

NORA: No One Revises Alone

Classroom Web Application Facilitating Peer Feedback & Discussion

by
Denzil Sikka
S.B., Massachusetts Institute of Technology, 2012

Submitted to the Department of Electrical Engineering and Computer Science in Partial Fulfillment of the Requirements for the Degree of Master of Engineering in Electrical Engineering and Computer Science at the Massachusetts Institute of Technology.

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A Classroom Web Application Facilitating Peer Feedback and Discussion

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Peer-to-peer interactions, either through discussion forums or the peer review process, provide students with essential articulation skills as they reflect and respond to the ideas of others. Unfortunately, many students lack confidence in the value of their thoughts and feedback, or students experience difficulty maintaining interest in a peer's thoughts/ideas, which results in a lack of motivation to participate or in comments that are overly superficial, flattering, or brief. The interactive application NORA emphasizes that no one reviews alone by allowing the users to write comments and then combine, like, and rearrange them on a large canvas as they analyze a piece of work, examine a topic, or provide feedback. Thus, NORA facilitates the peer review and discussion process, addressing the challenges faced by students. NORA's visual-oriented interface novel in how it presents content to the students in smaller pieces, allows several threads of comments to be seen at the same time, and provides for easy interaction between users as they write or combine comments, guiding them through specific learning goals chosen by the instructor. Targeted at college students, the application was tested in two different classes, *Rhetoric and Communication* and *Spanish I*, with different classroom activities that are typically done orally with extensive class discussion. In both classes, students analyzed the subject matter and reviewed the medium as they responded to the comments of each other and the guidelines provided by the professor. The peer-to-peer interaction allowed users to build upon each other's comments, and promoted accurate, thorough, and relevant feedback in an engaging manner. NORA was seen to encourage more interaction, draw out quieter and shy students, and boost the number of thoughtful, analytical responses.

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2 Introduction

In most classrooms, when instructors ask specific questions or invite general comments and inquiries, they are met with silence. Encouraging student participation in a classroom discussion is often like pulling teeth, and even if students are participating, it is often the same frequently vocal, confident students that dominate the discussion, ready to provide their thoughts while others remain shy or distracted.

Yet discussion is the only opportunity in a classroom to consider a topic, issue, or problem and exchange information, experiences, ideas, and opinions with one another. Discussions elicit higher levels of “reflective thinking and creative problem solving” [Ewens 96], promote better retention of information among students, and provide more engagement for students in comparison to lectures. Emphasizing participation, interactions, and dialogue is key to effective and engaging educational experiences, especially when higher education is concerned.

Similarly, classroom peer review, the process of students reviewing one another’s work and providing feedback, is an essential tool for the learning process because giving feedback involves having fundamental knowledge about the material being reviewed, requires analysis and reflection, and emphasizes the ability to articulate one’s thoughts and criticisms efficiently [Vatalaro 1990]. However, peer reviewing is not a standardized and well-defined activity, and engaging in the process of feedback is difficult, especially when students are not taught how to do peer review effectively. Peer editing can help students develop their analytical and critical thinking skills as well as increase their academic competency in an area while they provide feedback to others, thereby benefiting not only the reviewee but also the reviewer.

Current tools focus on either peer discussion or peer feedback, and none of them effectively facilitates both for a classroom of students. There is an obvious dearth in educational tools for this purpose.

As a means of addressing the challenges associated with classroom peer-to-peer interaction, we propose a reconceptualization of the peer discussion and feedback process as a single educational, collaborative online activity. NORA emphasizes that *no one reviews alone*, and the final design of the application facilitates and encourages productive user discussion by helping students to discuss the material through a chatting interface that sorts peer comments and feedback by content rather than time and to visualize large amounts of information and discussion in a single glance. This format engages students intellectually with the activity and teaches students how to interact constructively by allowing them to view the comments of their peers and build upon that.

NORA is targeted at higher education classrooms for older, ideally high school and college, students. NORA has generic features so that it may be used to facilitate several different types of activities, rather than focusing on one specific task or subject area. This generality was shown by the use of the application in the context of two different activities: one in an introductory language class, *Spanish I*, and the other in an advanced writing course, *Rhetoric and Communication*.

NORA provides several contributions, which will be described in more detail in the following sections. Primarily, the application contains a visual interface that displays several types of content in an efficient and organized manner. NORA minimizes the downtime or opportunities students have to zone out by maintaining constant engagement with the application while also reducing the spotlight and attention on any one student. Evaluations of NORA show

increased participation from all the students and responses that are more thoughtful, thorough, and analytical. In addition, the real-time element that NORA provides is satisfying for both professors and students because it promotes student-driven feedback, debate, and interaction with minimal prompting from the professor while simultaneously allowing the professor to get a better sense of the class's knowledge and understanding. Thus, NORA addresses the common challenges associated with peer feedback and discussion.

In the next chapter, context for the research that prompted the development of NORA is provided, describing the surrounding literature. Then, a brief overview of the system and the findings from prototyping are discussed. The remaining chapters present the observations from using NORA in two different classroom activities, before concluding with a discussion of the results and future work.

3 Related Work

This chapter presents the literature related to the peer feedback process as well as current tools used in the classroom. The search began with different classroom techniques used to encourage discussion or effective peer feedback. In addition, observations of how massive open online courses (MOOCs) use peer grading and discussion forums are presented. Finally, how to create and maintain engagement of students in a classroom application is explored.

3.1 Peer Feedback

Ideally, the peer feedback process, also known as peer review, encourages dialogue, facilitates assessment & reflection, accelerates learning, and educates both the givers and receivers of the feedback. Thus, many teachers stress the importance of peer feedback since the quality of given comments determine the quality of the revised writing [Althausser and Darnall 2001]. In addition, examining a peer's work helps student reviewers understand what an audience is anticipating in their own work and the process allows them to gain knowledge of effective strategies for completing the assignment or task in the future.

Unfortunately, the reality is that students do not observe and critique the work of their fellow peers with the conscientiousness and interest they would use to review their own work [Chisholm 1991]. In addition, when students engage in the exercise, their feedback is “superficial, overly flattering, vague [or] very brief” [Vatalaro 1990]. Many students feel uncomfortable with the task of having to pronounce a judgment on their peers' work. This discomfort may be the result of their desire not to hurt a peer's feelings, their inexperience with providing constructive criticism, or their belief that their feedback is less valuable than the edits provided by the teacher; regardless of the reason, students lack the motivation to put thought and

effort into their comments [Nilson 2003]. When peer review focuses on the outcome and final result of the feedback, student survey results indicate higher levels of satisfaction because it is clearer what feedback has been valued in the process. However, even when students believe their comments have merit, it is difficult for students to maintain interest when reading the work of their peers and to remain engaged, resulting in a declining quality of feedback.

3.1.1 Current Tools

If students knew that their feedback was useful or was being applied to revisions, then they would be more likely to put more thought and interest into the review process. Current software (Microsoft Word and Adobe) and the old-fashioned way of peer review with paper and pen make it impossible for reviewers to know that they have made “helpful suggestions or comments, [and] it also makes it nearly impossible for instructors to assess the review work of their students” [Hart-Davidson 2010]. Providing feedback on students’ reviews improves the quality of their future reviews. Thus, there needs to be process that provides feedback for reviewers on how helpful their review has been for the writer.

In addition, research has been conducted on the importance of training students in order to improve their ability to evaluate their peers effectively with current findings indicating that instructors should guide and coach students in the methodology of reviewing peer drafts through question prompts or a model of reviewing. This guidance will allow students to focus on more than the superficial improvements. Stanley [1992] examined the effect of a seven hour training session for ESL freshman university students, and results showed that the training enhance the effectiveness of those students peer evaluations in the future. Zhu [1995] employed a similar study, but used a “conference method”, which involves the instructor meeting with peer review groups individually after students have read and commented on each other’s writing, to train

students. This method resulted in peer evaluations with more substantial (in length and content) feedback and more engagement from students. Another study [Min 2005], combining the work of Zhu and Stanley, shows that training let EFL students also improve their ability to evaluate their peers and build their own confidence. In Calibrated Peer Review (CPR) [Chapman 2000], students evaluate other students' essays after calibrating their skills and going through a modified "training". In CPR, there are three stages: Text Entry Stage (read source material and compose), Calibration and Review (evaluate example texts before peer reviewing), Results (view results).

Hart-Davidson [2010] defines an excellent review as one that "makes accurate and fair evaluative statements about the features of a text, and offers specific, actionable advice about how to improve the text." The goal should be to create reviewers who can consistently produce those characteristics in their reviews.

3.2 Classroom Discussion and Interactions

Student behaviors with one another in the classroom environment are essential in influencing the manner with which learning happens. A comfortable peer climate enhances positive student outcomes and creates a connected classroom, which in turn leads to better participation, more hours studying, increased satisfaction and commitment, and higher academic engagement [Frisby 149]. One key factor in determining a classroom's climate is the type of classroom discussion and interaction that occurs between students. Ewens [1989] defines classroom discussion as "a diverse body of teaching techniques that emphasize participation, dialogue, and two-way communication". The obvious benefits of discussion include the development of an understanding of the material, the ability to articulate one's thoughts, the involvement in their own learning, and the appreciation for different perspectives. In addition, by

interacting with one another, students are considering information in new ways by evaluating and comparing their understanding with that of others, leading to enhanced student comprehension and retention of information.

Despite the benefits, one of the largest challenges with classroom discussion is inducing students to participate. Students may not participate because they are shy and introverted. While there are ways to force student participation, some teachers contend that the bulk of “participation in discussion should always be voluntary” in order for the student to benefit [Dallimore 105]. Even when students are ready to participate, they may lack confidence to speak during a class discussion because they do not want to misspeak or mess up in front of the rest of the class when attention is focused on them. Another issue occurs when a discussion is moving at a faster pace than the student is comfortable with. Thus, by the time the student has an articulate, reasonable comment, the discussion has moved on to a new topic. Of course, there are also the students who are bored in class and are happy to zone out and let the rest of their peers continue the discussion for them [Eberly 2013].

3.2.1 Current Strategies

Various strategies, including different seating patterns or establishing instructor expectations from the onset, induce more discussion and participation while addressing the challenges. However, there is no clear one solution that consistently works. Many teachers are opposed to cold-calling as a strategy to increase the number of students in a discussion because it is potentially embarrassing to the student and seems harsh. Making participation a large portion of the final grade “heighten[s] students’ awareness of participation” and is effective in keeping students motivated about raising their hands and contributing [Dallimore 2004]. However, participating and speaking up doesn’t necessarily mean that there is quality student participation

or an effective, efficient discussion taking place because students may be repeating the same material or trying to game the system. Despite acceptance of discussion as a key element of teaching, the current tools or strategies used by teachers fail to improve the frequency and quality of student participation consistently.

Due to the rapid expansion of technology over the past decade, professors have tried enhancing the interaction that takes place outside of the classroom in order to achieve the same benefits of classroom discussion. This outside learning includes using online forums as a type of educational technology that allows students to publish their own thoughts, discuss assignments, and peer review each other's work. An online discussion forum provides opportunities for active learning, removes the pressure to respond right away while being in the spotlight, and represents a more casual communication channel. In addition, the moment to respond or to revisit a discussion is not immediately lost once the moment has passed [Mak 2009]. However, community building through online forums have not been able to remove the main challenges faced by physical classroom discussion: student's lack of motivation to participate and in turn, a student's lack of engagement [Thomas 2002].

3.3 Massive Open Online Courses

Massive open online courses (MOOCs) allow any student to enroll in a course as long as they are able to access the course material online. Some MOOCs have enrolled more than 150,000 students. MOOCs will have to be self-sustaining some day, not only in terms of financials but also in regards to staff and student support.

3.3.1 Peer Grading

Coursera's humanities courses use peer-to-peer grading, with students first having to show that they can match a standard grading of assignments, and then grade the work of five classmates [Cooper 2013]. Initial MOOC-scale peer grading experiments have shown promise. Scott Klemmer, this past spring, taught a MOOC hosted by Coursera, integrating peer assessment. Piech [2005], under the supervision of Daphne Koller, states that based on his research of the Klemmer class that the ideal peer grading system should provide reliable assessment, balance workload across the students and staff, and be scalable as well applicable broadly to various problem settings.

Klemmer used materials such as grading rubrics to build on the technique of calibrated peer assessment. The calibration process required students to evaluate based on a rubric randomly selected submissions, of which one may be a graded by a staff member (known as a "ground truth" submission). The final score given to a submission was determined by the median of the corresponding peer grades. All grading was anonymized. Data analysis showed that students were harsher critics of one another, with 43% of the peer grades more than 10 percentage points below a corresponding staff grade. Still, Klemmer states that receive satisfaction and earnest reflection by providing peer feedback and grading, increasing their maturity and understanding.

3.3.2 Discussion Forums

In these massive classes, it is easy for students to feel isolated, and thus there's a real need for connections between students and a learning community fee. Forums have been identified as "providing the bulk of asynchronous communication and instructional interaction" [Mak]. However, most MOOC discussion forums have dozens of threads and thus,

“conversations have little chance of picking up steam, and community is more often stifled than encouraged” [McGuire]. In addition, currently much of the pressure to maintain an active forum is on the professors or staff, requiring them to regularly post new material and encourage activities and discussion. It is difficult to encourage enthusiasm and regular participation from students. A study on the first edX MOOC showed that out of the certificate earners 27.7% asked a question, 40.6% answered a question, and 36% made a comment on the forum [Breslow 2013]. A Stanford study shows that looking at discussion forum activity across 23 MOOCs on Coursera shows that most classes had below 5% participation in discussion forums and no higher than 10% in any class across all registered students, where the majority of students who participated had only one post (typically the introduction forum) [Manning]. Addressing the challenges with the use of discussion forums in MOOCs may have an effect on the retention of certificate earners as well as improve interaction between students in such a large educational community.

3.4 Engagement in Student Applications

In addition to improving students’ efficiency in the peer feedback process, we would like improve their engagement. Researchers have shown that integrating game elements into user interfaces could increase “user motivation and the playfulness of work activities” [Webster 1988]. Game designers offer several contradictory set of definitions for what it means to be a game: Sid Meier, designer of *Civilization*, states games as “a series of meaningful choices”; the authors of *Andrew Rollings and Ernest Adams on Game Design*, link games to “challenges in a simulated environment”; and Katie Salen and Eric Zimmerman in their book *Rules of Play* pronounce games as “a system in which players engage in artificial conflict [...] that results in a quantifiable outcome” [Salen and Zimmerman 2004]. Raph Koster, the author of *A Theory of Fun*, discusses that with so much quibbling, it is often hard to determine what features truly

compose a game and how would it be possible to adopt those characteristics into an assignment, task, or chore in order to induce pleasure as well as accomplish practicality.

Koster's own definition of a game is "one that teaches everything it has to offer before the player stops playing", discussing that games teachers and fun is another word for learning. Humans continue to play a game because they have a task that requires tackling, and whiles games are good teachers, they aren't necessarily teaching what we want to teach. So how can we take a concept or task and turn it into a game?

The main reasons for a lack of engagement in peer feedback as shown from the sources above are because students do not realize their feedback is useful or being applied, because there is no validation for the comments students leave, and because the outcome is abstract and unclear to the reviewer. The main challenges with participation is that either students feel shy and lack confidence, are distracted by moments of passive listening, or cannot keep up with the speed of the discussion. When designing a activity to address these challenges, we need to focus on how to maintain a student's engagement with the activity while reducing the pressure that they feel.

4 Design & Prototyping

In this section, the design and the principles that were experimented with are presented. These design elements are meant to induce the efficiency and engagement from students using NORA. The final interface is described with details of its development and evolution, explaining the most essential features. NORA was designed to be a platform that makes peer-to-peer interaction in the classroom engaging, effective, and educational. The application needs to address the challenges of motivation, validation, and participation.

The target audience of the application is high school and college students, chosen because they are often the target of online education and classroom studies, are most likely to use a tool like NORA in the classroom effectively, and have the fewest number of educational activities available to them.

4.1 Final Design

The generic structure of NORA has two columns. The narrower left column shows the main content and any relevant navigation elements, and the wider right column is a blank white canvas where the student-generated comments will appear (similar to post-it notes stuck to a whiteboard). In *Figure 5*, each cluster of sentences is a tab, which when clicked will show that section.

When a tab is clicked the first time, NORA allows students to answer the professor's questions and write comments on their own before seeing any of their peers' responses. The student must complete the task alone. Having done that, the student then can see the other submitted responses.

Hello Student4! You are in Game burke1.

Kenneth Burke's "Definition of Man":
You persuade a man only insofar as you can talk his language by speech, gesture, tonality, order, image, attitude, idea, identifying your ways with his. Persuasion by flattery is but a special case of persuasion in general. But flattery can safely serve as our paradigm if we systematically widen its meaning, to see behind it the conditions of identification or consubstantiality in general (Burke 55).

Paraphrase 1

We convince other people by being able to speak in the same ways that they do; for instance, by using identical kinds of words and images, sentence structures, tone of voice, hand movements, etc. Flattery is one specific way to gain accord, but it reveals the pattern of persuasion more widely, showing how others come to identify and agree with us.

Paraphrase 2

For Kenneth Burke, all persuasion is just flattery, and he believes that we only agree with each other and do what others want when they specifically mirror our ways of acting, thinking, and talking.

Paraphrase 3

Kenneth Burke's theory of identification suggests that persuasion functions through systems of similarity that a speaker creates with the audience, and that this identification is similar in kind, if not in extent, to flattery, which can function as a model. When a speaker actively chooses ways of speaking—phrasing, figures of speech, lines of thought—that align with those of the audience, the audience sees themselves as sharing an identity with the speaker, and thus can be convinced.

#grammar - Does it follow the rules of the language (e.g., subject-verb-agreement, tense, etc.)?

#meaning - Is the meaning/story of the passage clear?

#style - Is the vocabulary/word-choice appropriate in order to convey the author's intended meaning?

Done

Figure 1a.

(above) When a student visits a tab for the first time, the student cannot view the responses of their peers until they write their own comments.

Figure 1b.

(below) After writing their own comments, a student can then see the responses of their peers and begin interacting with one another.

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Add Another Comment

student1: it's original
#grammar +0

student2: yes
#grammar +0

student4: yes
#grammar +0

student3: it is original but not sufficient... I think Burke's primary focus is "word"
#grammar +0

student4: mostly -- how can we develop a "clear" relationship between us and the world if words convolute the relationship?
#meaning +0

student3: for the most part yes but I feel as though Burke is referring to words actually composing who we are not disconnecting us from the material world
#meaning +0

student1: yes!
#style +0

student2: I think "material world" limits Burke's original meaning
#meaning +1

student3: This version has a different structure
#style +0

student2: I think so
#style +0

student4: yes; but the use of "flattery" is reminiscent of Burke's wording which is fine but it's a bit unclear what you mean by it
#style +1

student1: This paraphrase leaves out a lot of the meaning of the original—for instance other kinds of symbol systems or the idea of what the "nonverbal" is.
#meaning +2

student1: I wonder whether the "entities that are unable" to express themselves are exactly the same as "the nonverbal"
#meaning +0

Comments are small in width, encouraging students to write concise, clear feedback with one main thought in each box (similar to sticky notes). More comments can be added at any time using the comment box as shown in **Figure 2**, which potentially allows students to categorize their feedback into different tags as specified by the professor (in the example, grammar, style,

meaning). Students can like comments and colors can be used to distinguish comments of different tag-types.

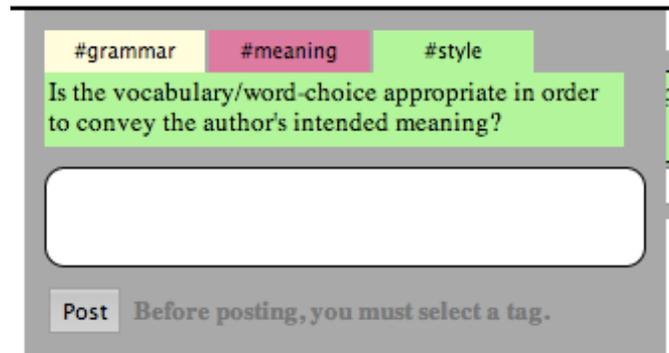


Figure 2a.

The comment box appears when the user clicks on the button 'Add Another Comment' (seen in *Figure 1b*). The comment box allows the feature of categorizing comments with tags previously chosen by the professor. The professor can require each comment to be categorized and can provide guiding descriptions to help the students as they work individually.

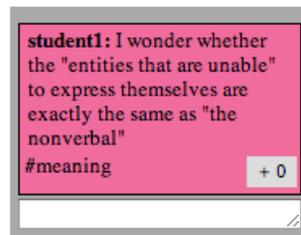


Figure 2b.

Comments are small in width, similar to sticky notes. They can be liked and they appear in the color of their associated tag.

During the design period, it became clear that there were four main areas to focus on in the development of the activity: reward, categorizing feedback, content presentation, and peer-to-peer interactions. These focus areas developed organically through the changes we made in all the original prototypes, representing that they are important elements of game design for the target audience. Thus, the final version of NORA is a fully implemented web application that builds upon these features.

4.1.1 Reward

Various techniques, including validating checkmarks and a score system with points, were explored in order to reward students for their participation and provide feedback about what comments were valuable and which ones were not. Many of the earlier prototypes showed that students like having the validation, stating that “it [the reward element] made me feel like I was right”, but there was no extra positive enthusiasm for points over simple validation through checkmarks or likes. In addition, if students had to go out of their way to write comments like “Good Job”, then positive feedback seemed unlikely to happen.

These findings resulted in NORA having a simple +1 button. The button provides the validating reward needed by the students, but also ensures that positive feedback is easy to provide, encouraging students to use it.

4.1.2 Categorizing Feedback

Having guidelines during the peer feedback process is necessary so students do not become either confused or bored and lose engagement. However, NORA needed to be run by the students rather than the teacher, so students would feel more comfortable participating and taking charge. Thus, through prototyping, it was seen that using tags helped students understand the exercise. The tags provided them the guidance without curtailing the students’ progress. By categorizing feedback, students understood exactly what was expected, and NORA minimized the work the teacher has to conduct while the activity is taking place.

In addition, it was seen that using tags sorted the comments by topic and also

provided an easy manner in which to visualize the conversations taking place among the students, allowing for the professor and students to easily perceive what was the most discussed topics on a single tab.

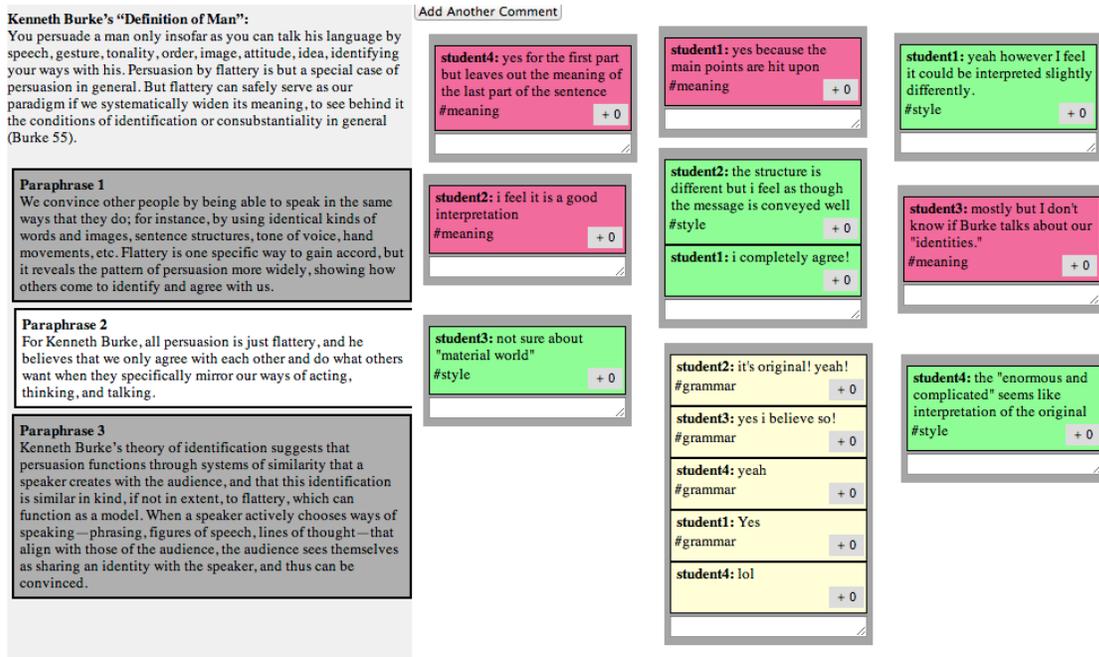


Figure 3.

Tags and their associated colors help understand the entire landscape of discussion at a single glance.

4.1.3 Content Presentation

Originally in early prototypes, the content of NORA was presented in a very linear manner, with the entire content seen first and discussion taking place below or in small columns on the side. The users were not engaged with these original prototypes, and so midway through prototyping, the manner in which the content was presented and the method with which users interacted with one another radically changed. The pace of the activity was increased by presenting the content in small clusters of information, which eventually became the final “tabs” seen in NORA. In the prototype, a chatting interface was used to allow students to interact with one another. Both methods enhanced

user engagement. The new technique for content presentation made it more game-like, encouraging increased discussion for each tab. However, the linear chat interface had many of the problems discussed before: the speed with which comments moved through the chat box made it difficult for users to keep track of the various threads of conversation being exchanged. In *Figure 4a*, an example of this original chatting interface from prototyping can be seen.

In these early prototypes, users expressed that the task was somewhat stressful due to the significant level of multitasking required: the reading of the content, commenting on the tab of information, commenting on each other's comments, and upvoting. This confusion prompted the change in NORA's layout into a two column, with content on the left and a blank canvas on the right. Building upon the success of the chat box and the criticism that too many activities at once hindered the feedback process, NORA redesigned the chatting interface. Rather than having users' comments be sorted by time as most chatboxes do, NORA allows users' comments to be sorted by topic, similar to threaded comments or a forum discussion. Thus, comments would not scroll away as more time passed and as more users added comments.

The new user interface removes the risk of missing unique comments that in the previous prototype would have scrolled away with time as more comments were entered into the chat box.

Anonymous User 12: #S not a big fan of using the dash, so +1 anonymous user 2

Anonymous User 9: #L "harmful pest" != "nuisance"

Anonymous User 8: #S "to name a few" is kind of lazy. where did that list come from?

Anonymous User 4: I don't feel the sentence is awkward by putting for humans at the beginning..

Anonymous User 7: #L not clear what these nuisances refer to

Anonymous User 9: "greatest pest", "biggest pest"... think greatest sounds better

Anonymous User 8: @user4 I think part of the reason it's awkward is because obviously humans are reading this

Anonymous User 4: g: the dash even if used should have spaces around it

Anonymous User 2: AU #4: "for humans" doesn't make the sentence awkward?

Anonymous User 6: For humans is kind of redundant. How about: "The world is full of pests, such as insects, rats, and snakes."

Figure 4a.

(left) The prototype's chatbox illustrates the vigor and interest with which users participated in critiquing the passage as well as their difficulties tracking one another's feedback, showing the success of using a chatbox to encourage engagement. However, major flaws of using a linear chatting interface include the fast-pace and the ease with which unique comments can be missed.

Figure 4b.

(below) NORA allows for multiple threads of conversation to occur simultaneously and provides a visual interface that is efficient and non-distracting in displaying all of the content, facilitating and encouraging productive user discussion.

The screenshot shows the NORA interface. On the left, there is a list of questions:

- ¿Qué representa el viento (wind) en la película?
- ¿Qué papel (role) desempeñan (play) las madres en la película?
- ¿Qué papel desempeñan los personajes masculinos?
- ¿Por qué se llama la película Volver?

 A button labeled "Add Another Comment" is located above the list. On the right, there are several chat threads, each with a pink background and a score indicator:

- Thread 1:** student1: Los papeles son muy importantes porque Raimunda es la hija de Irene pero también ella es la madre de Paula. (+2); student1: Si (+0); student1: Tu justo describes todos suss parentescos (+2); student1: Gracias! (+0); student1: De nada (+0).
- Thread 2:** student1: Heroe (+0); student1: Cierto, pero por que? (+0); student1: Porque Ustedes se encargan todos. (+0).
- Thread 3:** student1: La madres no son perfectas. Representan el pasado y los errores (+2); student1: estoy de acuerdo. Las madres no son perfectas y ellas saben que hacen errores (+0).
- Thread 4:** student1: Las madres protegen sus hijos porque los padres son malos (+0); student2: Si, pero Paula debe se protegen (+0); student1: ¿Tu piensas que Irene protogen sus hijas tambien? (+0); student1: No. Irene abandona su hijas. (+0).
- Thread 5:** student2: Guardiánes y protectores (+0); student1: No estoy acuerdo. Las madres abandonan sus hijas (+0); student3: Y Raimunda es una madre muy independiente (+0); student4: No cierto Dan. Raimunda es con su hija (+0).
- Thread 6:** student2: Las madres son los cuidadores de la familia. (+0); student1: Si, las heroes (+0); student3: Las madres son las guardianas de sus hijas (+0).

4.1.4 Peer-to-Peer Interactions

NORA begins with students choosing a Username and ActivityID. The ActivityID can be assigned by the teacher in order to create different sessions of the same activity, allowing students to work in smaller groups in larger classes or have various parts of the class work on different activities. Once a student has left a session, they can re-enter the activity session with their Username and the same ActivityID and find the state of the activity resumed without losing any past work. Students can join as many activity sessions as they or the teacher wishes.

In early prototypes, it was clear that being able to see what their peers were doing was a crucial factor in engagement. Users enjoyed the ability to comment, justify, or elaborate on why they did what they did, and they found fun responding to one another and building upon each other's comments. In addition, users enjoyed being able to view other people's comments as it showed them things they had missed, gave them confidence in their own comments, and allowed them to see what others focused on.

In the final design of NORA, the students can interact with each other in an activity session in three main ways: merging comments, liking comments, and adding followups. The comments in the canvas area can be combined when users drag and drop comments on top of each other in order to create larger threads of discussion (*Figure 5*). In addition, students can like comments using the '+' button. Lastly, students can add follow up comments in direct responses to a specific thread.

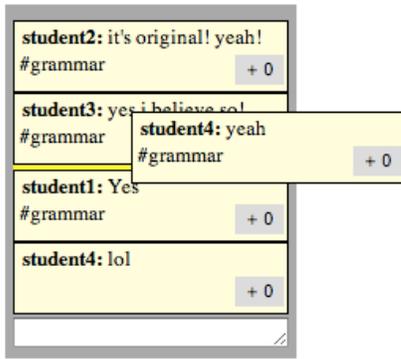


Figure 5. (left) Comments can be combined by the users dragging and dropping comments on top of threads. The comments can also be dragged out of threads to make new threads. The '+' buttons can be used to like comments, with the number updating with the number of likes. The text box at the end of the thread can be used to add followups to that thread.

As more and more comments are generated and interacted with, the canvas is filled with several threads, each distinct with its own topic, conversation pattern, and activity (for example, see *Figure 4b*). This structure of NORA allows for several conversations to take place at once, providing a satisfying visual interface that allows students to focus on the conversations that they believe are the most relevant or important to them while still getting a sense of the entire landscape of comments. In addition, this visual representation allows the professor at a quick glance to realize a general overview of the entire class as well as see into the mindsets of specific students.

This final design of NORA addresses the main challenges associated with peer feedback and discussion in the classroom, including engagement, participation by all users, and validation, while maintaining a low-key and move at your own pace environment.

4.2 Implementation

NORA was implemented using Node.js, which is a platform optimized for building server-side applications. JavaScript is utilized as the scripting language. Now.js is a framework built on top of Node.js that connects the client side and server side Javascript effortlessly. The core of NowJS functionality lies in the now object, which exists on the

server and the client automatically syncing between the client and the server and allowing for realtime interactions.

The overall system and various identifiers can be seen in **Figure 6**. Every activity has a key identifier, the *ActivityID*, and keeps track of three main elements: the users in that activity, the messages written in that activity, and the content in the activity. A user is distinguished by the username, and each user object can keep track of the comments written by that user and the messages liked by that user. Every message is distinguished by its message identification number, and each message stores which cluster it was written about, what the actual message is, if there are any relevant tags, who wrote the message, and how many times it has been liked. Finally, the content of the activity is simply a list of the different clusters that make up the content column of NORA.

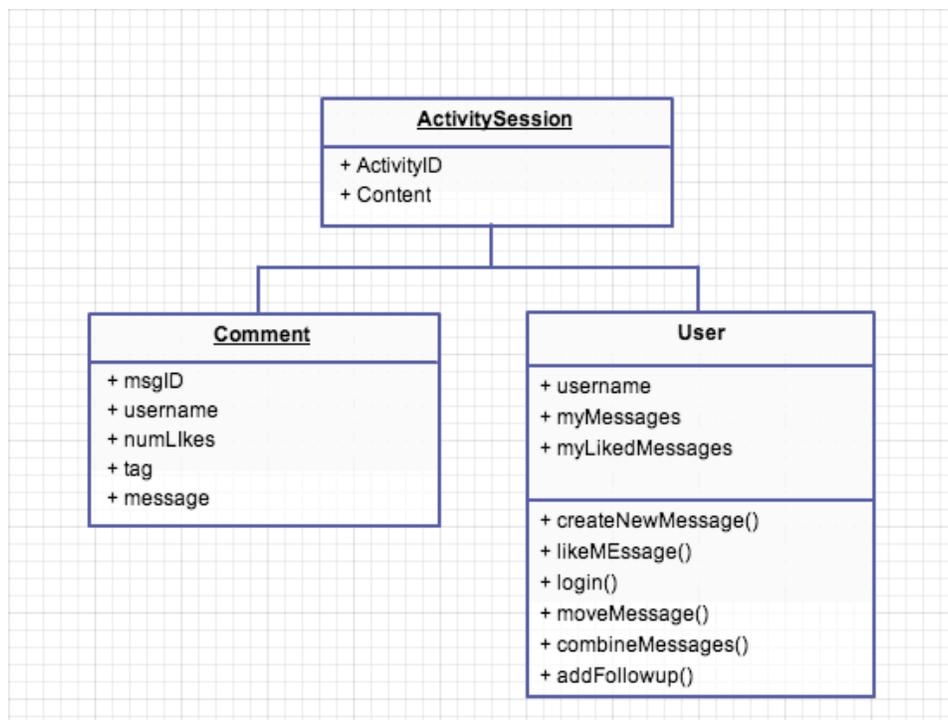


Figure 6.
Overall System.

5 Evaluation

NORA was tested with two different oral activities in the classes *Spanish I* and *Rhetoric and Communication*. Both activities are typically done with a worksheet and classroom discussion, but this time the activities were facilitated with NORA in class followed by a short oral discussion. Before deploying the app in each class with the students, we discussed with the teacher what the activity needed to succeed, and NORA was filled with the content and relevant guidelines that the teacher provided. However, no changes were made to the main framework and features of NORA for either activity, showing that the application can be used in different contexts. We tried to keep the majority of the work done by the teacher solely during setting up the activity. During the deployment of NORA in both classes, the teachers merely observed and the students required no additional guidance.

5.1 Rhetoric and Communication

Rhetoric and Communication is one of the offered classes at MIT in order to fulfill the Humanities requirement. Students who have a special interest in learning how to make arguments in written form are encouraged to take this class. Through the semester, students study different forms and structures of argumentation, learn how to organize ideas and be aware of their audience, and practice different forms of persuasion through the use of evidence, factual and emotional arguments, different figures of speech, and different forms and structures. The professor conducts several oral activities during the semester in order to teach these skills. There were thirteen students in the classroom.

5.1.1 Setup

In the typical paraphrasing activity conducted by the professor, students are presented with an excerpt from a speech or a literary work that they are already studying as well as example paraphrases that they evaluate on their own before participating in a classroom discussion. An example worksheet can be seen in Figure 9. The professor asks two main questions about each example paraphrase, trying to get the students to ascertain whether the paraphrase is accurate in meaning without plagiarizing the language or structure of the original. In addition, the professor uses the paraphrases to help students better understand the dense and complex material.

Paraphrase this passage from Maltz & Borker, “A Cultural Approach to Male-Female Miscommunication”:

“What girls learn to do with speech is cope with the contradiction created by an ideology of equality and cooperation and a social reality that includes difference and conflict. As they grow up they learn increasingly subtle ways of balancing the conflicting pressures created by a female social world and a female friendship ideology” (205)

Do the following sample paraphrases **accurately reflect the meaning of the original passage?**

Do they **use sufficiently new language and sentence structure** to convey the idea from the source in the students’ own words?

Sample paraphrases:

- A) Girls learn to use speech to deal with the conflicts between social pressure to cooperate and treat others as equal, as opposed to their reality in which differences create conflict. Girls become progressively better at negotiating the balance between social pressure and reality by using language more subtly.
- B) Maltz & Borker show that for girls, ideology creates conflicts, and language becomes a way of mediating between their own beliefs and those of others, from whom they may differ, but with whom they need to be friends (205).
- C) The social norms for girls include the expectations of fairness and social cohesion, but relationships between girls include the kinds of social disparities and tensions common to all human interaction; consequently, girls learn to use language to manage both these interpersonal conflicts and the conflicts between the reality and the expectations (Maltz & Borker, 205).

Figure 7.

The paraphrasing activity is typically done with worksheets like this one that the professor of *Rhetoric and Communication* created. The students go through the examples by themselves or in small groups, reflecting on the questions about accuracy and originality. This is followed by a full class discussion with the teacher guiding the conversation.

When adapting NORA for this activity, we added a new role for students that was important to the professor: the ability for each student to create their own paraphrase and receive feedback on it.

The thirteen students, in *Rhetoric and Communication*, were divided into four groups of either three or four students in each session. The entire activity was meant to take twenty minutes (from the students generating their own paraphrase to finishing up interactions with one another).

5.1.2 The Activity

Before engaging with NORA, to incorporate the professors desire that students create their own paraphrases, the students first must read the excerpt and enter their own paraphrase, before they have a chance to see any of the example paraphrases or the responses of their peers. This part can be considered an addition to NORA, as it is not a part of the real application. Instead, it allows for the students to generate the content they will be reviewing through the application.

Kenneth Burke's "Definition of Man":

You persuade a man only insofar as you can talk his language by speech, gesture, tonality, order, image, attitude, idea, identifying your ways with his. Persuasion by flattery is but a special case of persuasion in general. But flattery can safely serve as our paradigm if we systematically widen its meaning, to see behind it the conditions of identification or consubstantiality in general (Burke 55).

Paraphrase the excerpt. If you need help, get a



Figure 8.

Students must first analyze and understand the excerpt by themselves and demonstrate this understanding by writing a paraphrase of their own in order to generate the content to be used in this NORA activity.

Once they have written a paraphrase, they are moved to the actual NORA application, where in the left column they see the original excerpt as well as the example paraphrases and student-generated paraphrases of every student who is in the same activity session. After having reached this step, the students are led through critiquing each paraphrase with questions provided by the professor (on the right side of the screen) as shown in *Figure 9*.

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Paraphrase 1

We convince other people by being able to speak in the same ways that they do; for instance, by using identical kinds of words and images, sentence structures, tone of voice, hand movements, etc. Flattery is one specific way to gain accord, but it reveals the pattern of persuasion more widely, showing how others come to identify and agree with us.

Paraphrase 2

For Kenneth Burke, all persuasion is just flattery, and he believes that we only agree with each other and do what others want when they specifically mirror our ways of acting, thinking, and talking.

Paraphrase 3

Kenneth Burke's theory of identification suggests that persuasion functions through systems of similarity that a speaker creates with the audience, and that this identification is similar in kind, if not in extent, to flattery, which can function as a model. When a speaker actively chooses ways of speaking — phrasing, figures of speech, lines of thought — that align with those of the audience, the audience sees themselves as sharing an identity with the speaker, and thus can be convinced.

#language - Is the language sufficiently new and original?

#structure - Does the structure convey the idea from the source in the writers' own words?

#meaning - Does the paraphrase accurately reflect the meaning of the original passage?

Done

Figure 9.

Having written a paraphrase themselves, the students now can see the example paraphrases provided by the professor as well as the paraphrases written by their peers. At this point, they are ready to critique and provide feedback for the paraphrases using the questions the teacher provided as guidance.

After reviewing all the paraphrases, the student is again brought to the first paraphrase they reviewed. By this point, everyone has hopefully provided comments to that paraphrase, **Figure 10**. At this point, the students can begin rearranging the comments, combining similar comments, liking comments, adding more comments etc. increasing their interaction with one another. They will review the comments and interact with one another for all the paraphrases in their session. In addition, they will be able to see immediately the feedback and discussion surrounding the paraphrase they wrote themselves.

Kenneth Burke's "Definition of Man":
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[Add Another Comment](#)

I suppose so but I do not know what Burke meant in the first place?
 #language + 0

The author's structure conveys the idea but in new words so yea.
 #structure + 0

Yea I guess, the author of this paraphrase uses some new language.
 #meaning + 0

appropriate synonyms are used.
 #language + 0

: the writer's words are used sparingly although the structure used is strikingly similar to the passage.
 #structure + 0

: the paraphrase mirrors the meaning clearly.
 #meaning + 0

it's original
 #language + 0

the structure is different but i feel as though the message is conveyed well
 #structure + 0

: i feel it is a good interpretation
 #meaning + 0

The paraphrase utilizes many accurate summaries of Burke's original writing.
 #language + 0

: Yes but no mention of the symbolic.
 #structure + 0

Somewhat... I believe the paraphrase left out Burke's line concerning "so much... would not even exist were it not for the verbal."
 #meaning + 0

Figure 10.

Having reviewed all the paraphrases in their activity session, the students can now interact with one another's comments as well as see the feedback on their own paraphrase. The different colors represent the different tags or questions the professor provided to help guide each student's feedback and evaluation of the paraphrases.

When deployed in class, the students all quietly worked, not engaging with one another out loud except to occasionally laugh. There were no questions asked, and the students all progressed at similar paces. Unfortunately, every group had five or six paraphrases that they had to review, and so the students didn't have as much time to interact with one another. People actively quoted what the paraphrase stated, which was most likely because of the questions and the tag descriptions asked by the professor. The students respond at the end that the questions were confusing or the tags were not completely accurate.

5.2 Spanish I

Spanish I is one of the offered electives that students at MIT can take in order to fulfill the Humanities requirement or to travel abroad. The class is for students who have no previous knowledge of Spanish. Through the class, students are given an introduction to understanding, speaking, reading, and writing Spanish. The class maximizes the use of fundamentals of grammar in active communication (written and oral). Within the class, students are exposed to an audio and video based language laboratory program, which is coordinated with the class work and curriculum. There were nine students in the classroom.

5.2.1 Setup

The professor of *Introduction to Spanish* (or *Spanish I*) has her students at home watch *Volver*, a 2006 Spanish drama film that revolves around a family of eccentric women. In the next class, she passes out a worksheet with activities that the students work on followed by a discussion. In the worksheet, there are four open-ended analysis questions she has the students consider before they discuss them together as a class:

1. ¿Qué representa el viento en la película?
What does the wind in the movie represent?
2. ¿Qué papel desempeñan las madres en la película?
What role do the mothers play in the movie?
3. ¿Qué papel desempeñan los personajes masculinos?
What role do the men play in the movie?
4. ¿Por qué se llama la película *Volver*?
Why is the movie named *Volver* (which in Spanish means to return)?

Rather than using oral discussion, the professor opted to use only NORA for discussion of those questions. NORA was filled with the questions in the same way that the example paraphrases were added.

In the *Spanish I* class, there were nine students. Rather than dividing them into different sessions, the professor preferred to have them all in the same activity. The entire activity took twenty minutes (for the students to answer every question before going back and reviewing each other's comments).

5.2.2 The Activity

After the students logged in, they began to answer the questions one by one, but could see that there were four questions. By the time they had answered all the questions, the students could see each other's responses. The resulting interaction included combining comments, adding followups, creating new threads, and liking comments.

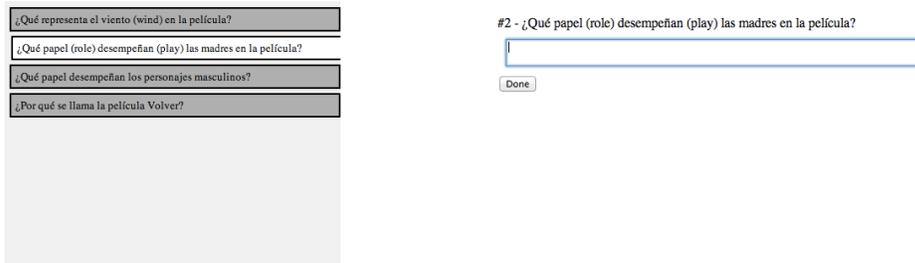
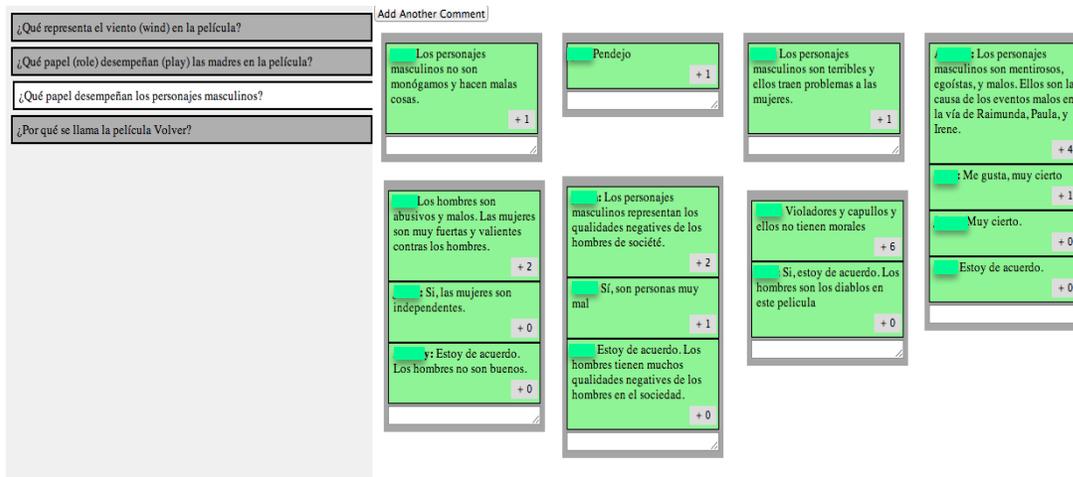


Figure 11a.

(above) Students see the above screen right after logging in, as they are guided through answering the questions provided by the teacher.

Figure 11b.

(below) Only after having answered all the questions are the students allowed to see the responses of their peers as shown in this screen.



The students were content interacting through the application and no one spoke aloud during the activity. One pair of students had to share a computer, and they found it annoying and stated that they wished they could have completed the activity individually. One student mentioned that writing a response and reading those of his classmates helped him understand the question and parts of the movie better. The students liked the questions because they required an ideal response amount which worked well with the sticky note type comments.

6 Results & Discussion

In both classrooms, NORA resulted in more interaction than a simple oral classroom discussion. Every student wrote their own comments, and in addition to that, they moved on to comment on their peers' comments, which resulted in a marked increase in student participation noticed by the professors. In the rhetoric class, students all wrote their own paraphrase and were able to see their peers' feedback. It was a surprise that none of the students communicated with one another orally in both classrooms, with all their focus on the application. This silence was unexpected but interesting to observe. In the Spanish class, the professor was surprised at how much the students were able to express themselves in the foreign language on fairly complex analytical questions. Students had access to online dictionaries, where they could look up words to help them articulate their thoughts, which allowed them to create an even more fruitful discussion while learning new vocabulary and teaching it to their peers.

Both professors remarked that some of the insightful comments might not have been brought up in a regular oral discussion. In fact, in the Spanish class, a debate broke out in one of the threads, which the Professor pointed out would have been unlikely during an oral discussion because the student who began the debate is generally laconic and shy in class. In addition to encouraging quieter students, students from both activities mentioned that the immediacy of reading and responding to fellow peers' responses helped with their understanding of the material. Specifically, one Spanish class student mentioned that "writing a response and then reading those of my classmates allowed me more time to digest the material and their answers", which pleased the professor.

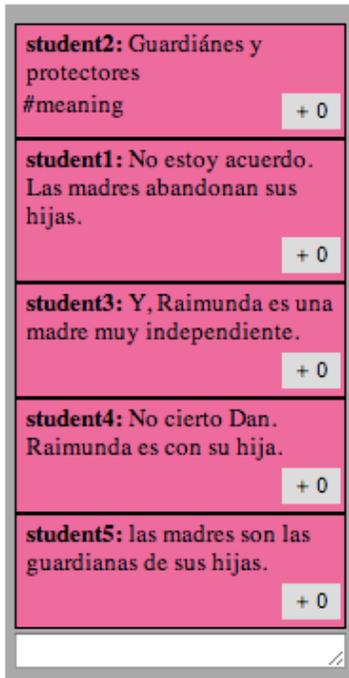


Figure 12.

A debate broke out in a thread that the Spanish professor remarked was unlikely to have happened during their oral discussion. Five of the nine students participated.

The question: What role did the mothers play in the movie?

Translation:

Student2: Guardians and protectors.

Student1: I don't agree. The mothers abandon their children.

Student3: And, Raimunda (the mother) is very independent

Student4: I don't think so Dan. Raimunda is with her child.

Student5: The mothers are the guardians of the children.

Another benefit of the real-time answers and interaction was the engagement of the students. Not talking to one another verbally despite being in the same classroom did not bother any of the students, and in fact, all the students during the activity seemed content and engaged with interacting with one another through the application. In some comments, smiley faces or casual comments such as “haha”, “kk”, and jokes could be seen, which caused some students to laugh out loud. The students did not treat NORA with formality and that may have helped with the free-flowing comments.

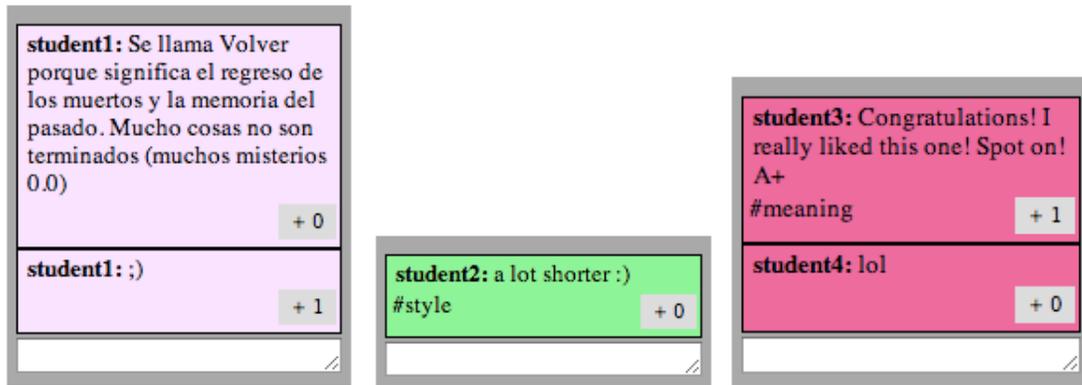


Figure 13.

Students created a casual chatting environment and felt comfortable enough to make jokes, use punctuation faces, and common chatting slang.

Moreover, many of the comments were thoughtful and analytical. Since many of the original comments were written before seeing the responses of their peers, student put time and energy into creating comments that were opinionated, original, and thorough. When all the comments are seen together on NORA's canvas, a diverse collection of ideas are shown. Because there was only one activity session and an extra computer, the Spanish professor was able to watch the comments appear in real-time and this allowed her to see what her students were writing before the oral discussion and she was able to get a better sense of what each student thought as well as note the understanding demonstrated by the class as a whole.

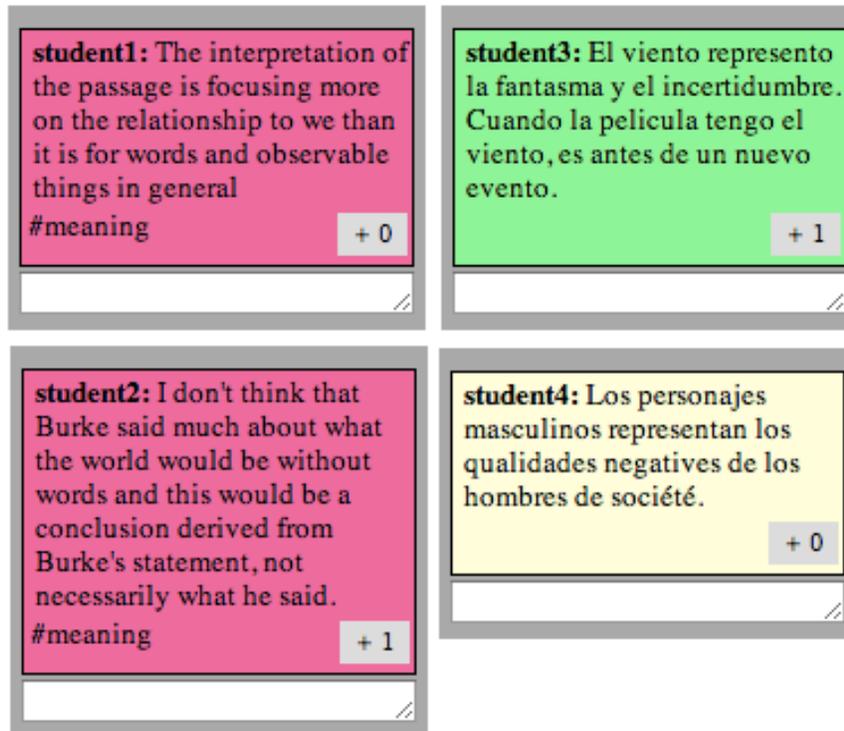


Figure 14.

The responses created by students were deep and analytical, showing obvious effort and thought. Here is a small sampling from both classes.

Unfortunately, in the paraphrasing activity, the students were unable to move through all the paraphrases in the time allotted. During the activity, students had to review not only the three example paraphrases but also the student generated paraphrases in their activity session, which resulted in them reviewing 7 or 8 paraphrases. With the limited time for the activity, the reviewing part reduced the amount of interaction time that the students had with each other. All the students agreed that the interaction with the other students and seeing what everyone else wrote is the most engaging part, and so the fact that it took so long to get to that point was tedious, especially since they didn't end up actually enjoying the interaction time because time ran out. A feature that allows the

professor to have certain students originally critique only specific clusters might be useful so that students can more rapidly reach the interaction segment.

Also during the paraphrasing activity, two of the questions asked by the professor are easily answered by yes or no, an urge which many students succumbed to. The question, categorized as #meaning, required more elaboration, and it can be seen that those comments and threads were the most insightful, interesting, and interactive. In the Spanish class, all of the questions required analysis on the student's part, and as a result, the answers were more substantive. NORA is simply a platform and so the questions, content, and the guiding elements added by the teacher will have a large effect on how students respond and interact.

In the paraphrasing activity, the groups were typically of size three or four, and each student was producing an average of three comments (not follow-ups) per paraphrase. Thus, there were at least twelve comments before followups were added. In the Spanish class, there was only one activity of size nine, and for each question, the students were simply producing one comment (not follow-ups). Thus, there were nine comments before students began to post followups to one another's comments. The size of the group seems to matter less than the number of original comments that are on the screen. From these two activities, it seems like around ten original comments is the ideal number before NORA's canvas begins to get crowded.

Our evaluations of NORA show that the application is engaging and educational. NORA's innovative visualization of content and unique chatting interface has addressed the challenges we first discussed with peer-to-peer interaction in the classroom. The casual chatting feel allows students to feel comfortable when writing comments and to

think more free-flow. In addition, students have the opportunity to answer questions and analyze without the distraction or influence of reading the answers of their peers. Finally, being able to build upon the comments of their peers and interact with one another gives students the time to digest the material and the immediacy of feedback on their own work. NORA minimized the downtime or opportunities students have to zone out by maintaining constant engagement with the application, thus increasing participation to constantly include all students in the class. For professors, a quick glance at the interactions taking place through NORA will give them an immediate understanding and a better sense of class's knowledge and thoughts, helping them tailor their lecture or following classes.

7 Future Work & Conclusions

Despite the success of NORA's deployments, there are still aspects that can be improved. More testing needs to be done in order to understand what sorts of activities NORA will work best with. In addition, there is pressure on the teacher to provide the right questions and content so there should be more guidance for professors as they adapt classroom activities to be conducted through NORA.

Having used NORA in two different contexts gives hope that the application can be used in several different types of classroom, but more testing will have to be done. Our current research shows that NORA can be used to analyze written excerpts and a movie. Ideally, the novel concepts and framework of NORA are generic enough that they can be applied to other domains. Could it be used to analyze coding styles? Could it potentially replace the typical discussion forum with its new visual interface? More specifically, can NORA be used in the online classroom, where the discussion that is so valued in the physical classroom is currently impossible? We have only breached the surface for the use of an application like NORA.

The two deployments of NORA give indication that the application maximizes engagement of students while minimizing distractions or moments of passive learning. The real-time synchronous element allows for immediate feedback, debate, and interaction between the students while maintaining minimal teacher involvement past the initial set-up. Students feel less pressure to respond quickly or haphazardly and can take their time to move from section to section, without feeling as if their comments are old news or the appropriate moment has passed. Because of this, the students are able to produce more thorough and articulate responses. In addition, the unique chatting interface

provides a casual feel, allowing students to build upon their peer's responses while feeling comfortable enough to use emoji or slang thereby building an online community and connections between each other. Finally, the visual interface, that sorts messages by content rather than time, allows the teacher as well as the students to see not only the entire landscape of the discussion but also any specific threads of conversation in a quick glance.

NORA is a promising beginning to web applications and tools that can be used in higher education classrooms, whether physical or online. There are several ways to extend its functionality and many more evaluations to conduct, but based on our findings, there is potential for NORA to improve the current manner in which peers interact, discuss, and provide feedback to one another in an educational setting. NORA will help maintain extensive interaction, effective feedback, and enthusiastic discussion in any classroom, making sure no one reviews alone.

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