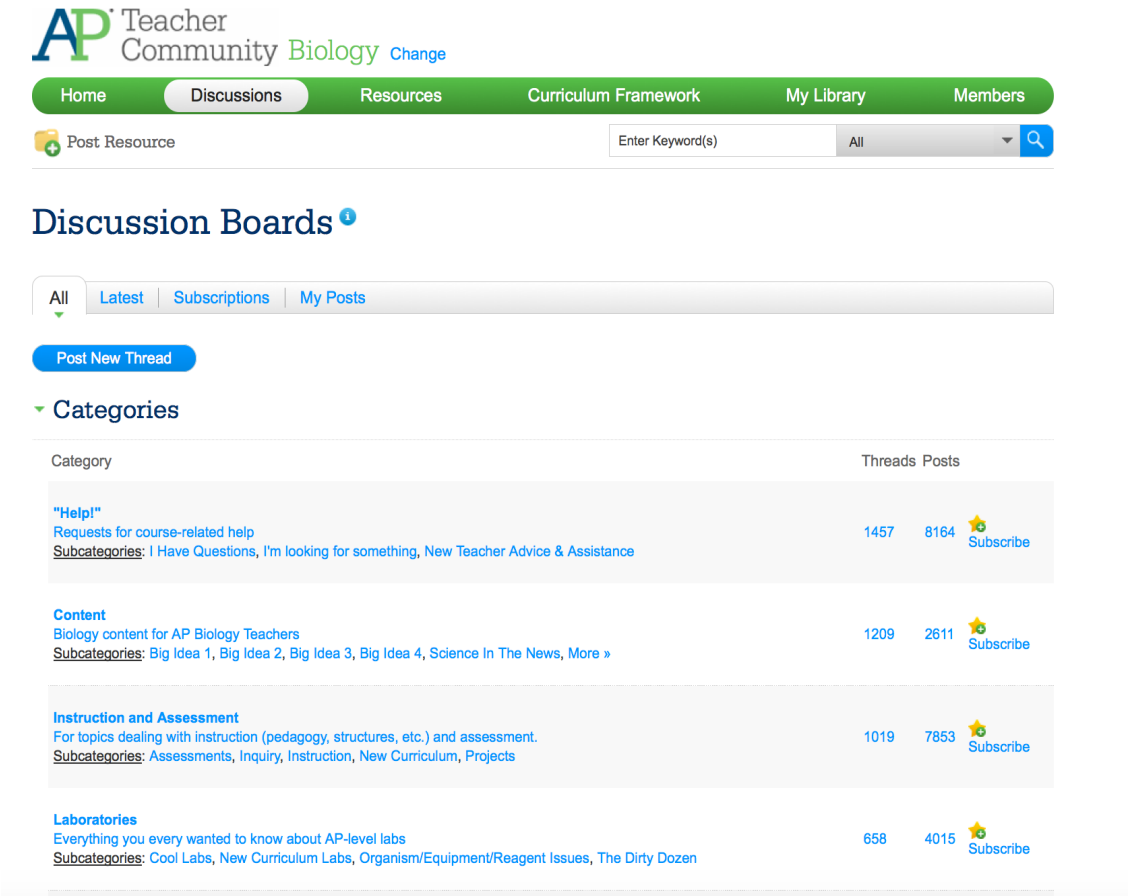


Figure 2. Screen shot of APTC *Discussion* page

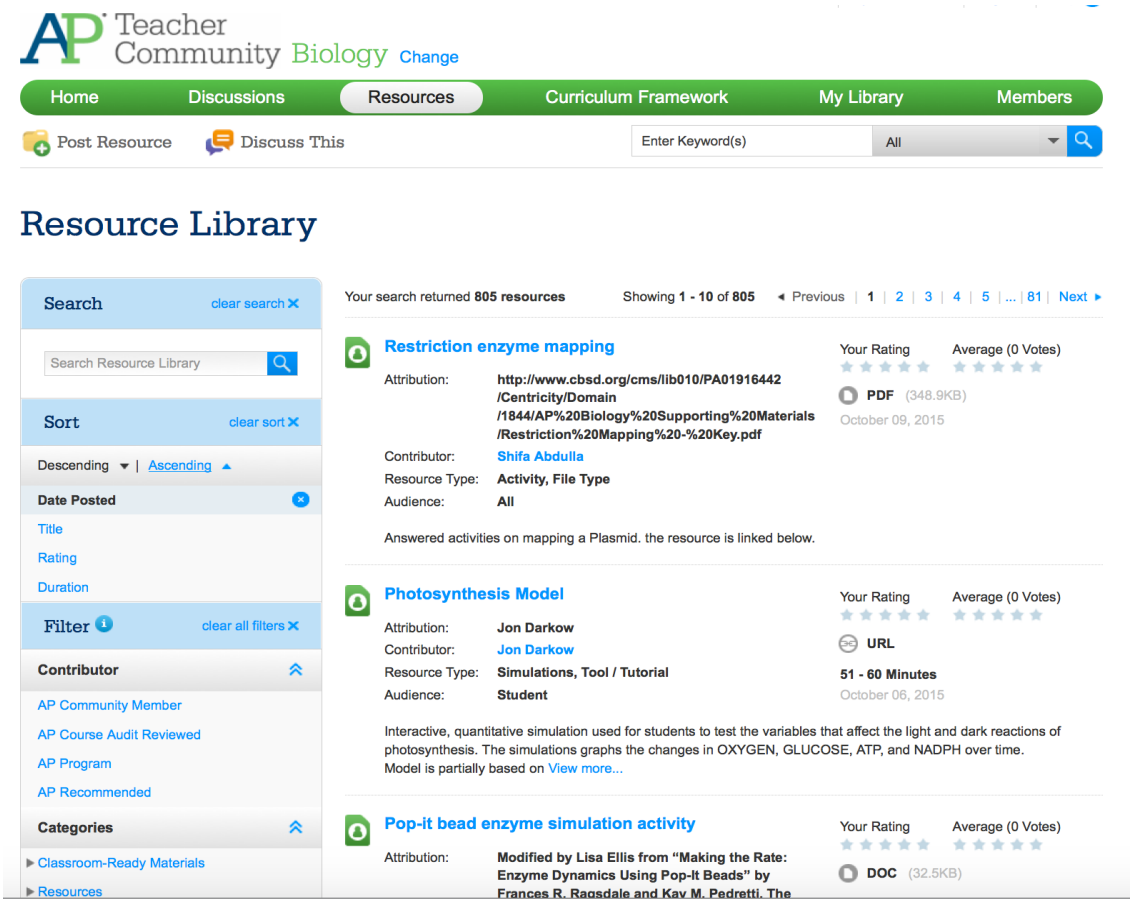


Figure 3. Screen shot of APTC *Resources* page

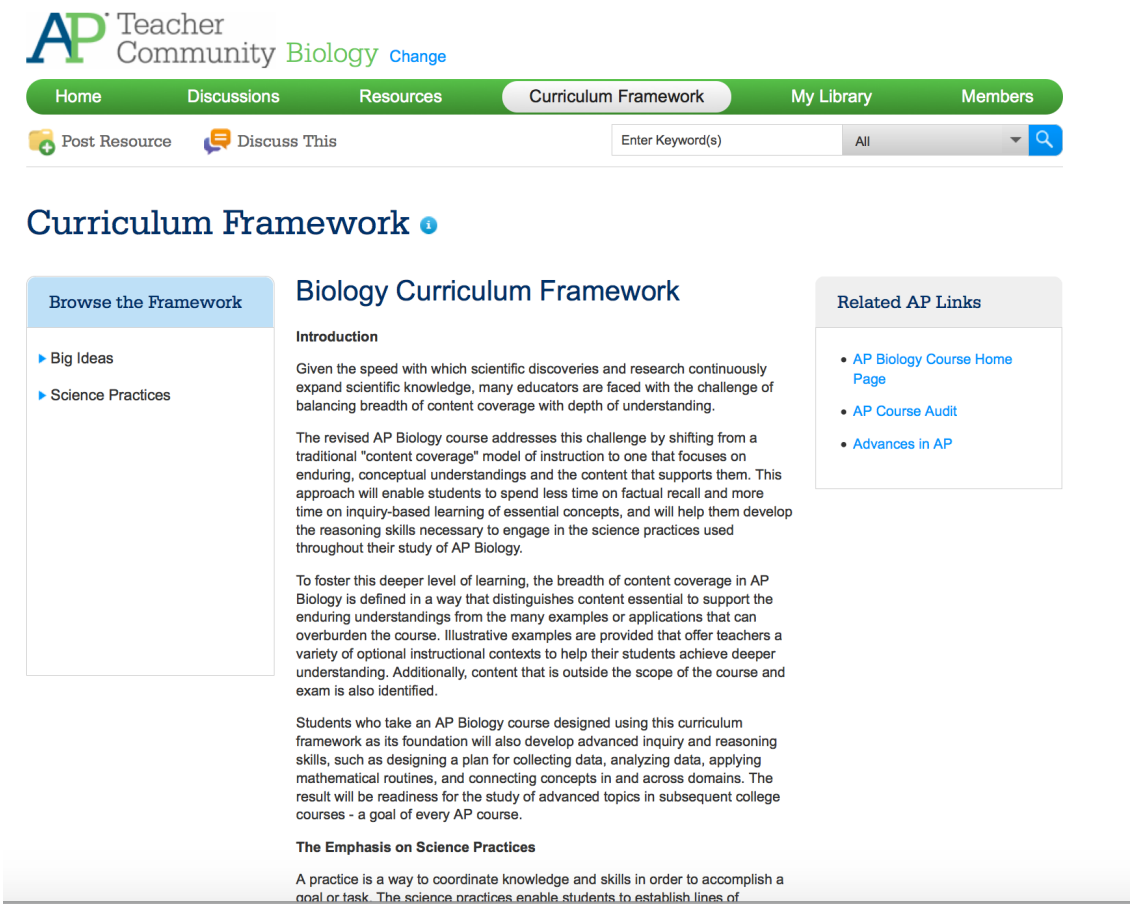


Figure 4. Screen shot of APTC *Curriculum Framework* page

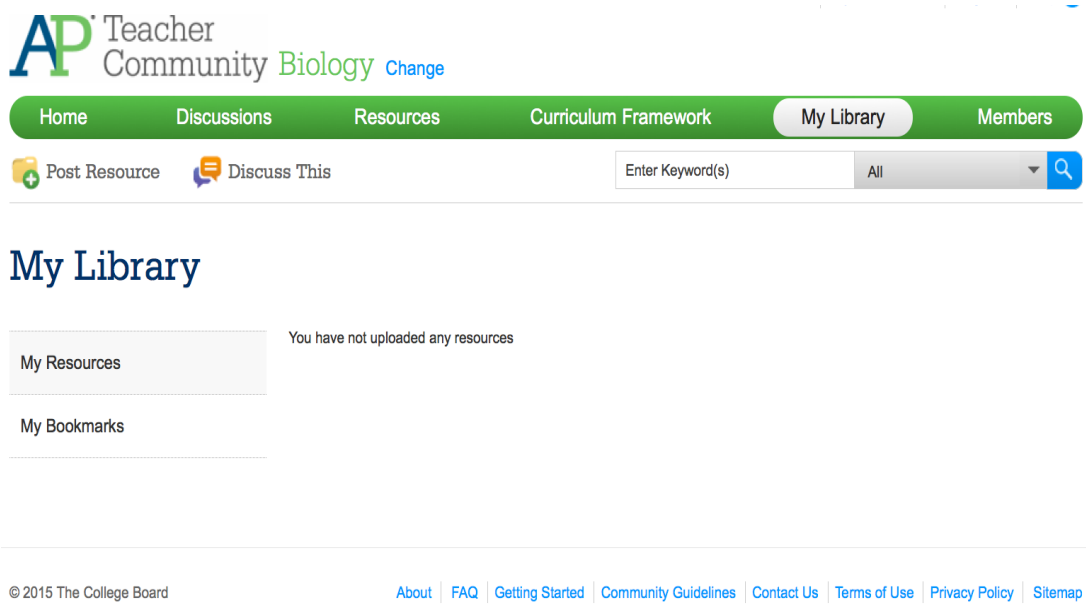


Figure 5. Screen shot of APTC *My Library* page

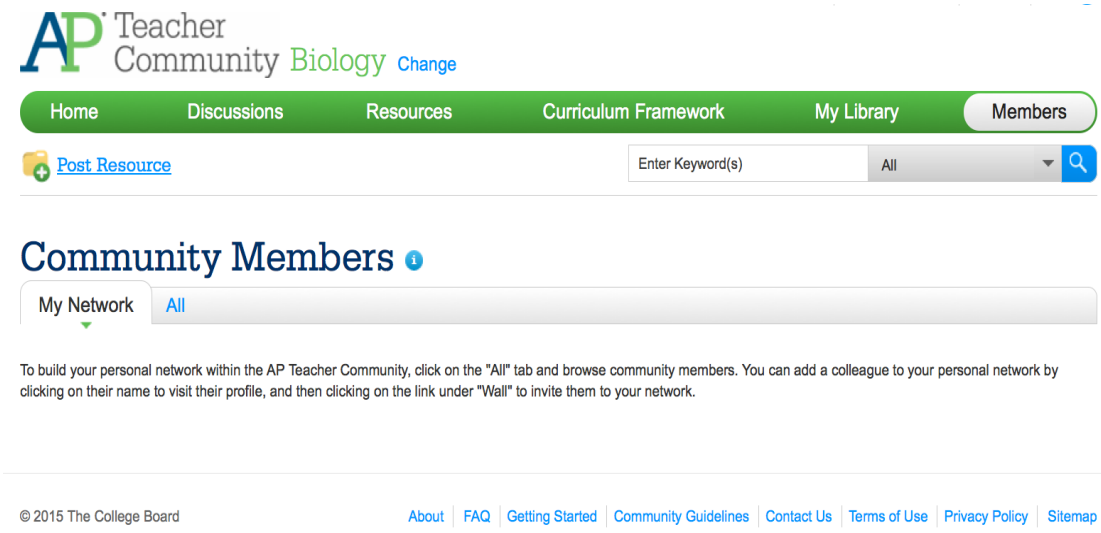


Figure 6. Screen shot of APTC *Members* page

Table 1. Case Study Participants

	AP Biology (n=24)	*AP Chemistry (n= 10)*	*Total (n=34)*
Teacher Gender			
Female	20	7	27
Male	4	3	7
Years of teaching AP Science			
0-2 years	5	3	8
3-5 years	5	2	7
6-9 years	8	0	8
10-15 years	1	4	5
16+ years	5	1	6
Geographic Representation			
Midwest	6	3	9
Northeast	5	3	8
Pacific	4	2	6
Rocky Mountains	1	0	1
Southeast	6	2	8
Southwest	2	0	2

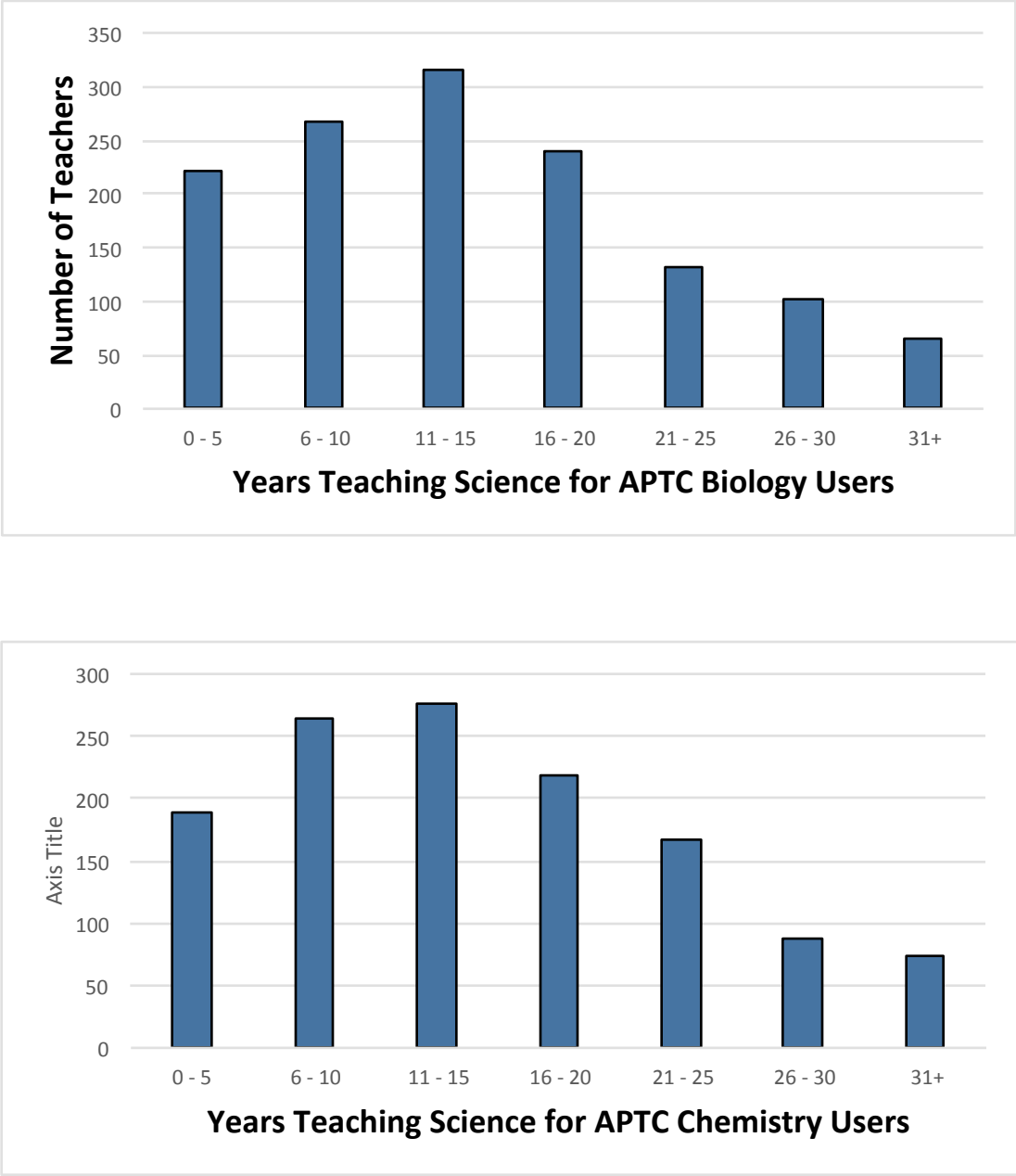


Figure 7. Bar graphs of years teaching science for APTC Biology (top panel) and Chemistry (bottom panel) users.

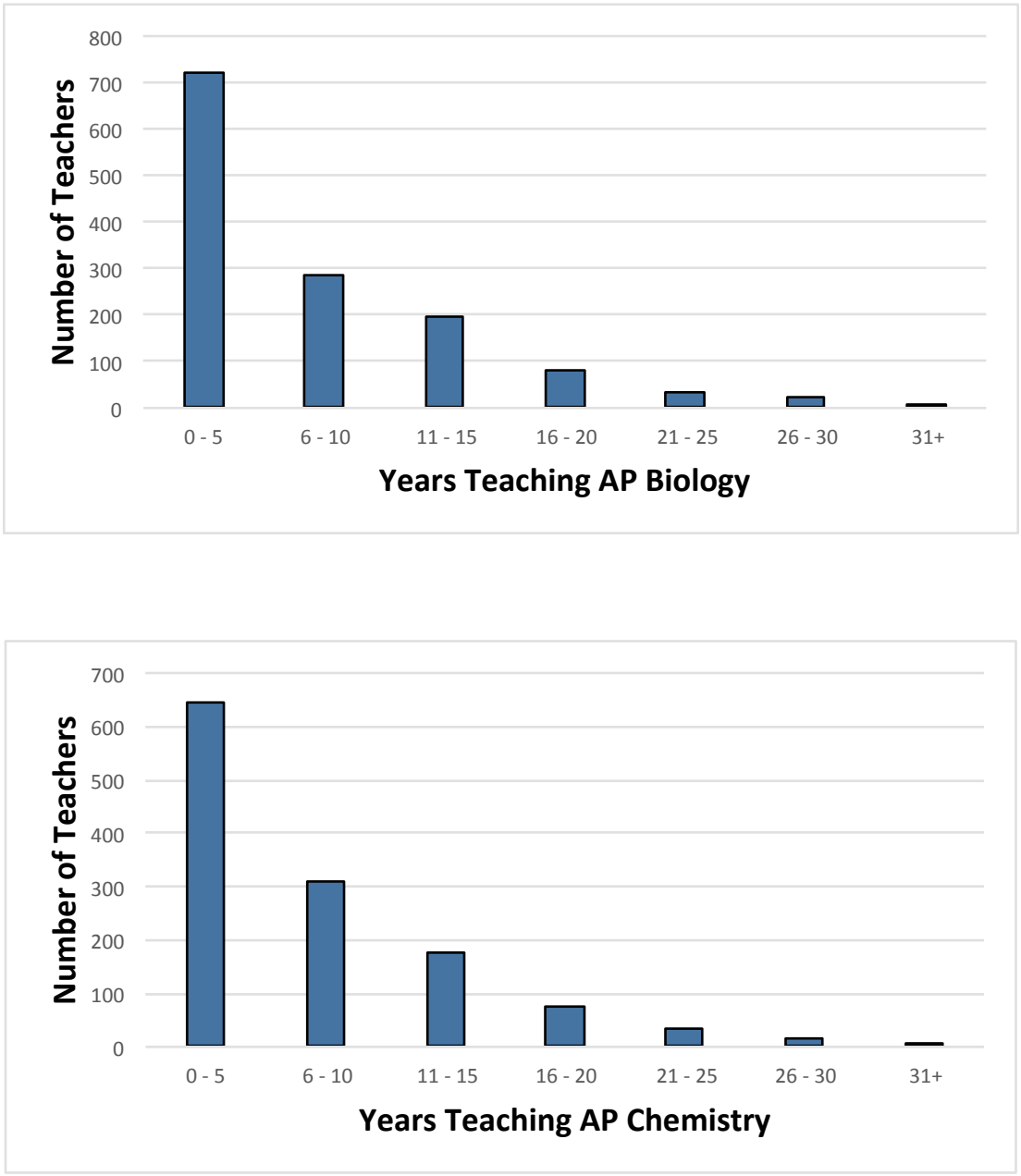


Figure 8. Bar graphs of years teaching the AP curriculum for APTC Biology (top panel) and Chemistry (bottom panel) users.

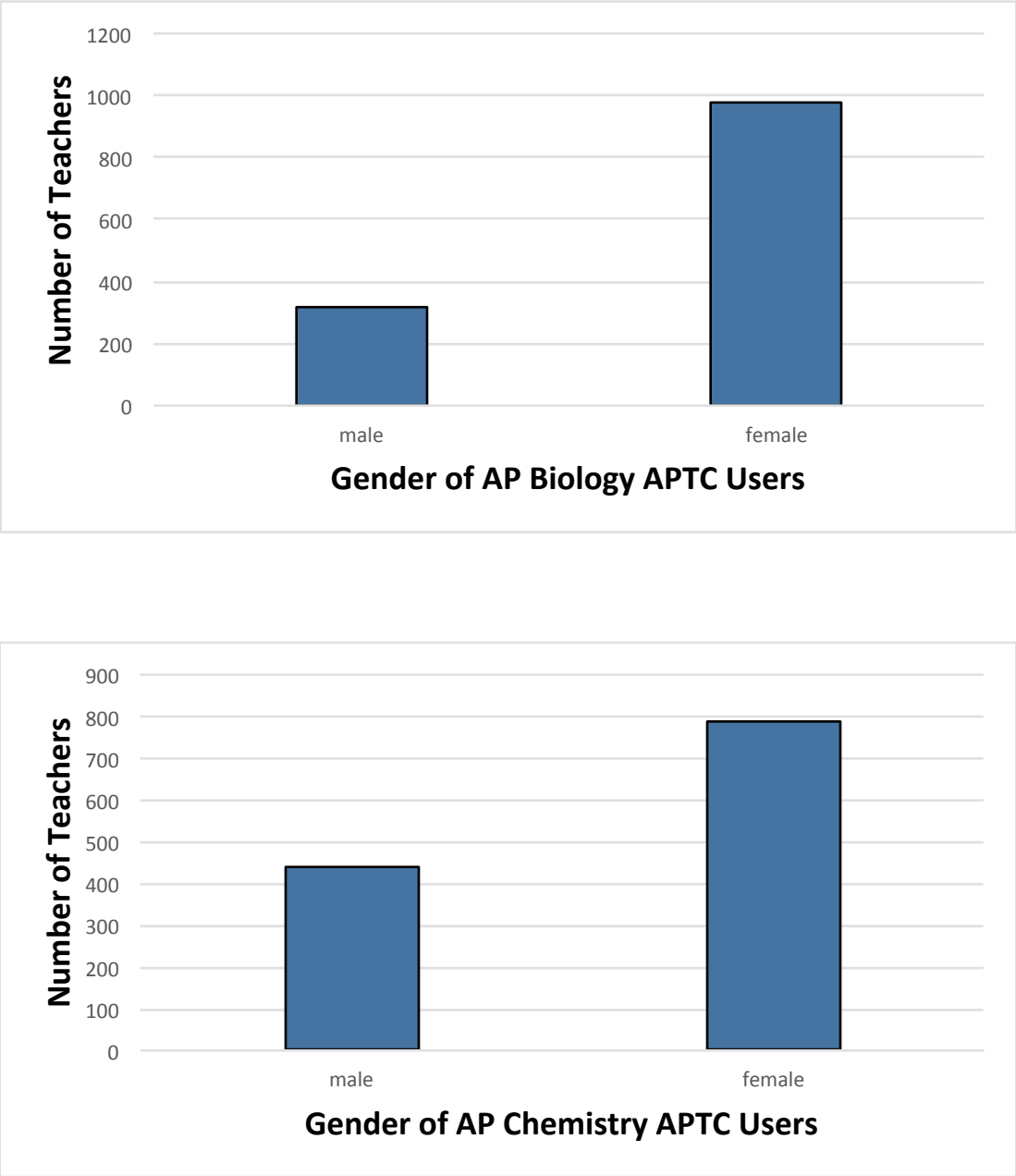
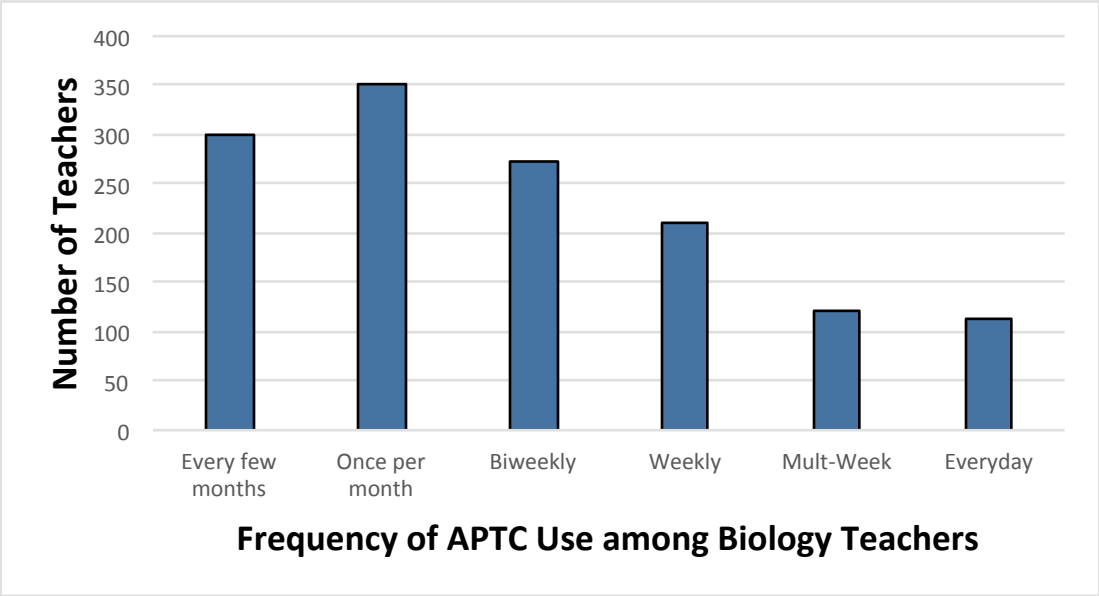
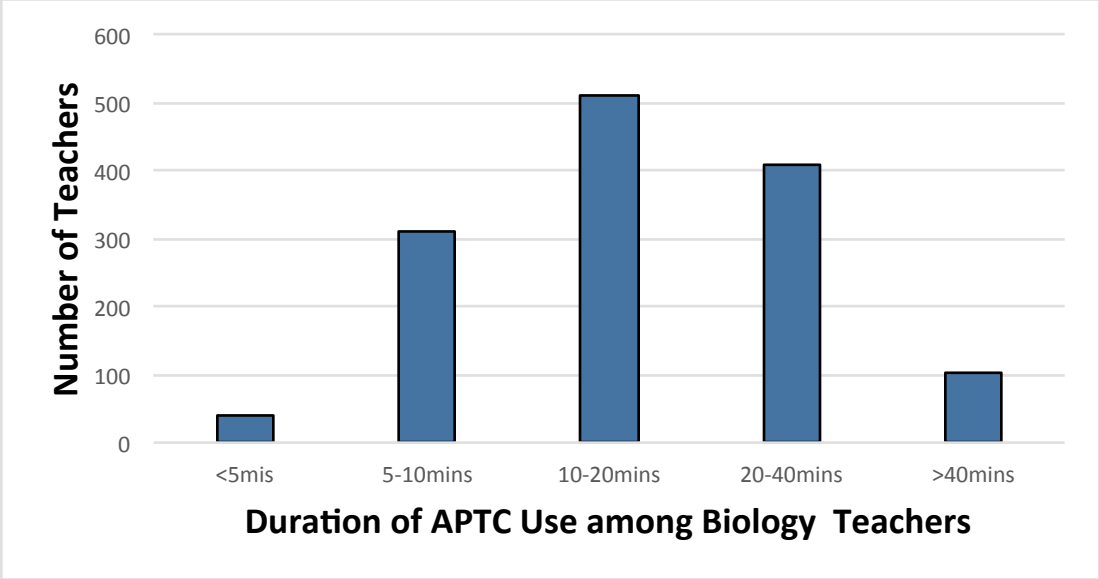
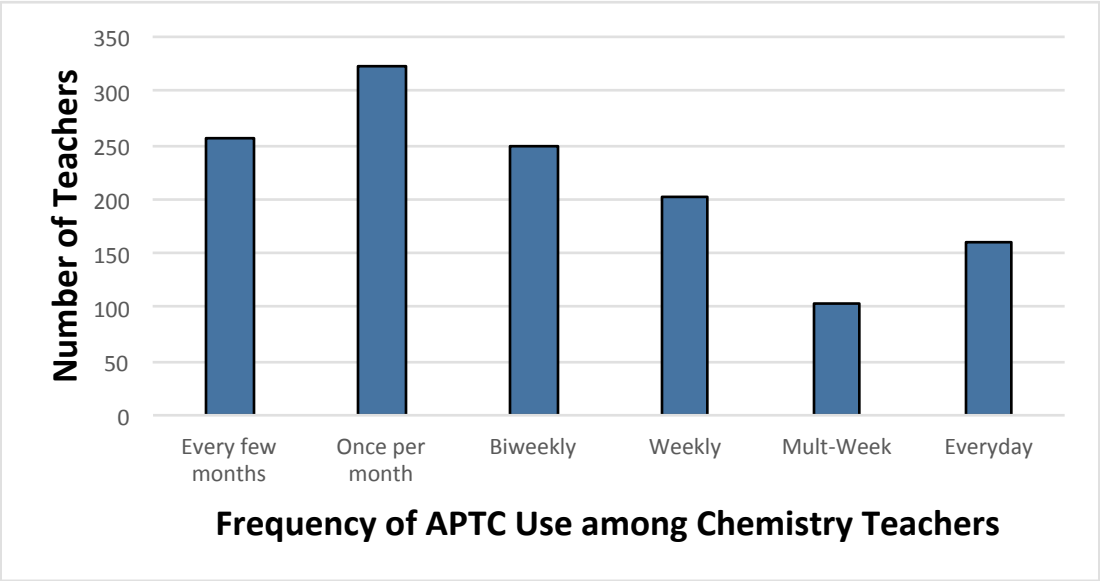


Figure 9. Bar graphs by gender for APTC Biology (top panel) and Chemistry (bottom panel) users.


400
350
300
250
200
150
100
50
0
Number of Teachers
Every few months
Once per month
Biweekly
Weekly
Mult-Week
Everyday
Frequency of APTC Use among Biology Teachers


600
500
400
300
200
100
0
Number of Teachers
<5mis
5-10mins
10-20mins
20-40mins
>40mins
Duration of APTC Use among Biology Teachers



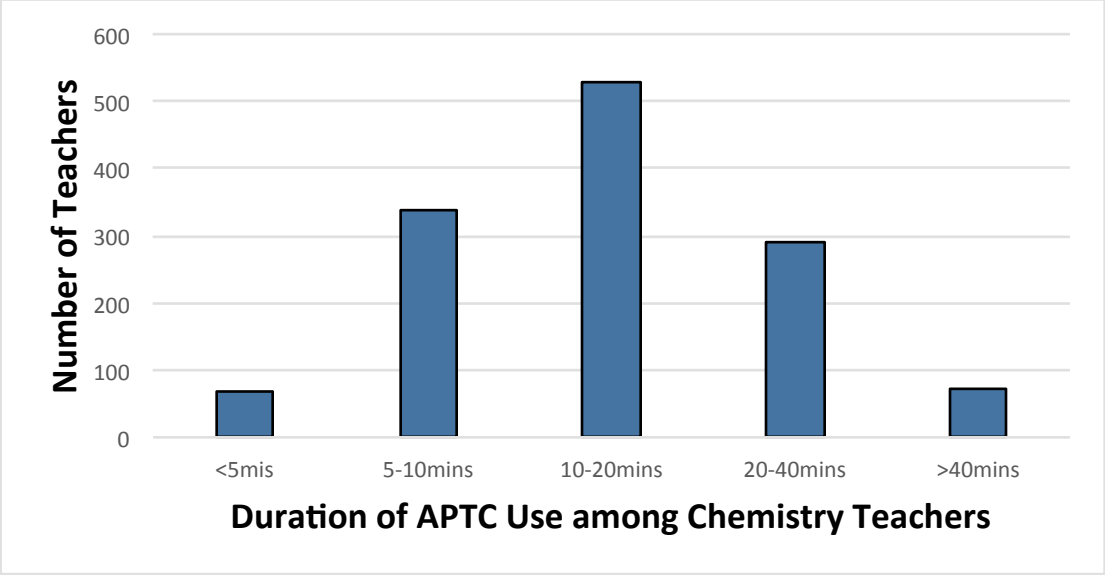
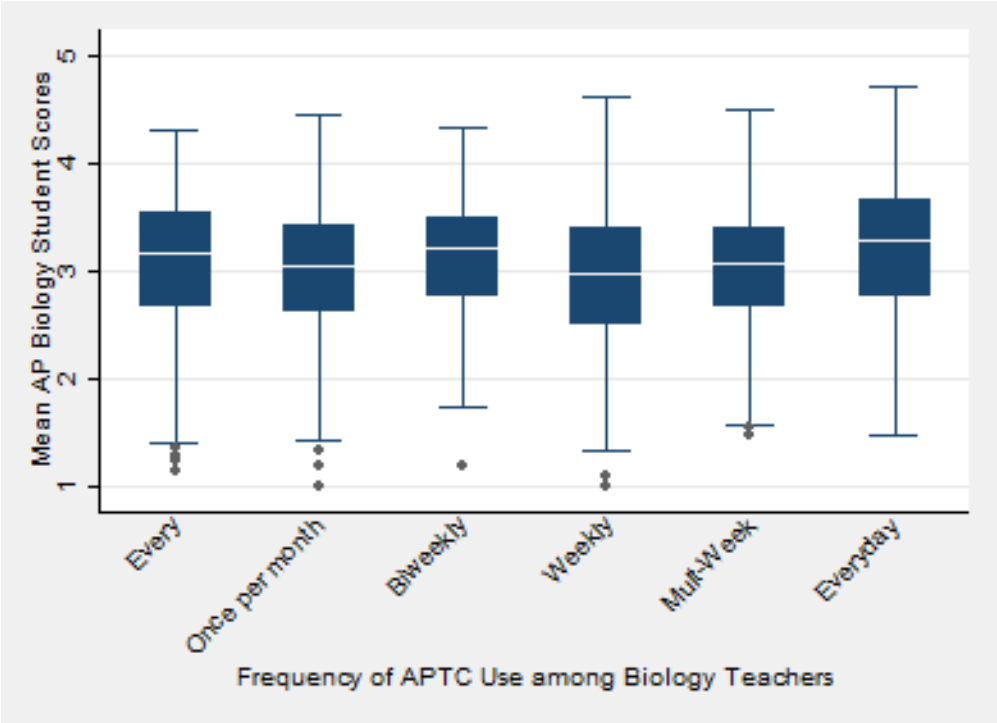
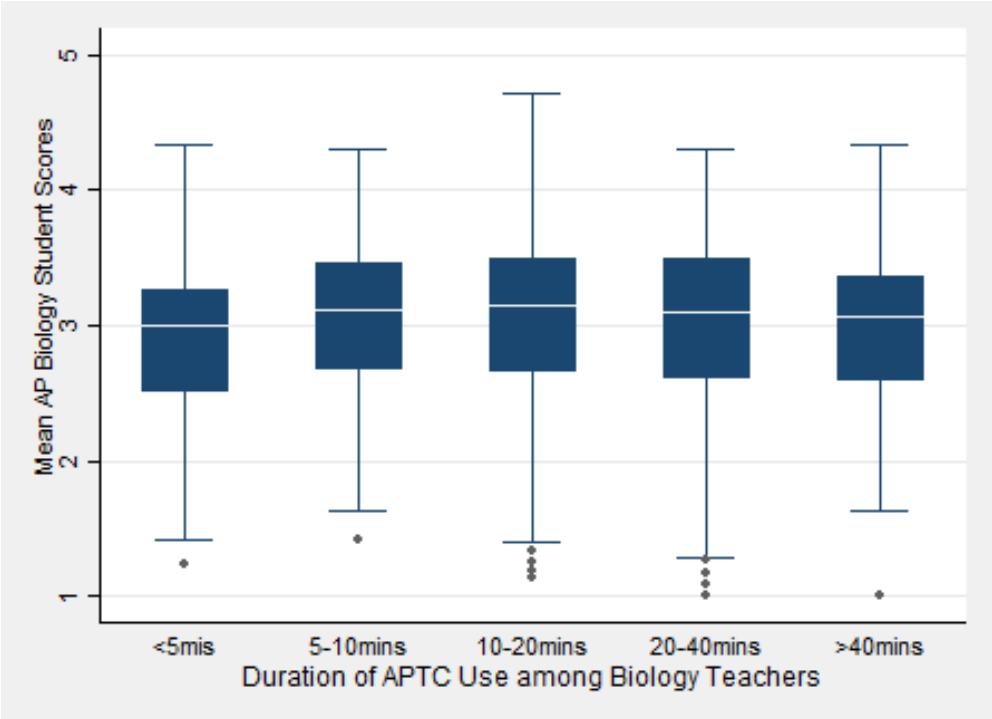


Figure 10. Bar graphs of frequency and duration (bottom panel) of APTC use among AP Biology (top panel) AP Chemistry (bottom panel) teachers.


Mean AP Biology Student Scores
1
2
3
4
5
Every
Once per month
Biweekly
Weekly
Mult-Week
Everyday
Frequency of APTC Use among Biology Teachers


Mean AP Biology Student Scores
1
2
3
4
5
<5mis
5-10mins
10-20mins
20-40mins
>40mins
Duration of APTC Use among Biology Teachers

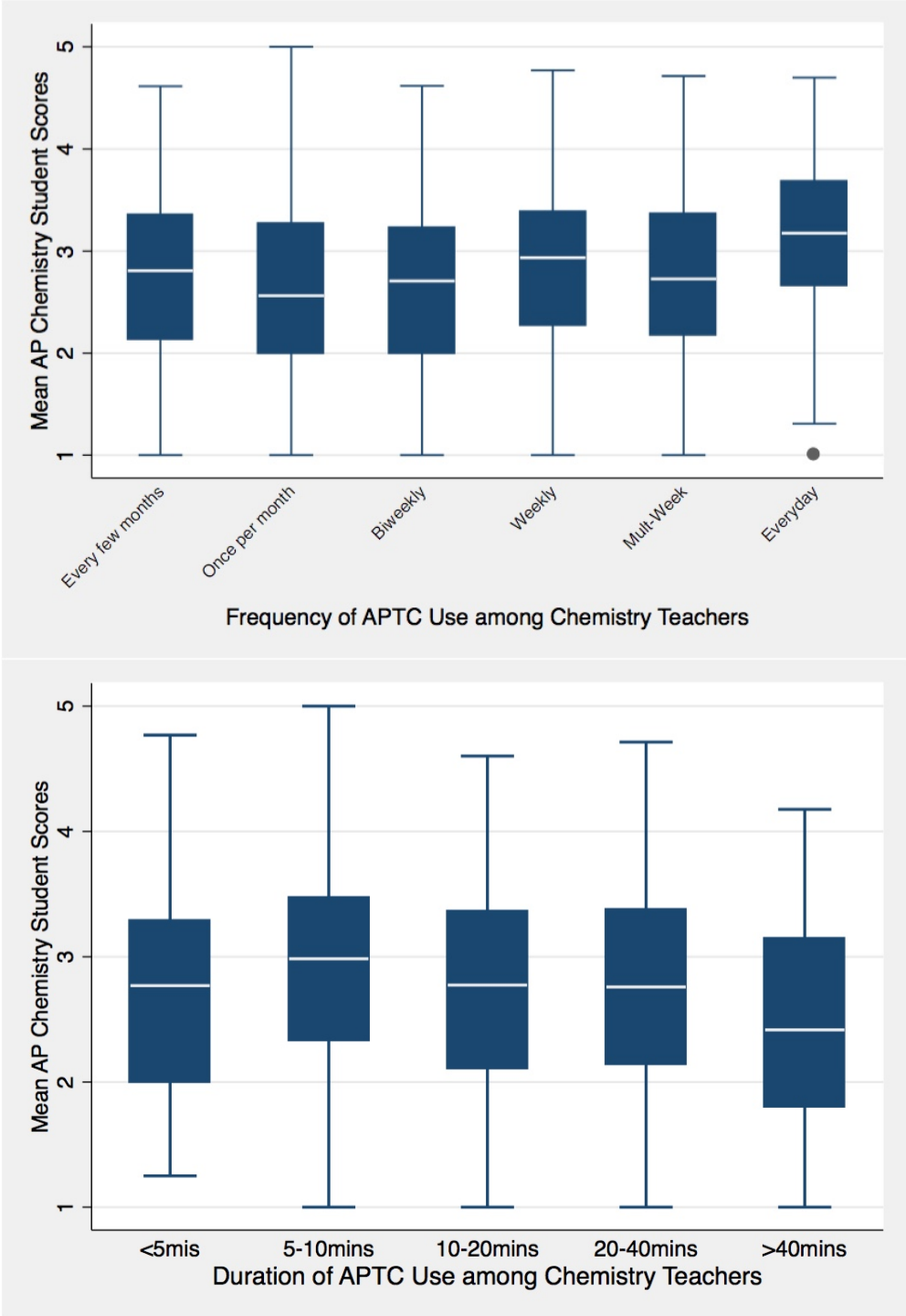


Figure 11. Box plots for frequency and duration of APTC use among AP Biology (top panel) and AP Chemistry (bottom panel) teachers. Everyday use indicates statistically significant difference in average AP scores for students. Duration does not highly correlate with AP scores (not statistically significant).

Appendix B: AP Teacher Community Data Sources

Data Source	Questions
Survey 2014	93. How often did/do you VISIT the AP Teacher Community web site? ● Only once every few months ● About once per month ● Every other week (twice per month) ● Once a week ● Several times a week ● Almost every day 94. When you visit the AP Teacher Community web site, about how much time do you typically spend in each session? ● Less than 5 minutes ● About 5 to 10 minutes ● 10 to 20 minutes ● 20 to 40 minutes ● More than 40 minutes 95. Was the AP Teacher Community responsive to your needs as a participant? For example, was the agenda flexible or customizable to accommodate your (and others') varying interests or needs? Or was the agenda fixed and followed rigidly? ● Almost completely fixed (1) ● (2) ● Equal mix of fixed and responsive (3) ● (4) ● Almost completely responsive (5) 96. Was student work or material a focus of the AP Teacher Community web site? For example, did you examine student lab reports or student test results as a means to understanding common student errors? ● Almost no focus on student work (1) ● (2) ● Some focus on student work (3) ● (4) ● Major focus on student work (5) 97. Was teaching modeled as part of the AP Teacher Community web site? Modeling teaching could include observing demonstrations of the type of teaching that would be seen in AP classes or watching videos from AP classes. ● Almost no focus on modeling teaching (1) ● (2) ● Some focus on modeling teaching (3)

	• (4) • Major focus on modeling teaching (5) 98. To what extent did the AP Teacher Community provide opportunities to build collegial and/or supportive relationships with other teachers? • Almost no opportunities to build relationships (1) • (2) • Some opportunities to build relationships (3) • (4) • Ample opportunities to build relationships (5) 99. Did the AP Teacher Community effectively support your needs with respect to teaching the revised AP course? • Not effective (1) • (2) • Somewhat effective (3) • (4) • Extremely effective (5) 100. You could have chosen to participate in this PD program or activity for many different reasons. Please rank your top reasons by dragging the small boxes on the left (max=3) to the big box on the right. Please drag your top 3 reasons for choosing this PD option from the choices on the left. After you drag the items, please drag to rank them from most important to least _____ For advice, suggestions, and support _____ I had the opportunity to interact with other teachers _____ It cost me no money _____ It was convenient _____ It emphasized content for the redesigned course _____ It emphasized the redesigned labs _____ It emphasized guidance on structure and planning for the redesigned course _____ It emphasized pedagogy for the redesigned course _____ It was required _____ Other (please describe) 101. What do you typically do when you visit the AP Teacher Community web site? Please click each element on the grid below somewhere between 0 and 100 to indicate the percentage of time you typically spend on different types of activities when visiting the AP Teacher Community. You can slide the ribbon bars after clicking. If you did not engage in a particular activity or do not typically engage in that activity, you can leave the ribbon/bar at "0". NOTE: All activities must total to 100% before you can move on from this item! The total will display automatically for you on the right, and the grid will not let you exceed 100% as you work with different ribbons. _____ Post a new thread _____ Comment on other posts

	_____ Read other posts and comments _____ Post resources _____ Find resources _____ Other 1 (Please describe) _____ Other 2 (Please describe) 102. Why do you visit the AP Teacher Community (please check all that apply)? ● To access resources anywhere, anytime about the AP redesign ● To ask professional questions of peers in a safe environment and receive answers from colleagues ● To read what other teachers are thinking about and recommending in responding to the AP redesign ● To share my own ideas and insights ● For social interactions with peers ● Other (please explain) _____ 103. What if anything would improve your experience with the AP Teacher Community?
Case Studies	**Interview #1** 23) Do you use the AP Teacher Community website? (a series of discussion boards that you enter from AP Central, login using your College Board Education Professional username and password) 24) How do you use the AP Teacher Community website? a. How often do you visit? b. When do you visit? c. Why do you visit? d. How long do you spend there in a typical session? e. When you're there how often do you: i. Post? ii. Answer others' questions? iii. Follow links to other resources 25) How has the AP Teacher Community been helpful in adapting to the redesign? a. How does the help provided by the AP Teacher Community compare to other PD experiences in terms of adapting to the redesign? 26) Do you recommend the AP Teacher Community to others? Why or why not? 27) How could it be improved? a. Would you login more often if there were opportunities such as: i. Webinars led by experienced AP teachers ii. Discussions with head AP readers iii. Other resources?

	Interview #2 18) How did you use the APTC website this year? a. What did you use it for? b. How often did you visit the site? c. How long do you spend on the site typically? d. Have you used the AP Teacher Community differently this year than in the past? How so? What explains the change? 19) If you don't use the APTC, are there other resources you prefer? What are they, and why do you prefer them? 20) If you have not become a member of the APTC, what are the reason(s) you have chosen not to join/participate? (Ask if an interviewee is not a member of the APTC) 21) If you visit the AP Teacher Community but never post, what explains why you don't?
Direct Observation	Organization of the community Top-rated posts by number of views Top-rated posts by number of comments Least-rated posts by number of views Least-rated posts by number of comments Content of top-rated discussions Quality and type of discussions Moderator behavior Response time for comments Interface/platform

Appendix C: Codebook Used for Analyzing Case Study Data

***** This codebook was developed with support from HGSE masters students Adrienne de Souza and Katherine Dlesk

Codebook

Code Family	Code	Definition	Examples	Notes
Benefit to teacher	Lesson Support	User mentions impact on teaching practice such as lesson planning, assessment planning, labs, or inquiry activities	"It has helped me in (e.g. lesson planning/ test prep/etc.)…"	
	Emotional / Community	User mentions impact on moral support / community aspect	"You don't feel so isolated…"; "The moral support helps"; "Hear other people's frustration"	
	Ongoing	User mentions benefit of having continuous APTC access (especially when compared to other forms of PD)	"You can do it anytime, anywhere"; "I can use it whenever I want"	
Frequency	Never	User mentions how often they visit APTC	"Maybe once or twice a week"; "once a month"; "every day"	*To avoid overlaps, where users mentioned a range that covered more than one sub code (e.g. "I went in daily or weekly"), the lower category was coded (in above

				example, it would be coded as “once or twice a week”)
	Once every few months			
	About once a month			
	Twice a month			
	Once or twice a week			
	Several times a week			
	Almost daily			

Length of Use	Less than 5 minutes	User's regular interaction time with the APTC is under 5 minutes	"I usually spend about 15 minutes on it"	*To avoid overlaps, mentions of exactly "5", "10" or "20" minutes were coded according to the lower category, e.g. 5 minutes was coded as "less than 5 minutes" instead of "5 to 10 minutes"
	5* to 10 minutes	User's regular interaction time with the APTC is between 5 to 10 minutes		
	10* to 20 minutes	User's regular interaction time with the APTC is between 10 to 20 minutes		
	20* to 40 minutes	User's regular interaction time with the APTC is between 20 to 40 minutes		
	More than 40 minutes	User's regular interaction time with the APTC is over 45 minutes		
School context	School context	User mentions other contextual details about their school that impact their teaching practice	"I'm the only AP teacher in my school"; "I'm teaching three other subjects"	

Setting	Setting	User mentions when/where they use APTC	"I use it at night"; "Use it during my breaks"	
Student Outcomes	Student Outcomes	User mentions impact on students	"My students enjoyed…" "I thought it helped students with…"	This code was created in Atlas.ti but not used.

Use	Barrier, Community	User views characteristics of the community itself as a barrier	"I've gotten negative comments on the APTC"; "I don't like getting community feedback on fixing my problems"; "I find the community intimidating"	
	Barrier, Interface	User cites some aspect of the interface as a barrier	"It's not user-friendly"; "You need to log in to a separate website"; "It's difficult to find things"	
	Barrier, Time	User cites time as a barrier to using APTC	"I don't have the time"; "It takes too much time"	
	Commentin g	User mentions commenting on another user's post	"I comment"	
	Following links	User mentions following links to other resources	"I follow links to resources"	

	Labs	User mentions using APTC to help with labs	"If I had questions on a lab…"	
	Liking	User mentions liking another user's post	"I like other posts"	
	Lurking	User often uses APTC but never posts; User goes onto APTC without a specific resource or question in mind	"I never post" "just go on to see what's there"	
Use	Posting	User mentions posting	"I post"	
	Specific search	User goes onto APTC with a resource or question already in mind to look for	"I go to look for specific resources"	
	Test-related	User goes onto APTC to for AP test information, such as date, or sample test questions.	"I looked for test questions"; "to see what others were saying about test results"	
	Other	User expresses desire to use APTC more	"I wish I used it more"; "I don't use it enough"	
Year to year change	Year to year change	User mentions a change in the way they use the APTC from one year to the next	"Last year I… this year I…"	
Years of teaching AP	0-5	User mentions how long they taught AP	"I've been teaching for 5 years"	

	6-10			
	11-15			
	16-20			
	21-25			
	26-30			
	31+			

Memos

Memo	Definition	Examples	Notes
Barrier - don't like to post, personal reasons	User doesn't like to post - is introverted, doesn't like social media	"I'm an introvert so I don't really post..."; "I'm not a huge fan of blogging…"	
Barrier - overwhelming	User mentions the volume of content as a barrier	"It was overwhelming…" ; "There are a huge number of discussions"	
Benefit - Content & Course Specific	User found APTC helpful because it's more specific to AP (especially compared to other forms of PD)		* Memo was created but never used
Email Digest	User mentions the email	"I get the daily	

	digests	email digests…"; "I get a summary every day of the discussion boards…"	
Helpful to new teachers specifically	User mentions that the APTC is useful to new teachers	"I used it when I first started teaching AP…"; "I could see how it would be helpful to new teachers…"	* Similar to (but not the same as) "Perception" memo below
Not Helpful for Redesign	User mentions that the APTC has not helped them with the redesign	"It was least helpful out of the professional development for the redesign…"	
Perception that newer teachers use APTC	User reports that APTC is mostly used by new teachers	"I got the impression it was mostly new teachers on there.."	* Similar to (but not the same as) "Helpful to new teachers" memo above
Unclear response	User contradicts previous comment, hard to understand statement		
Value of face to face	User expresses that nothing replaces face to face interactions, even if online community is good	"I prefer talking to other teachers face to face…"; "Sitting down and talking is just irreplaceable…"	