

## USING MENDELEY TO SUPPORT COLLABORATIVE LEARNING IN THE CLASSROOM

By

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### ABSTRACT

*The purpose of this study was to explore the use of Mendeley, a free online reference management and academic networking software, as a collaborative tool in the college classroom. Students in two iterations of a Graduate class used Mendeley to collaborate on a policy research project over the course of a semester. The project involved collaborative critique of an article, finding and annotating additional relevant literature, synthesizing all group articles, and creating individual policy briefs. The authors investigated how students used the software, tracking individual contributions and reviewing final student projects. The authors used survey data to gauge student experience with Mendeley. The authors discovered that in addition to facilitating collaboration, Mendeley was useful for organizing the material for the group project. The survey also revealed that there is a learning curve with Mendeley, which may prevent students from taking full advantage of Mendeley as a collaboration and reference tool. This study suggests that Mendeley can be used as a platform to facilitate learning through classroom collaboration.*

*Keywords: Mendeley, Collaborative Learning, Group Work, Educational Technology, Pedagogy.*

### INTRODUCTION

The current focus on the development of 21st Century Skills (Partnership for 21st Century Skills, 2014; Trilling & Fadel, 2009) among college graduates drives conversations about teaching and learning on campus. To this end, employers are demanding that graduates be versed in team work and in working collaboratively with others to achieve a joint goal (Adams, 2013). Working collaboratively can take many forms in college teaching, yet all too often students complain that these activities do not support their learning as it is easy for some students not to contribute as much as others and for some to take on more than their share. Still, college faculty pursue opportunities to infuse group work in their courses as they know the long term value of being a good team player for learning and for employment. This paper argues that well-planned collaborations for class assignments can provide a rich learning environment and positively contribute to student learning.

Collaborative writing is one means of fostering a collaborative skill base with students. Faculty members

have long recognized the value of writing with others in their own research (Creamer, 2004; Eddy & Garza Mitchell, 2012), but know that developing robust collaborative writing partnerships evolves over time. The typical semester or quarter provides scant time to get students comfortable with working together, thus it is critical to design well thought out and deliberate assignments to promote collaborative learning for students (Barkley, Major, & Cross, 2014; Beldarrain, 2006). The purpose of this study was to understand better how using a graduate student group writing assignment supports collaborative learning. The authors define group writing broadly as writing experiences that involve multiple partners working and writing together to produce a single text or product. Deep learning builds on students' past experiences, and a solid knowledge base provides the opportunity to adapt acquired expertise to new learning contexts (Budwig, 2013). The chance to work with peers provides students with a context for practicing newly gained skills, and enables them to learn from each other's varied experiences and knowledge about content areas (Nilson 2010). The increased evidence on the benefits

of collaborative learning requires new teaching strategies to incorporate this type of format in the classroom (Barkley et al., 2014). Fink (2013) argued that “although faculty members want their students to achieve higher kinds of learning, they continue to use teaching practices that are not effective at promoting such learning” (p. 3). Faculty members can employ a range of teaching strategies to create significant learning experiences (Fink, 2013); and collaborative, small group activities that promote active learning can provide the platform for this type of learning to occur for students.

## 1. Purpose

The purpose of this study was to explore the use of Mendeley, an online reference management tool for organizing, locating, and working together on research papers, as a collaborative learning resource in college classrooms. Mendeley can also provide researchers a platform to keep abreast of research trends and connect to other academics in their area of inquiry. It can, therefore, be a platform for Researchers, Scholars, and Students who wish to collaborate with their peers not only in the classroom but across the globe.

Mendeley provides a virtual meeting space for group work. It allows users to work individually or collaboratively on PDF (Portable Document Format) management and annotation, and citation organization for journal articles, book chapters, and student created papers. However, the most useful feature of Mendeley for the purposes of this study is the online synchronization tool, which makes the content and updates accessible at any time and from any place to all collaborators. This ease of collaboration makes Mendeley a powerful platform for researchers as well as students (Zaugg, West, Tateishi, & Randall, 2011). This study explains how the authors used this online reference management tool as a platform to allow for collaborative learning among students. The information presented in this study reflects how faculty members used Mendeley as part of classroom learning and course assignments and how this has made collaborating on projects effective and efficient. Additionally, the authors share examples of instructional uses of Mendeley to support collaborative knowledge construction.

## 2. Background Literature

Working collaboratively provides not only valuable interpersonal and team building skills that build networks, it can also deepen the learning experiences for students (Nilson, 2010). Further, research on collaborative learning highlights how these group environments may create an ideal model for constructing, reorganizing, and acquiring new information (Janssen, Kirschner, Erkens, Kirschner, & Paas, 2010). Currently, the general term used for collaborative learning is group work or group learning. According to Nilson (2010), the research on the effects of group learning has focused on three fundamental dimensions-achievement/productivity (learning), positive interpersonal relationships, and psychological health-and group work yields positive results on all of them (p. 156). With increased focus on student learning outcomes in recent years (Tremblay, Lalancette, & Roseveare, 2012), it is imperative to understand better how group work influences student learning.

Although there are still benefits to individual work and other types of teaching strategies that should complement course level group work, research in the classroom supports the benefits of group learning in different course levels and for different student experience levels (Nilson, 2010). The shift to group work means that students must assume more responsibility as a result of group expectations and responsibilities, and that faculty must structure the experience to obtain the best results. The push for increased interdisciplinary work in college (Lattuca, Voight, & Fath, 2004) adds support for the benefits of collaboration. Likewise, as noted above, employers seek new hires who are able to participate in teams and contribute to the group projects (Belbin, 2010).

Mendeley is a free online reference management tool that not only helps organize references, but also provides a platform for sharing and collaborating using full-text documents and artifacts (<http://www.mendeley.com/>). This resource enables students and academics to follow research trends, and connect with researchers in the discipline. The system utilizes both a desktop version to organize references and an online platform that allows for sharing of references and resources among participants.

Mendeley can serve as a tool and teaching strategy for collaborative learning in college classrooms. One of the major strengths of Mendeley as a collaborative tool is that it is simple enough for digital immigrants to use and technologically sharp enough to interest native users of social media, thus allowing researchers and students with varying technological skills to collaborate on research and class projects (Zaugg et al., 2011).

The name Mendeley is derived from the names of two scientists: biologist Gregor Mendel, famous for his work on cross-pollination in plants, and the chemist Dmitri Mendeleev who devised the first periodic table of elements and predicted the discovery of unknown elements from known elements (Hicks, 2011). According to Hicks (2011), Mendeley claims to similarly enable evolution and cross pollination of new ideas, and to help discover new elements of available research based on the articles present in a library.

Mendeley is one of a number of PDF management and citation tools available on the internet, but what sets it apart from the rest is that it goes beyond a simple citation tool and provides a social networking and collaboration platform for researchers (Barskey 2010, Bullinger, Renken, & Hallerstedde, 2010; Giglia, 2011). According to Zaugg and associates (2011), "incorporating this social networking approach to academic research also allows for peer review and feedback much earlier in the research process. It helps establish researcher expertise in more rapid, dynamic ways before an article is submitted to a potential journal.... Mendeley takes the genre of research citation management software to a new, and potentially powerful level, and offers a glimpse of how academic scholarship may adapt to the affordances of an evolving Internet" (p.36).

Thus, the software is particularly useful in graduate programs that intend to socialize students into the profession because faculty can model the research process using Mendeley in a range of class assignments.

Using reference management tools with social networking capability, like Mendeley, allows students to both share their own contributions to a group project and to work together on a project; this type of group work in the classroom, and

beyond, has great potential for enhancing collaborative learning. Indeed, society is increasingly linked and connected in multiple ways, and social network theory (Scott, 2012) underscores the importance of individual connections and the hubs these connections create.

Mendeley provides one platform for supporting collaboration in the college classroom because multiple students can access, critique, and share comments on a document. Additionally, the social nature of the online exchanges provides a means for scaffolding socially constructed knowledge (Barton & Cummings, 2008). Students construct their own learning with help from their peers and serve to facilitate the learning of others. Throughout, students are guided in building their knowledge base by faculty during this process of collaborative learning.

### 3. Project Background

The setting for the project reported in this study was a small, public research University in the United States. The instructor decided to experiment with the use of Mendeley for a class project because it emphasized the use of collaboration, and provided the ability to share broadly the techniques involved in critiquing research articles. The group assignment occurred in two iterations (fall 2012 and fall 2013) of a graduate level course on educational policy, using the same assignment over the two iterations of the course. The authors used feedback from year one to tweak the assignment and to provide additional scaffolding on the use of the software as a tool.

In 2012, the class size was 26, and in 2013, there were 19 students in the class. Both classes consisted of Master's and Doctoral students, and included students specializing in Higher Education, K-12 Administration, Educational Technology, and Gifted Education. Technology center staff members were invited at the beginning of the semester to conduct Mendeley training sessions for the students to create higher comfort levels with using the reference management platform. The training session was shorter in year one, but was lengthened for year two based on student feedback from year one.

#### 3.1 Students

Students were grouped by the instructor in groups of four or

five in 2012, and groups of two or three in 2013. The change in group size was based on feedback from students in year one. The students had a choice among several topics and self-selected into these areas. For example, one group focused on financial aid, another on policy regarding gifted education, and yet another on technology in education. The instructor participated in each group on Mendeley to oversee and evaluate student contributions. Mendeley provides a notes section in which comments may be made by the instructor on each project.

### 3.2 Assignments

The final project for the course built on four sequential parts. The first portion required student groups to collectively critique a common research article. Second, each student found and annotated additional relevant literature to their group topic, which they then shared with their team. Next, the team synthesized all of the articles they collected on their topic. Finally, each student created an individual policy brief that focused on a particular aspect of their group's topic.

The first step in the assignment involved students accessing a Journal article on Mendeley that was assigned by the instructor. Mendeley facilitates collaborative critique of research articles as it allows group members to highlight, annotate, and comment on the PDFs. Each group member's highlights appear in different colors on the article and the annotations appear under the user names of the participants in the notes section. In this way, group members could see each other's critiques as well as comment on each other's annotations.

As noted above, the second step involved individual group members finding and annotating a research article relevant to the topic for their group. Each group member, then, commented on the annotations by the other group members. This process enabled students to pool their critique of all the articles collected by the group members. Other group members were able to see each group member's additions on Mendeley.

The third step required students to work together to create a meta-analysis of all the articles annotated and critiqued by team members. The themes across all articles in the group

were tied together to come up with a cogent argument regarding policy in the area of the group's selected topic (e.g., financial aid). The synthesizing of the key points and findings in the articles in the meta-analysis helped students see how arguments were built within the articles. The critique provided by group members helped model this process, and contributed to the knowledge construction by the students.

### 4. Methodology

In addition to the evaluation of students' postings on Mendeley for the two-year period, the authors used survey data to gauge the experience of the students with Mendeley. At the end of each of the two semesters, the students were provided with the survey to determine the effectiveness of using Mendeley for the project, and to get feedback for the future use of Mendeley for this and other courses.

The survey had eight questions based on a Likert scale that queried the students about whether it was easy to learn and to use Mendeley, to what extent Mendeley facilitated collaboration and organizing of information for the class project, how Mendeley helped in organizing information for their own research, whether Mendeley enhanced their learning, and finally, if they used Mendeley to create references lists in Microsoft Word or to organize other class readings. Additionally, the survey contained four short answer questions: 1) What did you enjoy the most about using Mendeley?; 2) What problems, if any, did you encounter in using Mendeley?; 3) What can be improved about the use of Mendeley for this class project?; and 4) Would you use Mendeley for collaboration and/or organizing documents in the future? Why or why not?

Given the small sample size for each class offering, basic descriptive statistics were used, but no tests for significance in change over time were conducted. The small sample size in this study precludes generalizability of the findings, but the findings provide a basis for others to use and build upon both for their research and for their teaching. The following section presents the findings from year one and year two of the class assignment.

### 5. Findings

The survey data from the two iterations of the class

assignment using Mendeley showed improvement in student satisfaction. Lessons learned from year one provided feedback that directly influenced the use of Mendeley in year two. The authors have organized these findings by year to show the progression of their understanding of the effectiveness of using Mendeley as a tool to support collaborative learning. A summary of the Likert scale survey questions illustrates the changes in student perception over the two years.

## 5.1 Year One

Survey results from year one indicated that although students found Mendeley useful for collaboration and organization for the project, they struggled to learn the software and reported that they did not feel that Mendeley greatly enhanced their learning of the material. One student reported, *"At times, I was confused between the online vs. desktop versions and syncing."* Another student suggested, *"A bit more tutorial for those who are less-than-technically savvy,"* and still another recommended, *"Ongoing training throughout the semester."* Yet, despite these espoused frustrations by students, their learning products evidenced more collaboration within groups, and the software provided the faculty member an easy tool for evaluating the contributions of each group member.

Some problems students experienced were due to group size. In year one, a few students reported having problems viewing group members' annotations. "I uploaded my articles and added notes, but my group could not see them. It was very frustrating," commented one student in a group of five. Students working in smaller groups and pairs for other projects rarely encountered such problems. Moreover, students in larger groups found it challenging to add more to the critique as many who joined the discussion late found the entire document highlighted and annotated, and could not think of what to add to contribute to the further critique of the article. The technical problems continued for some students and they had to find other ways such as emailing annotated PDFs, to share their annotations. Students who requested help from Mendeley support staff reported prompt assistance that helped them resolve problems.

Several technical lessons were learned from the first iteration of the assignment. The instructor made specific changes for year two, which included:

- Smaller Groups
- Three per group
- Multiple groups per topic

Online Mendeley training module for viewing ahead of the first class

- Continue in-class training
- Provide follow-up training
- Resources
- Use year one students to mentor year two students
- Build bridges with instructors in other classes to use Mendeley
- Clearer links to learning goals

Even though the final products for the group work and the process of joint critiquing provided evidence of positive outcomes to collaborative learning, the students' frustration with some of the mechanics of the software appeared to overshadow their views of how effective the technology was to their learning. A key finding from year one was that the addition of a technical tool to support collaborative learning can result in enhanced student outcomes, but when the technology itself becomes the center of the students' attention versus what they can do with the technology to support their learning, something must change.

## 5.2 Year Two

Year two started with a longer training session on the first night of class for the students that involved both technology center staff and students from year one serving as mentors. Group sizes for the project were also reduced from four or five to students working in pairs or groups of three. Individualized and group follow up training were provided for those needing additional help. The smaller groups enabled the selection of a larger range of articles for use in the collaborative annotation of the first common article. Because of the viewing options in Mendeley and the fact that the instructor was a member of each group, in year one if more than one group selected the same article; all

student commentary was on a single document versus on distinct group documents. From an assessment perspective, this made tracking of group and individual contributions complex for faculty evaluation. Instead, in year two, the selection of a unique article by each group to review jointly eliminated this complexity and provided for more group self-direction on selecting an article that aligned best with the topic area selected by the group.

The researchers administered the same survey from year one to year two students at the end of the semester. As noted in the methodology section above, the sample size precludes any test for significance, but the anecdotal evidence in the movement of the means between year one and year two illustrates the change in student opinions. Figure 1 highlights the comparison of the survey data and indicates that year two students found Mendeley easier to learn and use than year one students. Students rated Mendeley's effectiveness in enhancing collaboration, organization, and learning higher in year two. However, the downward trend continued for students using Mendeley as a reference management tool, and as an organizational tool for their other classes. As the intention of the use of Mendeley as a learning tool was not to convert students to this online reference platform, rather to use the software to promote collaborative learning, we had less concern over the extension of the use of the software beyond the class. That said, institutional attention to the longer range effectiveness of Mendeley as a mechanism to support

collaborative learning in other courses and in their graduate program should be considered. Nevertheless, the improvement in ease of learning, enhanced collaboration, organization, and learning are indications of the success of using Mendeley for the project.

Some technical problems persisted for a few students in year two. One student, for instance, reported, "I couldn't see my group members' comments initially," and another reported, "Occasional sync issues, nothing major" as one of the problems. Students also generally expressed satisfaction with the way Mendeley was used for the project. "I thought it was great!" commented one student, and "I do not think that any improvements is needed," commented another. Some students felt they needed more support. The difference between the web and desktop versions continued to baffle some students in year two as illustrated by one student's comment, "Still don't understand difference between web and regular Mendeley." Another student still felt the need for more training and commented, "I would like to discuss how to sync and upload documents during in-class training." Yet, as in year one, the students' ongoing contributions to the group assignment and their final products provided evidence that student learning was enhanced due to the collaborative learning occurring as a result of using Mendeley.

## 6. Discussion

The authors' experience with using Mendeley as a platform to promote collaboration in the classroom showed mixed results. On the one hand, evaluation of the course projects and collaborative student participation in both years provided evidence that the group work resulted in enhanced understanding of the subject matter. On the other hand, student frustrations with the software and the indication that students did not envision using this tool beyond the class created barriers to learning. The authors were able to take feedback from year one students to facilitate an enhanced learning experience of the students in year two. The authors found that Mendeley provided a platform that supported small group collaboration, especially for complex learning tasks involving evaluation, such as a group critique of research articles. The

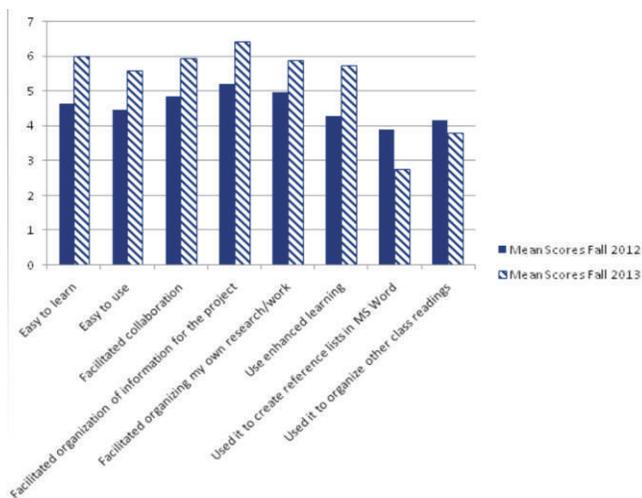


Figure 1. Survey Results Fall 2012-Fall 2013

technology provided a visual tool for students to see how others were annotating and commenting on articles and in turn, how they used this basic building block for the group synthesis in writing a summary of the collection of articles. Historically, one of the challenges with group work is the difficulty in ascertaining if all group members contributed equally to the project. Using Mendeley enabled the instructor to keep track of the level of participation by each group member over the course of the project. In effect, students could not hide behind the work of others as the system identified who contributed in the group work.

The assignment for the course showed that students engaged in the higher levels of learning in Bloom's (1971) taxonomy. Specifically, the software provided students a chance to apply their learning about policy as they critiqued the articles uploaded in Mendeley. The article critiques and searching for appropriate literature to support their group project area allowed students multiple opportunities to analyze and evaluate not only the literature they found and reviewed, but also each other's work. Finally, the creation of their policy briefs generated an opportunity for authentic learning to occur as the students used the research they had found and analyzed to create their own research brief.

As with other types of technology, there is a definite learning curve for students in using Mendeley. The authors learned after year one that a half-hour in-class training session was insufficient for many students who had no prior experience with the Mendeley software. When the authors reinforced the initial training with ongoing support in year two, they saw marked improvement in students' comfort level with Mendeley. Because this course is at the graduate level, all the students are adult learners (Knowles, 1980). As such, adult learning theory highlights how it is critical for adults to link their new learning to their past experiences and to understand why they are learning something new. Knowing this, for their work with Mendeley, the authors recognized the need to explain the links among the users of the software, learning outcomes, and the assignment requirements. Although technical difficulties occurred even with increased training, the survey revealed that Mendeley training before and during the project facilitated student

learning of the tool as well as the content. Because adult learners are self-directed (Knowles, 1975), when students are more prepared and feel they have the problem solving tools available to them for meeting any problems with technology, as was the case in year two, they experience less frustration and ultimately learn more.

The research data highlighted that students consistently underutilized the reference management feature of Mendeley. The authors have used Mendeley in their own research work to create reference lists, and find it very useful. The tool is not perfect, however, it makes creation of bibliographies easier, and provides a virtual space for references the authors have accumulated over the years. Some students were using other reference management tools such as Endnote, and did not want to switch over to another program. Still others found the Mendeley reference management tool too complicated to use. This aspect of using Mendeley as a collaborative research tool could improve the student experience, and perhaps with enhanced training in this area, students will begin to utilize this tool more.

## 7. Recommendations

Based on the experience with using Mendeley as a collaborative tool for the classroom, the authors can make several recommendations for Faculty Members and Institutions. First, the authors believe that proper training and support throughout the semester is critical. The authors found that a short training session is insufficient in making students comfortable with the technology, especially for those who have no experience with the Mendeley software. As mentioned earlier, the learning curve for Mendeley is steep for some learners, and faculty members need to keep in mind that they will have to provide initial and ongoing training to students if they wish to introduce them to Mendeley for a class project.

Secondly, the authors learned that Mendeley works best in smaller groups. In larger groups, the authors experienced both technical and assessment challenges, however, groups of two or three worked very well for the project. Therefore, the authors would recommend using Mendeley in small group collaborative projects.

Lastly, the authors recommend that institutions need to

consider putting into place institution wide support systems to encourage the use of technological tools, such as Mendeley, to facilitate collaborative learning. Currently, there is more emphasis on technology as a means to enhance classroom teaching with a focus on individual student learning. However, the authors feel that the immense potential of technology to enhance collaboration that transcends the limitations of in-person collaborative work is not fully appreciated or exploited by institutions. The explosion of social media and other networking platforms may create expectations for students in higher education settings, which can help facilitate the support of collaborative learning assignments.

## 8. Implications

As noted earlier, the authors are not claiming generalizability of the results of their study due to the small sample size that precluded statistical testing. The authors believe that the study has implications for further research on using Mendeley, and other technological tools, to facilitate collaborative learning in the classroom. The authors envision a larger study, for instance, that would survey a large sample of students or researchers who have used Mendeley to collaborate on research projects. Perhaps, a future study can also compare the effectiveness of several technological tools for collaborative writing.

The authors also believe that this study can be useful for Faculty Members who are looking to use technological tools for collaborative learning in their classrooms; perhaps they can glean lessons from this study and use Mendeley for their collaborative assignments. Students and Scholars too can use Mendeley as a collaborative platform for their research, and can potentially benefit from this study.

## Conclusion

Research documents that collaborative work can enhance learning for college students (Nilson, 2010), and online collaboration tools like Mendeley can help support learning in complex collaborative classroom projects. This study detailed how the authors used Mendeley in one such project in a Graduate class. Over the course of two years, two sets of students in the same course used Mendeley to collaboratively annotate and critique research articles

collected around themes of shared interest. The final product for the project was an individual policy brief by each student. Lessons from year one were applied to the project in year two which resulted in a better learning experience for students. The evidence of students engaging in learning at higher levels of Bloom's (1971) taxonomy and the support of their adult learning preferences (Knowles, 1975, 1980) point to the value of using Mendeley to support collaborative learning. Improvements in the technical aspects of student experience with Mendeley in year two indicates that training for use of the software is critical to gaining greater leverage for collaborative learning.

This research concluded that collaboration was enhanced as a result of the technology, but that scaffolding and support is required to achieve deep learning outcomes. The hands-on nature of the project afforded students the opportunity to practice their research critiquing skills and ability to synthesize literature via collaborative learning. Thus, institutions of higher education should focus attention on providing support for a range of technologies that can help support student assignments and projects using collaborative learning as a strategy.

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