How are teachers providing opportunities for collaboration and critical thinking in online learning at the secondary level during the COVID-19 crisis?

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Abstract

This paper studies the instructional strategies and tools secondary school that teachers used during the COVID-19 quarantine to promote collaboration and critical thinking amongst their students through virtual learning. A sample of the literature about online instructional techniques and critical thinking or collaboration is reviewed. We collected data from 36 secondary instructors by means of online surveys and virtual interviews. Results show a correlation exists between those teachers who report higher amounts of participation and the assigning of group work, but the correlation is not significant. Interviews indicated that group work is usually reported to be optional, with few students actually choosing to complete group assignments. Teachers are using varying amounts of instructional techniques which can promote critical thinking; however, many teachers reported barriers to such instruction, mostly related to the effects of the pandemic and its related policies on students.

Key Terms: Collaboration, Critical Thinking, Asynchronous, Online/Virtual Instruction

Introduction

Background. Starting in early March and extending to the rest of the school year, the COVID-19 pandemic forced North Carolina public schools to transition to online instruction. In this paper, we explore the methods and activities teachers have used to foster collaboration and critical thinking amongst their students during the COVID-19 quarantine. As the COVID-19 pandemic forced schools to close, teaching moved to a remote environment that was significantly different from the classroom. Face-to-face contact was possible only through online communications platforms. Teachers might be able to speak to the entire class at once, but could not monitor student engagement and understanding in the same way as they did in the classroom. Whole class discussion required different rules and procedures. Small group analysis and evaluation activities were difficult, if not impossible.

Rationale. As students in the Master of Arts in Teaching program at UNC-Chapel Hill, we have learned the effectiveness of an inquiry-based approach to promoting critical thinking and collaboration with our students. There is strong evidence to show that inquiry-based, collaborative approaches to learning support knowledge growth by individuals and groups. Students engaged in inquiry-based learning develop content knowledge and learn increasingly important 21st Century skills such as teamwork, problem-solving, and knowledge application (Baron & Darling-Hammond 2007). The teaching methods that we have learned have been geared towards combining collaboration and critical thinking in a classroom environment, and we have had the opportunity to practice these skills in the classroom. In a remote environment, it is not clear if and how teachers promote critical thinking and collaboration.

As we anticipate employment as secondary teachers in the Fall and the likelihood that at least part of our instruction will take place online, we wanted to investigate how we can continue to promote these skills without face-to-face interaction between students in a classroom. This is tied in numerous ways to the school improvement plans (SIPs) of our student teaching contexts. For instance, one of the improvement goals at Chapel Hill High School is to "Encourage and enroll more minority students in Honors and Advanced Placement courses". In order to do so, students in all levels of classes will need practice with the kind of critical thinking required in advanced courses. Furthermore, collaboration leverages the cultural assets of many minority students, enabling them to effectively demonstrate learning. In addition, the Brogden Middle School SIP envisions that students will receive "high quality, rigorous instruction that uses inquiry-based, collaborative instructional strategies to challenge and engage students in content, resulting in increasingly complex levels of understanding."

To answer our research question, we reviewed the literature about online instruction to identify best practices for promoting critical thinking and collaboration. We identified several promising practices and surveyed secondary teachers in the Research Triangle area to determine how they were using these and other practices in their online classrooms. We gathered more detailed data from a subset of the survey respondents who agreed to be interviewed about their teaching practices during the school closure.

Definitions. For the purpose of our investigation, we defined critical thinking as analyzing and applying knowledge, evaluating the validity of information and arguments, synthesizing information, reflecting on one's own thinking and learning (metacognition), and creating products or solutions. We defined collaboration as two or more students working

together to achieve a common goal through collective planning, constructive criticism, support, and integration.

Literature Review

This literature review is intended to sample the research about online teaching practices that provide opportunities for collaboration and critical thinking for secondary students, which is the teaching context of the authors. We searched peer-reviewed journals and databases for articles addressing how secondary teachers implement collaboration and critical thinking via online learning. Due to the ever-evolving nature of educational technology, recency was prioritized and all articles are no more than 10 years old. The studies involved classroom contexts from elementary to post-secondary. Some of the studies included in the literature review address both critical thinking and collaboration online; most address one or the other. Some address either general online learning practices or the use of digital tools in a classroom or blended environment to promote critical thinking. None directly addresses online teaching in the context of a global pandemic. Possibilities are presented in the studies for providing opportunities for collaboration and critical thinking online, but challenges such as cost, asynchronicity, and social-emotional development of secondary students are not consistently considered.

Collaboration. Hawkins et al (2012) raised the concern that teachers' perceived disconnectedness in online learning may inhibit collaboration. Moore (2018) found that some communication tools may be effective at facilitating effective collaboration online among teachers, but effective student to student collaboration is not addressed. deNoyelles et al (2014) and Schindler and Burkholder (2014) review the research on Asynchronous Online Discussion (AOD), finding that AOD could support effective discussion involving critical thinking if instructors provide appropriate prompts, structure, and guidance to the discussion. Krishnan (2018) showed that the use of a specific online collaborative tool to engage students in a collaborative critical thinking activity by synchronously writing an argumentative essay together was more effective than individual writing assignments. Tucker (2015) suggested that social media may enhance the collaboration of "virtual communities of practice" by establishing "swift trust" between participants (46-47). Blas and Paolini (2014) showed that multi-user virtual environment (MUVE) games improved collaboration skills and content knowledge for students.

Critical Thinking. Kumar (2019) finds that award-winning postsecondary online educators used student-reflection activities (discussion posts, student-created presentations, podcasts, blogs) to deepen learning; required students to reflect on their summative assessments; and asked them to self-assess their interactions with peers. These activities can promote analysis, evaluation, and metacognition, but their effectiveness at doing so was not evaluated. The research conducted by Kong (2014) adapted techniques developed for use in a flipped classroom environment for use in a digital classroom. The techniques were found to be effective in promoting critical thinking. The classes used digital tools during in-person meetings, but the techniques may be transferable to a fully online context using online video platforms such as Zoom or Google Hangouts. Hwang et al (2011) found that concept maps can be used collaboratively through an educational application to support metacognition for elementary students. A potentially expensive educational technology was used, called a "Concept Map‐Oriented Mindtool for Collaborative U‐Learning." Yang et al (2012) demonstrated that

Digital Storytelling (DST) can improve critical thinking, as well as English achievement and learning motivation for in-person English as a Second Language (ESL) classrooms, but DST certainly has potential for use online. Steele et al (2019) found that virtual reality, augmented reality, and mixed reality applications can facilitate arts-based creative thinking, reflection, and evaluation, though teacher guidance was needed for facilitating reflection. Neither study about games or virtual environments factored in cost, which must be considered in instructional decision making.

Conclusion. None of the studies suggests that there is a magic wand that can be waved over the online learning environment to ensure that critical thinking and collaboration will occur. Still, practices and tools are available for teachers to adapt and integrate into the contexts of their own online classrooms. The studies reviewed here also have some limitations. Several address practices used with postsecondary students, whose capacity for mature social interactions, abstract thinking, and executive function is more developed than that of secondary students. More scaffolding and structure likely will be required to implement the identified practices and tools at the secondary level. The studies in this review also were conducted in settings where students and teachers chose to engage in online or digital learning activities. They may not be as applicable to a mass, largely-asynchronous, involuntary online learning context such as the one presented by the COVID-19 pandemic. Our research investigates how teachers are promoting critical thinking and collaboration during this pandemic.

Methods

To conduct our research, we utilized anonymous online surveys and virtual interviews. The online survey was administered using the application SurveyMonkey. We chose this instrument because of its intuitive user interface and ability to efficiently visualize response statistics though graphs. The survey provided respondents with lists of content delivery methods and types of student activities from which they could indicate those in use in their remote teaching. For the activities list, respondents indicated whether the activity was to be completed by individuals or groups. Respondents also had an open-ended "other" option by which they could note unlisted methods and activities that they were using. The methods and activities listed were based on the activities that authors knew to be in place at the surveyed schools and those identified in the literature as being beneficial to critical thinking and collaboration. Some activities identified in the literature, such as collaborative online gaming and virtual reality, were not listed due to cost, but the "other" option provided teachers the opportunity to indicate their use. The survey also included open-ended questions that asked respondents to note the following:

- How they had changed their teaching during the transition from the classroom to the remote learning environment in order to provide students with opportunities to evaluate, analyze, reason, and create.
- The barriers they have encountered in making that transition.
- The tools and activities they had found to be most effective for engaging students in online learning.

The survey also included questions about the level of participation by students in online learning, student access to technology, school level, and personal demographics. Respondents

also were provided with the opportunity to provide their email if they were willing to be interviewed about their responses.

We sent surveys to secondary teachers in four school districts in the Research Triangle area and received responses from 36 teachers (11 middle school and 25 high school). Six of the teachers we surveyed indicated that they were willing to be interviewed. We decided to conduct interviews with willing teachers to provide further illumination of the data that we initially collected through surveying. Although interview questions were prepared beforehand, an unstructured format was followed during the interviews to allow for a more natural progression of each discussion. Thus, interviewers were able to digress into more interesting thought trees or regress if a question lacked the potential for depth and development. The data was then collected and analyzed accordingly.

Results

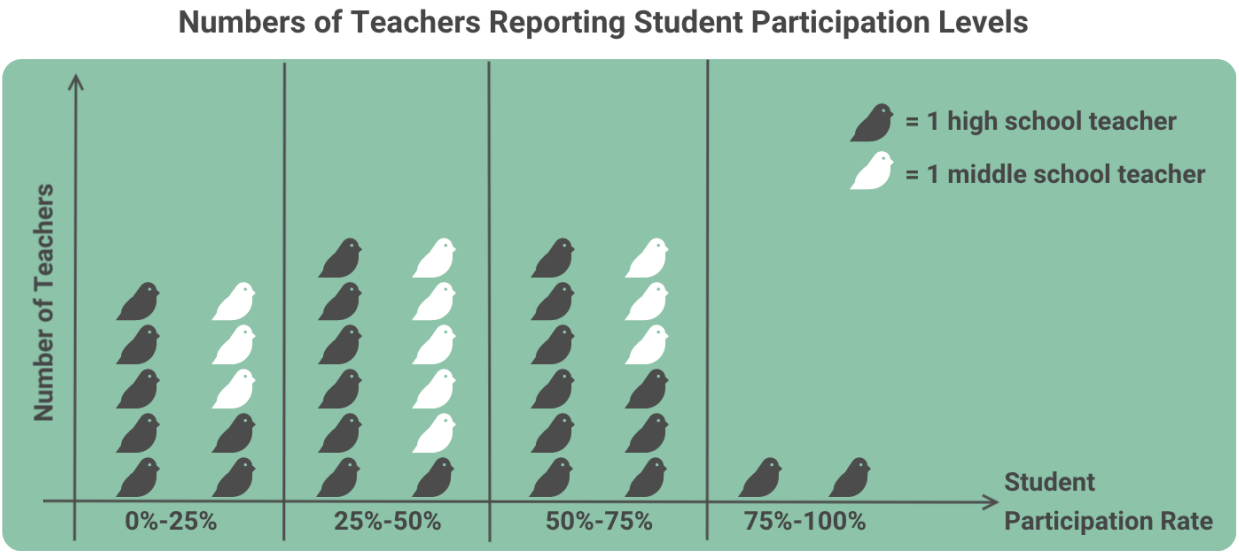

Figure 1. Student participation rates are disseminated into four separate tiers with each tier containing the number of teachers that reported their perceived student participation levels.

Out of the 36 teachers surveyed, ten teachers reported that 0-25% of their students were regularly participating and completing assignments, twelve teachers reported 25-50% participation rates, another 12 reported 50-75% participation rates, and only two teachers reported a participation rate above 75% of students. This data was relatively consistent between high school and middle school teachers although no middle school teachers reported a participation rate higher than 75%.

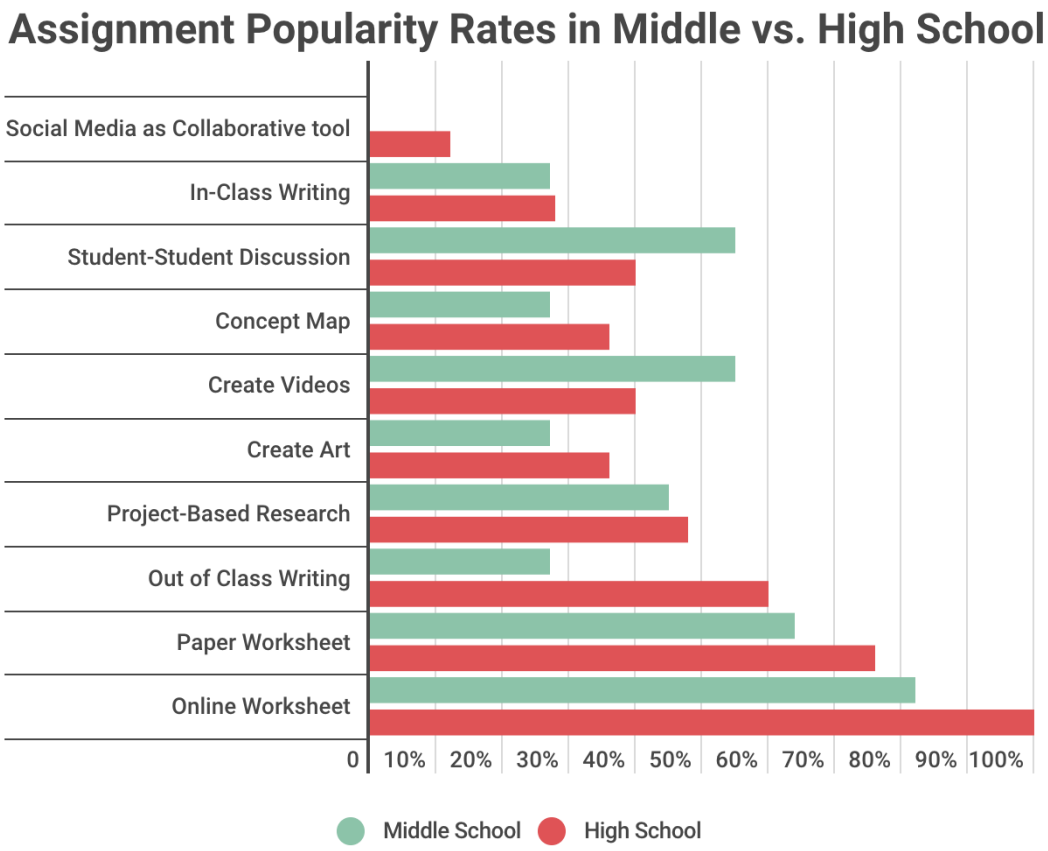

Figure 2. A grouped bar graph is shown above. Data was collected from 36 teachers in total (11 middle school, and 25 high school).

We asked teachers about what kind of instructional activities they had assigned since distance learning began. Figure 2 above shows the popularity of assignment types amongst both high school and middle school teachers. By far the most popular assignments were worksheets. The largest difference between high school and middle school assignments was found in analytical or creative writing assignments to be completed outside of class: 60% of high school teachers assigned this type of activity, compared to 27% of middle school teachers. High school teachers were more likely to assign eight out of ten of the specified activities; however, activities that involved student to student discussion and video creation were significantly more common in middle school classes. Although they were nowhere near as popular as worksheets, many of the activities that teachers reported assigning are ones that research indicates are impactful in developing critical thinking skills. Assignments that asked students to write creatively or analytically, conduct research to solve a problem, create art or a video, participate in discussion with other students, or use a concept map all came in between 31% and 50% usage amongst teachers surveyed.

In interviews, teachers also described other types of instructional techniques that facilitated opportunities for critical thinking. A social studies teacher reported using Padlet for an online discussion tool, but did not report successful discussions as a result. Though the same teacher was unhappy about assigning more multiple-choice problems, she nevertheless designed them to "require higher-order thinking to answer." A science teacher assigned a project in which

students had to apply their knowledge of ecosystems to create an "edible ecosystem" in their homes. She also had students create concept maps to metacognitively reflect on their learning and synthesize it into one graphic display. A high school history teacher framed each unit around "essential questions" and required students to synthesize readings to answer the essential questions.

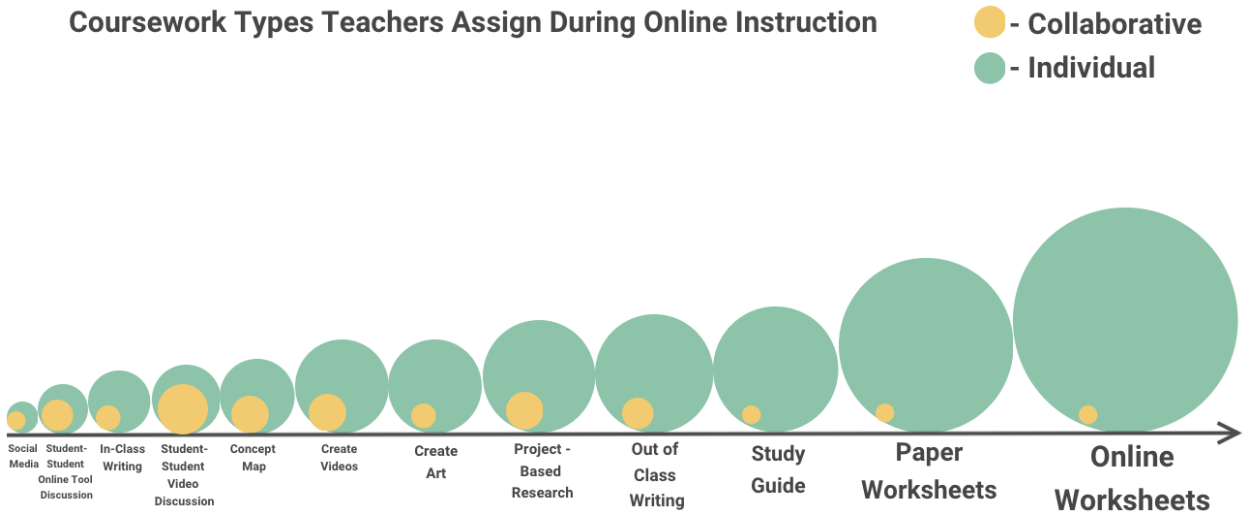

Figure 3. The diameter of each circle represents the popularity of each assignment type. The larger the diameter, the more popular the type of assignment. The yellow circle symbolizes if a given assignment was performed in groups. The designation of group or individual was made by the survey respondent, and some teachers called discussions individual work while others called it group work.

In addition to asking about what type of assignments teachers assigned during virtual learning, we asked teachers to report whether they assigned these activities as individual or group work. As shown in Figure 3, group work was far less common than individual work during virtual learning. Only 22% of teachers surveyed used group work in any form as part of their online instruction. Group work was more common amongst middle school classes (27%) than in high school classes (20%). The most popular forms of group work were student-to-student discussion (14%), concept maps (11%), and creating a video (11%).

Interviews illuminate the quantitative data presented here. All four teachers who mentioned class video discussions in their interviews reported that they were of limited value, but for different reasons. Of the four, the two middle school teachers reported that online video discussions themselves had been ineffective with their students. These teachers also reported that while asynchronous discussion and collaboration tools were available, they had not been used before the school closure and the teachers did not feel that their use could be taught remotely. The two interviewees who teach 11th and 12th graders reported that the video discussions were effective in promoting critical thinking, but only for the limited number of students who attended.

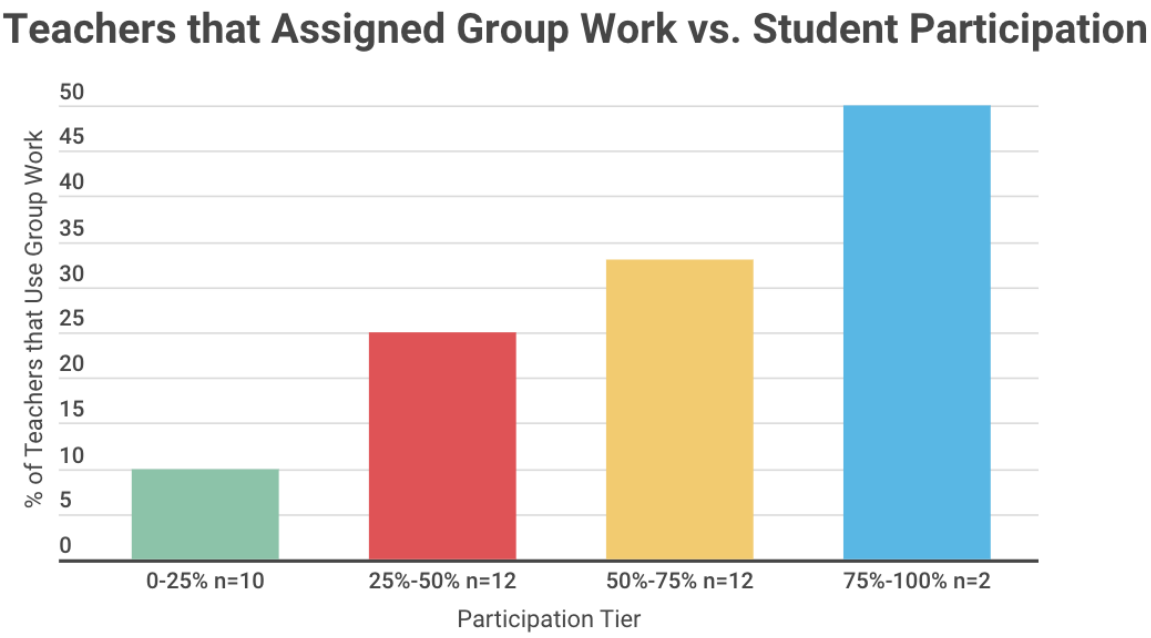

Figure 4. Participation tier describes the level at which students are regularly completing assigned online learning activities, as reported by the teacher. Variable *n* represents the total number of teachers within each participation tier.

Though we did not set out to analyze the relationship between participation and collaboration/critical thinking, some trends have become manifest. This does not directly answer our research question, but participation does tell us about some of the contexts in which collaboration or critical thinking assignments are occurring. Participation is also possibly a result or implication of such assignments. Figure 4 suggests that a relationship exists between reported higher amounts of participation and the use of group work. Of the 10 teachers who reported 0-25% participation, one teacher (10%) used group work; of the 12 who reported 25-50% participation, three (25%) used group work; of the 12 who reported 50-75% participation, four (33%) used group work; and of the two teachers who reported 75-100% participation, one (50%) reported using group work (Figure 4). However, interviews illuminated that when teachers reported assigning group work in the survey, students did not necessarily engage in the activity as group work. Three out of six teachers interviewed reported that they provided options for collaboration but that very few students, if any, actually chose to do the work with other students. (Two of the other three did not report assigning group work, and one reported assigning a partner project, but low levels of participation overall. It was unclear whether any students collaborated in this case). In any case, the number of teachers assigning group work is small. The correlation between group work and participation is .25 and the p-value is 0.14, indicating that there is not a statistically significant correlation between these two variables.

Another trend in the participation data was the frequency with which teachers met with their class. Of teachers who reported 0-25% participation, 30% reported meeting at least weekly. Amongst the other three groups of teachers, 65% reported meeting at least weekly. It is possible that less frequent meetings were a reaction to, and not the cause of, lower participation; however, despite our inability to prove causation, it is striking that the classes with the lowest participation

rate were also more than twice as likely to not be meeting regularly. It is also worth noting that middle school teachers were more likely to meet regularly with 72% meeting at least weekly compared to 52% meeting at least weekly amongst high school teachers. The more frequent meeting may be the result of school or district policies rather than teacher decisions.

Participation by Assignment in a Seventh Grade Social Studies Class												
Activity	Test, Webquest	Notes, Online worksheet	Online worksheet	"Build a city" project	Reflection	"Fun facts" worksheet	Online reading	Online reading	Online worksheet	Research Project	Online worksheet	Online worksheet
Participation	72.64%	73.58%	69.81%	61.32%	50.00%	71.70%	51.89%	60.38%	63.21%	70.75%	62.26%	55.66%

Figure 5. Participation in each online activity in a middle school social studies class. Participation began to decline after the third assignment. After that, two assignments had significantly higher than average participation, and two had significantly lower than average participation.

One teacher tracked participation data in his class by assignment and found that some kinds of activities were more likely than others to be completed by students (Figure 5). His activities with the lowest participation rates were a student reflection (with no due date) and an online reading assignment, at 50% and 52% participation, respectively. He ascribes the low participation in the reflection activity to the absence of a due date. The activities with the highest two participation rates (after week 2, when participation started dropping) were a "Fun Facts" assignment and a "People Who Made Change" research project. The project required students to synthesize information, evaluate the actions of a historical person, and write about them. The teacher explains that students prefer to do assignments that are varied and interesting to them. He says when students encounter assignments which are too easy, such as the online reading assignments, they react by not participating: "They see it and say 'that's a waste of my time.'" Perhaps this data may also be explained by the presence or absence of critical thinking skills in an assignment.

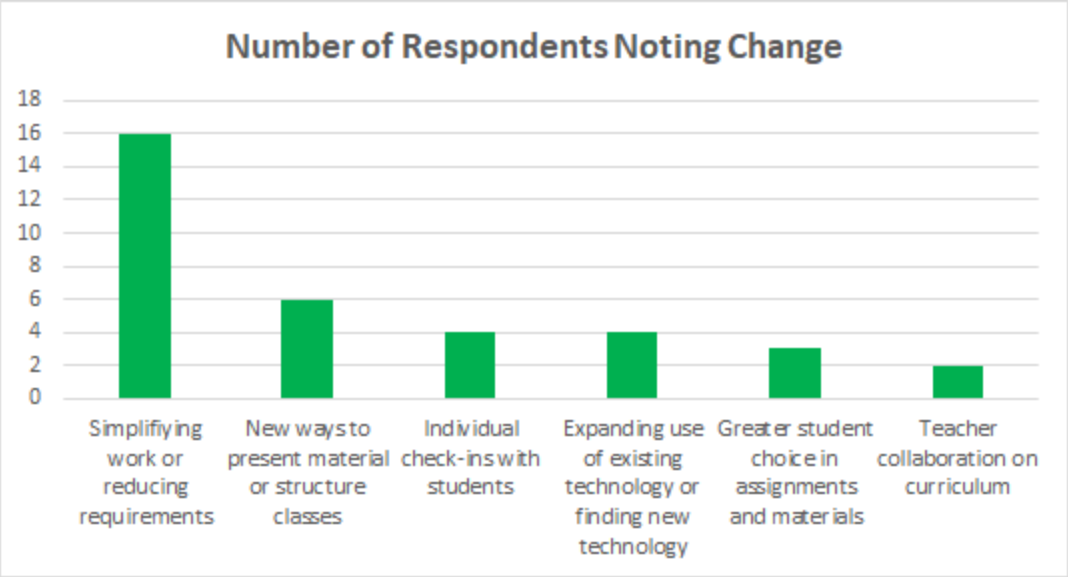

Figure 6. The number of teachers reporting changes to how they taught for critical thinking in each of six researcher-assigned categories.

In addition to the specific types of activities from which respondents could select (Figures 2 & 3) the survey provided respondents the opportunity to describe how they had changed their teaching in the remote learning environment to provide students with opportunities to evaluate, analyze, reason, and create. We sorted these responses into categories that we defined from the data. Based on the responses, teachers may have interpreted the question as applying more broadly to how their teaching had changed. Of the 30 teachers who responded to this question, 16 indicated that they had simplified the work or reduced their requirements or expectations. Some responses indicated that critical thinking aspects of the work were being reduced, while others were less clear as to what elements had been removed. Some noted that they had extended deadlines or were more flexible about them. Six respondents indicated that they had changed the way that they presented material (videos, new texts) or the structure of their classroom (flipped class). The structural changes in this category were those developed by the teacher, rather than those imposed by the school or district. Four teachers indicated that they had expanded the use of technology, such as Canvas and Actively Learn, or experimented with new technology, such as Edpuzzle and Flipgrid. Teachers also found ways to make one-on-one remote contact with students, increase the flexibility of the activities, and collaborate with colleagues to produce curriculum.

An interesting finding that we did not predict or ask about in our survey, but which came up in interviews, regards the relationship between pre- and post- COVID-19 instruction. Teachers did change much about their instruction, as described above, but in interviews, teachers reported that their instructional techniques and technologies during the COVID-19 online instruction were shaped in large part by what instructional techniques and technologies were used before the pandemic. Four of the teachers interviewed explained that they chose specific

technologies (i.e. Google Classroom, Newsela) specifically because students had used them in class before. “Teaching students how to use [new tools] remotely did not seem feasible,” reports one teacher. Instructional techniques, too, were influenced by pre-online instruction: teachers who reported assigning “little group work in class before COVID” also reported assigning little to none online. One teacher stressed that five different aspects of her online instruction were elements she had been implementing all year: using Google Classroom, providing options for demonstrating learning, reflecting on student learning with the students, assigning concept maps for metacognition, and modifying assignments for struggling individuals. For every aspect of online teaching we discussed, she explained how she had been using similar techniques all year. The exception to this finding is that one teacher advocated for changing online instructional techniques often to keep students engaged. These changes/continuities all illuminate the processes teachers used in designing online instruction.

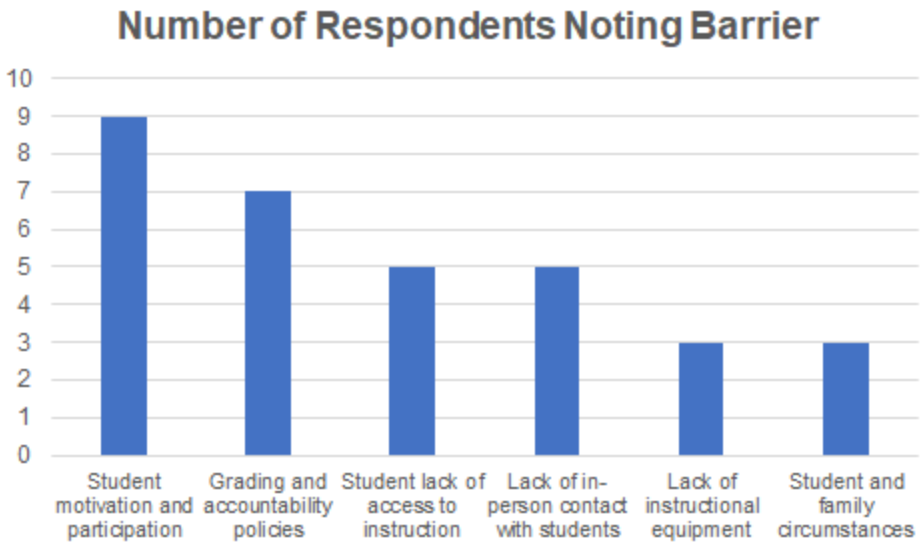

Figure 7. The number of teachers reporting barriers to teaching online for critical thinking in each of six researcher-assigned categories

Teachers were asked in an open-ended survey question what barriers they had encountered to providing students with opportunities to evaluate, analyze, reason, and create. Fourteen of the 36 respondents noted barriers that they had encountered. Our review of the teacher responses placed the barriers into six categories. The teachers who noted student motivation and participation as a barrier focused on low attendance at video class meetings, assignments not being completed, and perceived student apathy or laziness. Five teachers who noted this barrier blamed it at least in part on district accountability policies that prevented the grading of assignments. Another respondent saw grading practices as a barrier to providing opportunities for critical thinking opportunities, but saw the problem as being rooted in pre-COVID grading policies:

> We have taught these kids for years to focus on grades and not learning. That's not right, but it's how they've been trained--jump through the hoop for the grade. You're

not going to suddenly have kids engaging in learning for its own sake or for the pursuit of mastery. This makes it hard to motivate students.

Students lacked access to instruction because of both internet access limitations and the unavailability of materials (e.g.: lab equipment). Teachers noted that the inability to interact with students as they work or engage in whole-class discussion prevented them from using their normal methods to promote critical thinking. Only one teacher noted the English proficiency of students as a barrier.

Discussion

Teachers navigated an asynchronous learning space by assigning the following activities: worksheets, study guides, out of class writing, project-based research, art projects, creating videos, concept mapping, student-student video discussion, in-class writing, student-student online tool discussion, social media tasks, individual projects, and personalized online math practice tools. We have found some of these activities to be more conducive to developing collaboration and critical thinking skills than others. The literature review suggests that project-based research, art projects, creating videos, concept mapping, student-to-student discussion, writing, and social media tasks are more likely to promote critical thinking. Tasks involving group work are a necessary part of collaboration. As shown in Figure 4, participation rates increased with the amount of group work that was assigned, although this relationship was not statistically significant. It's also interesting to note that teachers reported using similar instructional techniques and technologies after the transition to online learning as they did before the transition.

Critical Thinking. We defined critical thinking tasks as tasks that provide opportunities to analyze and apply knowledge, evaluate the validity of information and arguments, reflect metacognitively on one's own learning, create artwork, and solve problems. The degree to which a task develops critical thinking is directly proportional to the properties addressed in working through the task. Assigning worksheets is the most popular task amongst teachers (Figure 2). Teachers we interviewed indicated that these worksheets lacked many of the qualifications for critical thinking.

Worksheets generally focused on applying content knowledge, but neglected the other criteria. As the second most popular assignment, writing tasks show high potential for critical thinking depending on the prompt. Writing tasks can provide opportunities for analysis, evaluation, synthesis, and creativity. In analyzing our surveys and interview responses, we don't know to what extent teachers used writing tasks to promote these aspects of critical thinking.

Project-based research is a commonly used assignment amongst both middle and high school classes with nearly half of secondary teachers using it as an instructional method (Figure 2). Within the field of education, project-based tasks are well known to be an effective tool for developing competent learners and critical thinkers (e.g. Baron & Darling-Hammond, 2007). Typically, this is because of the rigorous process of questioning, hypothesizing, collaborating, and revising that projects require; thus, it is a highly effective tool for critical thinking under normal circumstances. However, within the context of asynchronous learning, it becomes increasingly more difficult to uphold the rigor of this process. Our literature review indicated that

the rigor can be upheld with structure and feedback, but our interviews did not indicate that these were consistently in place (Schindler & Brukholder 2014, deNoyelles et. al. 2014) .

Approximately one-third of teachers assigned art projects in their digital classroom. Naturally, this task addresses the critical thinking criteria of creating artwork to express content knowledge. This task type has also been shown to apply knowledge of content in a creative way, and because of this is a strong tool for critical thinking. However, as noted, teachers who use this assignment type are in the minority.

Assigning student-to-student discussions are popular amongst teachers with about half of the teachers using them for instruction. This task can provide opportunities for problem-solving and evaluating the validity of the arguments of their peers. It is important to note that the asynchronous nature of much online instruction makes it difficult to evaluate the effectiveness of these discussions. Interestingly, middle school teachers use this instruction task more so than high school teachers (Figure 2). (The only other assignment type for which this is the case is the task of creating videos). Middle school teachers, also, however, tended to report the failure of their online discussions to facilitate critical thinking, due to problems such as student participation, student maturity level, and limitations to technological interactions.

Videos are similar to artwork in that they both require creative expressions of knowledge. Applying knowledge in a unique and creative way pushes students to investigate new perspectives in order to better understand the content. This task shows a strong potential for critical thinking if done with this as a focus; however, we did not see significant evidence of this task being used accordingly among the teachers.

Concept maps were assigned by 27 percent of middle school teachers and 60 of the high school teachers. Defining terms pushes students to apply knowledge, and finding relationships amongst terms pushes students to analyze and evaluate the validity of their conceptual understanding; all of which is addressed through the creative process of generating a map. Hwang et al (2011) found that concept maps are useful for helping students metacognitively connect the various aspects of their content knowledge. Thus, the subset of teachers that utilize this assignment within their classroom is doing well to develop their students' critical thinking skills.

Lastly, the least popular assignment type is the use of social media. Only used in a handful of high school classes, social media as a tool for collaborative discussion lacks most of the criteria for developing critical thinking abilities. Students are able to share their knowledge, and analyze arguments of others; however, they are limited to typed-out discussion, images, or character count limits depending on the social media platform. This makes it difficult for critical thinking criteria to be addressed. It may aid in the development of virtual communities of collaboration (Tucker, 2015), but we did collect any qualitative data about its implementation in secondary classrooms.

We did not set out to investigate the relationship between critical thinking assignments and participation, and the data did not suggest such a relationship. However, one teacher found that a research project which requires students to evaluate, write, and synthesize produced significantly higher participation rates in his class than a textbook assignment, which presumably did not emphasize opportunities for critical thinking.

Collaboration. The main techniques used for collaboration were student-to-student discussion by video and by "online tool such as a Google Doc". Middle school teachers reported higher use of video discussions, but those who we interviewed noted frustration with the

effectiveness of online video discussions for promoting critical thinking. High school teachers that teach upperclassmen reported online discussions which successfully promoted critical thinking, but only for the low number of students who attended. These anecdotal findings come from a limited sample size of two middle school teachers and two high school teachers, so the results cannot be generalized. Still, it is worth considering whether the age of the high school students is more conducive to successful online video discussions.

For every activity on our survey, at least one or two teachers indicated that they had assigned it as group work. However, interviews illuminated that teachers who provided options for collaboration often had very few students, if any, actually chose to do the work with other students. Thus, reported assigning of group work doesn't indicate actual engagement in group work.

As was the case with critical thinking, we did not set out to investigate whether a relationship exists between participation and activities which promote collaboration. We did, however, notice that teachers who reported higher amounts of participation also reported more use of group work. As discussed above, many teachers who reported assigning something as group work did not actually have any students do the assignment as a group. Furthermore, the sample size is too small to draw any statistically significant conclusions about the relationship between collaboration and participation or the direction of causality.

It is not surprising that online collaboration was difficult at the middle and high school levels, and perhaps more difficult at the middle school than high school level. Effective collaboration online has been found to be possible at the post-secondary level (deNoyelles et al, 2014; Moore, 2018; Schindler & Burkholder, 2014; and Tucker, 2015), but as we predicted, it is potentially more difficult at younger ages. The reasons for this finding may be the social-emotional development of students in middle and high school, as well as the pandemic context in which we conducted our research.

Continuity with pre-online teaching. One significant finding is that, for better or for worse, teachers reported using similar technologies and techniques before and after coronavirus. The answer to how a particular teacher is "providing opportunities for collaboration and critical thinking in online learning during the COVID-19 crisis" may depend largely on how they were providing such opportunities before. This conclusion depends on data from only four interviews, so more research is needed to determine the strength of the correlation.

Limitations. This research project was constrained to a short time frame of two weeks. This placed many limitations on our project overall, but our findings must be considered preliminary until more robust data collection methods can be used to reaffirm them. As noted earlier, we were only able to collect data from 36 different teachers; six of whom were available to interview. This is a small subset of teachers; thus, the opportunities for finding statistical significance are limited. Focusing on secondary teachers, we shared our survey with both middle and high school instructors; our responses were unbalanced in this regard as we received 11 responses from middle school teachers and 25 responses from high school teachers. To acknowledge this imbalance, we focused on the ratios within each level of instruction; however, it leaves our data skewed. Lastly, because of our inability to directly observe classroom environments or communicate with students due to the COVID-19 quarantine, we had to rely heavily on the teachers' perceptions of their own instruction. This imposed a heavy amount of subjectivity on our data.

Our research also is affected by our own experiences, perceptions, and biases. Our research question is based on our own belief that teaching should promote critical thinking, and that collaboration is an essential tool for doing so. While supported by research, this belief may have led us to overlook studies and survey questions not congruent with this belief. Similarly, our interviews may not have delved into areas that would have revealed the effectiveness of other approaches. Though we tried to define critical thinking and collaboration precisely, objectively, and broadly, these definitions inevitably carry subjectivity with them; teachers and students may conceptualize critical thinking in other ways. The types of activities that we think of when reading the descriptions in our survey may be different from those thought of by our survey respondents who have greater and more varied teaching experiences than we do. The survey itself was developed by an author with years of survey-writing experience, not in the field of education. All the authors are white men from middle-class backgrounds, and we may have missed implications that the survey and interview questions would have to people who identify with different genders, racial and ethnic backgrounds, and socio-economic statuses. Most of our respondents identified themselves as white, but half of the respondents who provided their gender indicated that they identified as female. There was not time to field-test the survey with teachers, so we did not have the opportunity to evaluate the clarity, reliability, or validity of our questions.

Implications for Practice. Our research sought to identify how teachers were providing opportunities for collaboration and critical thinking during their COVID-induced online teaching. Our research identified several promising practices for doing so but also found that most of these were not used by a majority of teachers. Teachers perceived that there were barriers to engaging students in online critical thinking and collaboration, including student participation. Several of our respondents indicated that they struggled to replicate the teaching techniques of their classrooms in an online environment. Our survey did not ask teachers to compare their pre and post COVID teaching practices, and we only were able to gain this information from a small number of interviews. As a result, we could not evaluate whether the level of critical thinking and collaboration activities taking place in an online environment had changed from the level prior to school closure. This would be an area for further study.

As we consider how this research can inform our own practice, we should not take a deficit approach to these findings. Given that many of the promising practices were developed for voluntary post-secondary online teaching contexts, rather than during the instantaneous switch to online learning brought about by COVID-19, it is encouraging that some teachers have included these activities in their online teaching. As new teachers, we will have the benefit of planning and reflection time as we develop our teaching methods for an environment that likely will include some online teaching. We will need to consider why we used certain methods in our student teaching before we consider whether and how to replicate those methods for remote instruction.

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