Analyzing MOOC Discussion Forum Messages to Identify Cognitive Learning Information Exchanges

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ABSTRACT
While discussion forums in online courses have been studied in the past, no one has proposed a model linking messages in discussion forums to a learning taxonomy, even though forums are widely used as educational tools in online courses. In this research, we view forums as information seeking events and use a keyword taxonomy approach to analyze a large amount of MOOC forum data to identify the types of learning interactions taking place in forum conversations. Using 51,761 forum messages from 8,169 forum threads from a MOOC with a 50,000+ enrollment, messages are analyzed based on levels of Bloom's Taxonomy to categorize the scholarly discourse. The results of this research show that interactions within MOOC discussion forums are a learning process with unique characteristics specific to particular cognitive learning levels. Results also imply that different types of forum interactions have characteristics relevant to particular learning levels, and the volume of higher levels of cognitive learning incidents increase as the course progresses.

Keywords
MOOC discussion forums, Bloom's Taxonomy, Levels of cognitive learning, Anderson and Krathwohl's Taxonomy, information seeking.

INTRODUCTION
In this research, we investigate the application of cognitive learning theory for understanding three distinct discussion forum message types (e.g., threads, posts, and comments) as instances of both an information seeking and learning process. Specifically, we seek to develop an inferential model for identifying the cognitive learning category of a student's information exchange based on attributes of the discussion forum interaction (i.e., the message) and characteristics of the information seeking exchange within the forum. By discussion forum exchanges, we refer to the

micro-level behavior employed by the student when interacting with a discussion forum, which is specifically posting a message.

An online discussion forum (a.k.a., discussion board, discussion group, message board, online forum) for a course is an online technology that provides students the affordance to submit messages, reply to messages, see messages, rank messages, and see responses to messages. Typically, messages and replies are organized in threads. One can view a forum as a place for online conversations via posted messages. Discussion forums in online courses are similar to forums in other domains (Kaiser & Bodendorf, 2012; Prabowo, Thelwall, Hellsten, & Scharnhorst, 2008).

Understanding discussion forums is especially important in Massively Open Online Courses (MOOCs), as well as other online courses. MOOCs are typically offered with video-based lectures, students usually lack the opportunity to have interactions and discussions with other students and the instructor relative to traditional resident courses. An internet forum provides a platform to facilitate interactions and discussions between learners and instructors. In addition, the instructor and TAs are able to monitor the learning progress based on the posted discussions (Stephens-Martinez, Hearst, & Fox, 2014). As MOOCs continue to rise in popularity (Russell & Klemmer 2013), researchers are examining specific aspects of MOOCs beyond simply exploring descriptive data and completion rates, including innovative research facets (Kulkarni et al. 2013; Coetzee, Fox, Hearst, & Hartmann, 2014).

A challenging and interesting aspect of MOOC research is the investigation of discussion forum exchanges. In terms of qualitative research, the volume of forum interactions in a MOOC makes reading, coding, and analyzing this textual data time consuming and resource intensive. For instance, the seven-week Penn State MOOC *Introduction to Art: Concepts and Techniques* have more than 50,000 forum interactions.

Forums are not employed uniformly across all MOOC designs. For example, some MOOCs mandate forum interactions as part of course completion, while others do not. Still, as in most online courses, MOOCs typically rely on the discussion forum as a surrogate for the conversations that would normally occur in the resident classroom. So,

MOOCs generally have this aspect in common, which facilitates our line of research. However, there have been little prior studies evaluating whether or not these discussion forums actually contribute to student learning.

This research project analyzes forum datasets from the Penn State MOOCs (http://www.coursera.org/psu), (see Figure 1) leveraging an automated analysis technique focusing on keywords and a cognitive learning taxonomy. In the research reported in this paper, we use the forum postings from the *Introduction to Art: Concepts & Techniques* MOOCs (https://www.coursera.org/course/art).

Figure 1. At the time of the study, Penn State offered 8 MOOCs, including the one use in this research, *Introduction to Art: Concepts & Techniques.*

The outcome of this research is:

- a deeper understanding of the contribution of MOOC discussion forums to the overall learning environment,
- guidelines for MOOC discussion forums structure based on desired learning outcomes at temporal points through the course, and
- the motivation for better discussion forum tools and methods that make scholarly contributions more apparent and discoverable.

REVIEW OF LITERATURE
With the emergence of e-learning, researchers have examined various aspects of asynchronous discussion forums, focusing on areas such as the role of the instructor in online forums (Mazzolini & Maddison 2003), the structure of the forums (Thomas, 2002), the use of social network analysis to better understand interaction patterns (Thomas, 2002), and the impact of forums on learning (Green, Farchione, & Hughes, & Chan 2013; Chan, Hayes, & Daly 2010).

While prior work has examined discussion forums, few studies have examined discussion forums specifically in a MOOC context. Among those that have, Kop (2011)

examined learner experiences in MOOCs, finding that learners often lack the self-direction and critical literacies necessary to have a quality learning experience. Kop, Fournier, and Mak (2011) identified the importance of presence in MOOCs, with both student and instructor presence having a positive impact on learning outcomes.

Both of these studies have implications for how forums might be implemented in MOOCs, but these studies focus on the presence of individuals in the learning space, not necessarily the contributions of the students' discussion forums exchange to achieving the course objectives.

In this research, we investigate discussion forum messages as an information seeking behavior using cognitive learning theory in order to understand the employment of forums in a MOOC. Specifically, we aim to discover an inferential framework based on learning theory for identifying the cognitive category of a student's information need based on characteristics of the discussion forum exchange and inherent information seeking process attributes.

Prior research on discussion forums has not proposed a model for individual differences and characteristics of messages tied to a learning taxonomy. One potential approach to achieve this, which we employ in this research, is the interpretation that student exchanges within discussion forums are part of a learning process (e.g., Bloom & Krathwohl, 1956). Schmeck (1988, p. 3) defines learning as ''an interpretative process aimed at understanding reality''. We posit that exchanges with a discussion forum are an information seeking process that can be analyzed using a cognitive learning methodology.

Limited prior work has interpreted information seeking, as a learning activity, mainly anecdotally. For example, Dewey's ''learning- by-doing'' (Dewey, 1993) is often used to provide the pedagogical underpinning for interactive learning environments. Marchionini (1995) states that information seeking is closely related to both problem solving and learning (p. 5–6).

In empirical work that does exist, Lee et al. (2006) showed that consumers use online discussion boards as knowledge sharing devices. Jansen, Booth, and Smith (2007, 2009) explored information searching as a learning process, showing that there are distinct behavioral differences in searching based on the underlying cognitive learning goal.

Based on this prior work, we believe that discussion forum interaction is an online conversational form of information seeking and is, therefore, a learning activity.

Based on this premise, there are several open questions. *Are there specific information behaviors in forum exchanges that map to particular levels of a cognitive learning model? If so, what are these mappings between exchanges and learning? What does this insight tell us about the underlying needs of the students?* These are some of the questions that motivate our research.

RESEARCH QUESTIONS

The goal of this research is to validate anecdotal viewpoints and statements concerning MOOC discussion forums.

In the Art MOOC, the instructor noted that the discussion forum was instrumental in course communication and was a source for many poignant and extremely interesting discussions. It was a tool for clarification, communication, and connection, which allowed the learners to share their artworks, ideas, and questions. The instructor also noted that it was amazing to see the posts and responses growing by the hundreds within minutes and the passion in the students' conversations.

If the discussion forum is a valuable learning resource, there should be indications of such learning in the discussion forum messages. Therefore, we investigate two research questions, which are:

- Research Question 1: *What are the major linguistically content features of discussion forum messages?*

The terms that one uses in communication are indications of what one is paying attention to, how one is feeling about something, why one organizes information, how one analyzes information, what information topic one is thinking about, and how one is thinking the information. As such, a linguistic content analysis can provide insights into message structure in MOOC discussion forums.

Along with the topical classification of forum messages, we used the linguistically content classification as a basis for research question number 2.

- Research Question 2: *Are MOOCs discussion forum messages exchanges occurring within a learning context?*

If online discussion forum messages are learning events, then one would expect differences in linguistically terminology from different learning levels. In order to analyze this question, we used Anderson and Krathwohl's (2001) redesign of Bloom's taxonomy of learning in the cognitive domain to identify key terms for each of the six categories within the taxonomy. Using an automated algorithm, we then classified forum messages overall in the course and also temporally by week.

Using more than 50,000 messages during a seven-week period, we analyzed the forum messages for the present of these keywords in the forum messages. We also categorized forum messages using a three-tiered hierarchical classification based on type of exchange.

This study is significant both in the heterogeneous nature of the participants (representation from more than 175 countries) and the automated technique used to parse through tens of thousands of forum messages. Other contributions also include the development of a keyword list used for identifying levels of Anderson and Krathwohl's taxonomy and a structural representation of discussion forum messages.

DATA AND METHODOLOGY

The initial aspect of the project is the collection, cleaning and aggregation of forum data from one of the Penn State's MOOCs.

Data

The data for this research was the online discussion forum messages from the *Introduction to Art: Concepts & Techniques MOOCs*. This MOOC ran for seven weeks, although messages continued (and still continue at the time of this study) to be submitted.

Discussion Forum Structure

We define the process of discussion forum exchanges occurring at three levels, which are:

- **Thread** (e.g., the message containing the initial forum topic),
- **Post** (i.e., the message within the thread), and
- **Comment** (e.g., the message that is a reply to a post or another comment).

We use the term, **message**, to refer to the any of these three communication products. Messages are the result of a person interaction with a discussion forum in order to communicate with others on the forum. See Figure 2 for an illustration of the hierarchical nature of *threads*, *posts*, and *comments*.

The discussion forums within the Art MOOC were initially divided into forum threads: "Introduce Yourself", "General Discussion", "Technical Issues or Questions", "Art Techniques and Materials: Questions or Clarifications", "Artist and Artworks: Questions and Clarifications", and "Weekly Lesson Discussions"
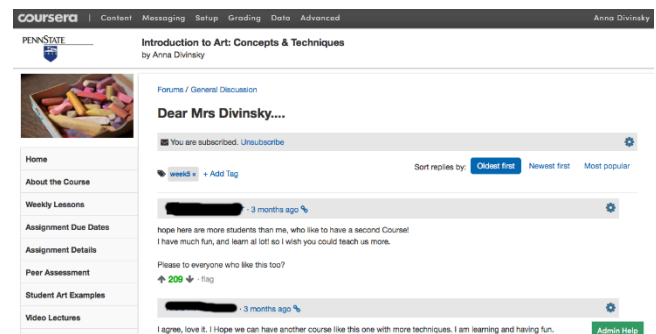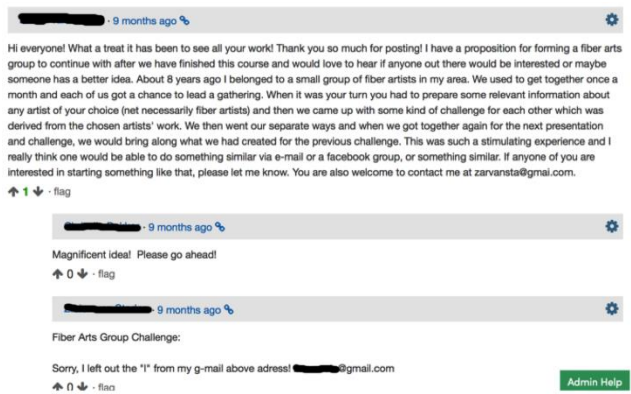

Figure 2. A thread structure of the Introduction to Art MOOC discussion forum, started by a student expressing thanks to the instructor.

Having specific categories in place helped guide the students within the discussion and allowed the instructor to sift through the questions, responding to the most urgent queries.

The students could also begin their own individual threads and search for topics (see Figure 2).

During the seven week MOOC, there were the following occurrences of threads, posts, and comments (see Figure 3, which illustrates instances of each).

- Threads - 8,169
- Posts – 29,595
- Comments – 22,166

Figure 3. A post (the top most forum message) followed by two comments (the bottom two, indented forum messages) from Introduction to Art MOOC forum.

Examples of forum postings and comments from *Introduction to Art: Concepts and Techniques* MOOC are:

I'd love to get insight into your method of developing some of those geometrical pieces. The craftsmanship is amazing.

Yes, they are looking good! I like the shiny surface. One suggestion: make the leaves bigger as apple leaves are bigger than that relative to the size of the apple.

Can not quite understand the perspective as I am not an artist, but it would be great if you can share some pointers or more pics. Thxs.

This really helped me understand what a good critique should be - thank you - excellent work.

This image was actually a test creation I was working on trying to see how best to simulate a painting-like scene from a photorealistic one.

Thank you for trying to put the course into perspective. These discussion forums are like trying to herd a bunch of cats. In some parts of the forum it's like a toxic event has turned students into zombies feeding on the flesh of the living or rather the pixels of the digitized virtual students. I'm sure there is an online psychology course where all the students do is monitor the discussion forums and check off the most apparent psychosis on display.

Discussion Forum Pre-Processing
Once we collected the data from the MOOC course website, we cleaned the data prior to processing and analysis. To clean the data, we used the Natural Language Toolkit (NLTK), which is a platform for building Python programs to process textual language data. NLTK provides interfaces to more than 50 corpora and lexical resources, such as WordNet. We primarily used the suite of text processing libraries for tokenization, stemming, tagging, and parsing.

For the data cleaning and pre-processing, we preformed the following steps on each discussion forum message:

1. Remove html tags
2. Remove punctuation
3. Remove stop words, and make words lower case
4. Remove non-ASCII code words
5. Applied stemming

We left any posted URLs within the messages.

METHODS
In our analysis, we took two distinct approaches for investigating each of our research questions.

Content Analysis Approach
For research question one, we performed content analysis using the Linguistic Inquiry and Word Count package. Linguistic Inquiry and Word Count (LIWC) is an application that affords analysis of a wide variety of different features of text, including linguistic processes such as number of pronouns. It also provides for analysis of psychological processes, such as affective practices.

We used LIWC to conduct a topical and term analysis of the messages. This textual analysis provided us a foundation to conduct a more ambitious analysis focused on cognitive learning.

Taxonomy of Cognitive Learning Analysis Approach
For research question two, we draw on constructs of learning levels in the cognitive domain as articulated by Anderson and Krathwohl (2001), an updated variation of Bloom's Taxonomy of the cognitive learning domains (Bloom & Krathwohl, 1956).

Bloom's taxonomy is one of the most widely accepted cognitive learning frameworks. In 1956, a team of educational theorists led by Benjamin Bloom developed a series of learning categories that categorized questions by level of abstraction, and Bloom's taxonomy is now a well-known classification of learning in the cognitive domain (Bloom & Krathwohl, 1956). Bloom's taxonomy is based on difficulty of abstraction, ranging from recognition of facts to development of creative concepts.

Since its initial publication, a number of investigations have examined the theoretical validity of Bloom's taxonomy with mixed results. For comprehensive reviews of the studies, see (Furst, 1981; Seddon, 1978). However, Bloom's taxonomy is widely accepted in a variety of research fields and has had substantial impact in the field of learning. Given its wide acceptance and use, the taxonomy is regarded as a functional and, therefore, successful

framework for examining learning in a variety of domains (Seddon, 1978).

One of the governing principles of the taxonomy is its descriptive scheme in which each type of learning goal can be represented in a relatively context free manner (Bloom & Krathwohl 1956 p. 14). In this respect, one can use the taxonomy to determine the level of learning, while crafting questions for an educational setting. There are several articles on how to develop questions based on Bloom's taxonomy (cf. Lord & Baviskar ,2007).

Classification	Definition
Remembering	Retrieving, recognizing, and recalling relevant knowledge
Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, explaining
Applying	Carrying out or using a procedure through executing, or implementing
Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, attributing
Evaluating	Making judgments based on criteria and standards through critiquing
Creating	Putting elements together to form a coherent whole

Table 1. Anderson and Krathwohl's taxonomy with definitions (conceptual level).

In this research, we flip the normal use of the taxonomy. The typical approach is to use the taxonomy to develop exam questions or learning objectives. Instead, we use the taxonomy to classify existing forum messages to determine if they confirm to an existing level in the taxonomy. Our assumption is that, as the messages are part of an information seeking process, the messages will contain keyterms that identify the appropriate learning level.

Anderson and Krathwohl's taxonomy (2011), is the specific taxonomy that we employed in this research. The gist of the Anderson and Krathwohl's taxonomy (2011) is presented in Table 1.Classifying discussion forum messages employing on Anderson and Krathwohl's taxonomy is not straightforward. Although the categories reflect distinctions among the behavior of learners, Bloom and other researchers acknowledge that classifications are not sharp (Anderson & Krathwohl, 2011).

Therefore, we also concede that the classification attributes that we developed may not be exclusive of each other.

However, there are prior works on developing such questions and learning objectives (cf. Lord & Baviskar, 2007; Ferguson, 2002), and we leveraged previous works on developing the attributes for each level (cf. Lord & Baviskar, 2007; Ferguson, 2002). Table 2 presents the key elements used to classified forum messages, using the present of keywords derived from prior work, both academic and practitioner. We leverage 244 recognized cognitive learning key terms from which we developed a key term listing to facilitate identification of the cognitive level of discussion forum messages (Cannon & Feinstein, 2005; Munzenmaier, 2013).

Classification	Classifying forum message
Remembering	Message must describe, list, or name factual information
Understanding	Message must translate, construe, interpret, or extrapolate information
Applying	Message must exploit information and put the resulting knowledge into action
Analyzing	Message must deduce, scrutinize, or survey information
Evaluating	Message must appraise or relate information to the real world
Creating	Message must formulate, generate, restructure, or combine information

Table 2. Classification characteristics for discussion forum messages (operational level).

RESULTS

Based on our investigation of online discussion forum messages from *Introduction to Art: Concepts and Techniques*, we find explicit learning aspects in information seeking and providing the messages and interacting among those messages. We first discuss the results of our content analysis.

Linguistic Inquiry and Word Count Analysis
LIWC can analyze more than 80 different parts of text. Based on our examination, the two parts of text that seemed to have the most impact in online discussion forums are (a) pronouns and (b) affective processes.

Concerning the use of pronouns, there was a decrease, although marginally non-significant, use of personal pronouns within post and messages over the 7 weeks of the course, as shown in Figure 4.
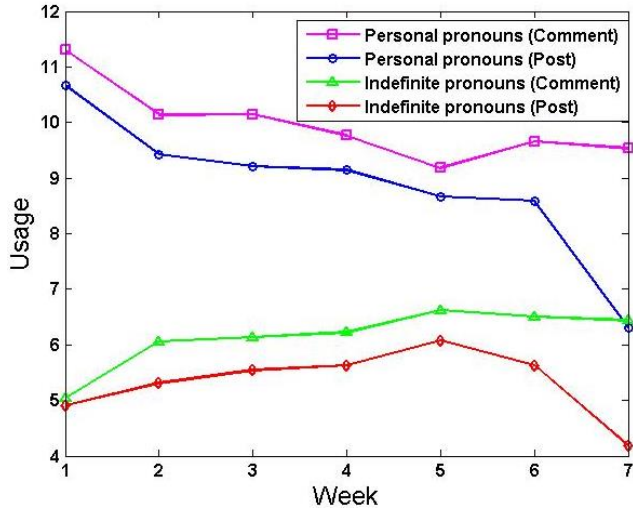
Personal pronouns are words that are associated with a particular grammatical person. Indefinite pronouns are pronouns that do not refer to any specific person, object, or place.

The average use of personal pronouns dropped from 10.76 during week 1 to 9.40 during week 7 for posts and dropped

from 11.30 to 10.16 for comments. The average use of indefinite pronouns was 4.91 in week 1, rising to 6.08 in week 5, before dropping to 5.04 in week 7 for posts.

For comments, the use of indefinite pronouns was 5.04 in week 1, rising to 6.44 in week 6, dropping to 6.04 in week 7.

Figure 4. Use of pronouns over the 7-week Penn State MOOC: Introduction to Art: Concepts & Technique.

The use of pronouns has been acknowledged as an indicator of focus and attention (Campbell &Pennebaker, 2003). So, it would indicate that there was a decrease in individual focus as the course progressed, perhaps indicating a broadening of message topics to overall course theme or topics.

Some examples of pronoun term usage in the course are:

*Hi Francelene **I** guess you can use the envelope if **you** want to but there is not need. In my case **I** am going to use a different material for my envelope (not paper) so will not be possible to mail my artwork! Good luck with the assignment.*

*Hi Sarah Great painting. **I'm** drawn into it and want to explore all angles of it.*
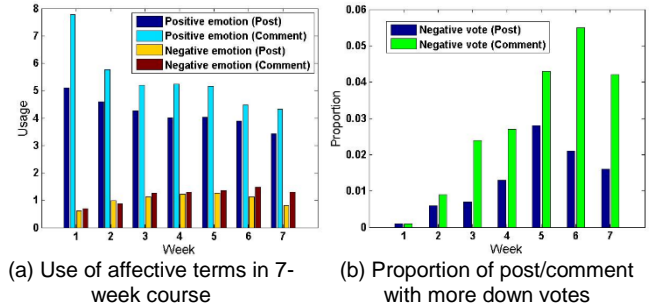
*That tree is amazing and **you** added such life to it. **I** agree with your comments about Goldsworthy and I'm sure **he** would have liked it also*

*Does **anyone** know if it is acceptable to submit additional photos if needed? The directions for the assignment state the work can be any size and even mentions multi-sided cards- but does not address this issue.*

*The **other** threads have been amazingly positive. See especially the thread where folks are posting their work for this week for comment.*

We also examine use of affective processes, such as positive emotions, love, amazing; negative emotions,

anxiety, anger, sadness, based on the occurrence of linguistic content, with results shown in Figure 5(a). This analysis provides sight of affective state of forum discussions that could be considered as an alternative approach for sentiment analysis in course-level communication (Yu, Kaufmann, & Diermeier, 2008; Gonçalves., Araújo, Benevenuto, & Cha, 2013).

(a) Use of affective terms in 7-week course
(b) Proportion of post/comment with more down votes

Figure 5. Use of affective terms over the 7-week Penn State MOOC: Introduction to Art: Concepts & Technique and the Reflection on Votes.

We see that average usage of positive emotion terms dropped from 5.14 for posts/7.77 for comments during week 1 to 3.42 for post/4.32 for comments during week 7. The use of affective terms is tied to concepts such as self-efficacy. In addition, an increasing trend of the use of negative emotion terms can also be observed. A similar trend also reflects on the proportion of posts and comments that receive more *down* votes than *up* votes (see Figure 5(b)). (The vote feature in the MOOC forum allows users to express their opinions whether a post or comment is helpful with an up vote or not helpful with a down vote.)

Some examples of affective term usage in the course are:

*That's the point I started this thread. It's not complaining. It's the **disappointment** from the lack of feedback. It could help from making the same mistakes in the future*

*Everyone seems to know what they're doing! It makes me **nervous** to look at all of the wonderful work so many have done. I'm hoping to be inspired by all of you but **scared**.*

*Listen I am not better than you. I feel very **frustrated** because I cannot draw and use color well but with perseverance we can unlock our artistic side. This course is to help us do this.*

*I'm new to art and hoping this course would be **fun** and **exciting**. Always **enjoy** learning something new.*

*Hello Lynn your elephant looks **amazing**!!!!!! And the look in the eyes is so expressive **loved** it.*

Taxonomy of Cognitive Learning Analysis
We then examined the use of cognitive terms in forum messages (i.e. regardless of level of cognitive learning that they represent), as shown in Figure 6. *Average Overall* is

the number of keywords divided by the number of posts. *Average Per Post/Comment* is the number of keywords that occur in the posts or comments that contained keywords.
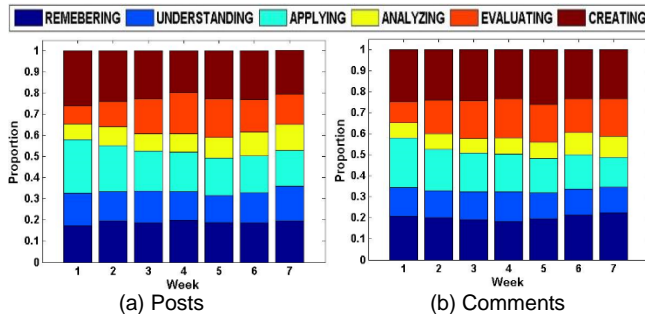

Figure 6. Average and Overall use of cognitive learning terms in posts & comment over the 7-week Penn State MOOC course.

As shown in Figure 6, the occurrence and use of cognitive learning identifying keyterms increases over the seven-week period of the course. The occurrence of cognitive keyterms is also notably higher in posts relative to comments, indicating that posts may be the most impact learning events.

A Kruskal-Wallis test revealed that there was a significant difference by week in the use of cognitive learning terms in posts over the seven weeks of the course (H(6) = 36.6, p < .01). A Kruskal-Wallis test also revealed that there was a significant difference by week on the use of cognitive learning terms in comments over the seven weeks of the course (H(6) = 23.6, p < .01). The trend is an increased use of cognitive learning terms as the course progresses.

We then examined the specific occurrences at each level for both post and comments, as shown in Figure 7.

Figure 7. Use of cognitive learning terms in posts (a) and comments (b) by level over the 7-week Penn State MOOC course.

In Figure 7(a), we map the occurrences of cognitive keyterms by cognitive level per week for posts. We see some general takeaways. First, there is a great variance in the distribution of cognitive term types at the start of the MOOC. By the end of the MOOC, there is a tightening, resulting in a reduced variance of cognitive term distribution by level in the messages.

In Figure 7(b), we map the occurrences of cognitive keyterms by level per week for comments. Interesting, we do not see the same tightening of cognitive term variances as the MOOC progresses, as we start for posts.

In Table 3, we present the number of posts containing cognitive keyterms by cognitive level and by week. In Table 4, we present the number of comments containing cognitive keyterms by cognitive level and by week. From Figure 7 and Tables 3 and 4, we see several trends.

- The proportion of APPLYING decreases in both posts and comments during the 7-week course.

- The proportion of EVALUATING increases from week 1 to week 4, and then decreases, generally, for the last three weeks.

- The proportions of REMEMBERING, APPLYING, EVEALUATING, and CREATING are all similar by week 4 for posts.

- The proportions of REMEMBERING, APPLYING, and EVALUATING are all similar by week 4 for comments.

Some examples of cognitive term usage at each level are:

REMEBERING

*Chirp! haha ""Once I felt"" is a great subheading. I NEED SOME ADVICE on felting...like **how** to source bulk roving and the best quality for high end finished products. Great stuff Ellis! No worries about your esteem...look what you're sharing with us!!!!! Keep going.*

*that's just great. Keep looking to see if I can **identify** the different candies*

UNDERSTANDING

*Thanks for all the pointers. But I was wondering how does ""Paint"" from Microsoft (Windows) **compare** with the tools/packages mentioned here. Thx.*

*I really like your idea. To me it's like the hollow celery stalks **represent** the decommissioned bridge and the rocks the people that use it now. Great that you were able to see the reactions and **discuss** the installation with people as well. Stay inspired!*

APPLYING

*I really like your use of water colour and the different tones you achieved. The **select** colour scheme gives it a*

sense of two opposites fighting for control over your brain. Love it!

*I'm going to do some research and try to practice some of those strokes and try to **adapt** it to my own style. ^^ I really love the effect! I look forward to seeing more of your work I think I could really learn a lot from you!*

ANALYZING

*Suppose it comes down to me not **distinguishing** between digital and hand crafted art any differently to **differentiate** between say painting and sculpture its all art. I'd hazard a guess that your friend has like me access to a good selection of digital and film based kit and uses the right tool for the job in hand!*

*This piece is original because of the combination elements that you chose. If you were to work on further iterations of the idea I think that you would get to a place you feel more comfortable. For example what is the **relationship** between the images and the lines. Exploring those **relationship**s could open new areas of creativity and interest.*

EVALUATING

*   **Agree** with you about black and white. Especially drawings. Sometimes it has an expressive quality that can't be matched by color or more elaborate media. Love especially Degas and Ingres Rembrandt and Hopper's drawings. Have a great book that has the drawings of Henry Moore created when the people of London were hiding in the subways during the bombing of London by the Nazis. It's powerful.*

Somebody else must have said that it looked unfinished. My first thought was that you have managed to get a remarkable likeness!

*The assessor wanted some of the background included to balance the composition probably. I find it difficult to tell how well values have been translated when someone uses newsprint. As for technique ... without seeing a close-up it is difficult to **assess** ... perhaps the assessor found glue smudges or smudged paper? It is very difficult to glue newspaper without getting some smudging. The pieces making up the face could have been smaller to better see the grading of values. After having said all that I also have to add that your portrait is one of the better I've seen. You have managed to make the features show a face which is both sensual and innocent. Shade more around the chin and neck and that darker strand of hair along the cheek and I'm sure you can add some background without the face getting lost.*

CREATING

*It is amazing the way you **compose** the flowers with such amazing combination of colors....each color brings out the others....watercolor is a fun medium to do and you did wonderfully*

*I love photography too even though I don't have good camera and good technique :P. I like to shoot by feeling the beauty of nature moves me a lot! This was taken in last Spring This is the summer busy bee. This was taken in last Fall. This is the winter in 2011. It became colder last winter ice coved all over the pond I didn't get the same pretty picture........ I usually **modify** my pictures in photoshop it makes the colors so beautiful :)*

Tables 3 and 4 show the Kruskal-Wallis H Test results for cognitive terms at each level across weeks. All but one test was significant (***Evaluating*** for comments; see Table 4).

Week	Total Posts		Learning Posts		Learning Keywords Per Post	Number of keywords	REMEMBERING		UNDERSTANDING		APPLYING		ANALYZING		EVALUATING		CREATING	
1	**15500**	**52%**	8565	55%	2.17	18615	3211	17%	2882	15%	**4720**	**25%**	1363	7%	1580	8%	**4859**	**26%**
2	4356	14%	2465	57%	2.06	5091	**1001**	**20%**	695	14%	1105	22%	457	9%	599	12%	1234	24%
3	3173	10%	2018	64%	2.22	4477	834	19%	674	15%	845	19%	365	8%	740	17%	1019	23%
4	2026	7%	1309	65%	2.21	2896	**573**	**20%**	391	14%	544	19%	254	9%	**565**	**20%**	569	20%
5	1433	5%	876	61%	2.23	1952	369	19%	250	13%	341	17%	**192**	**10%**	353	18%	447	23%
6	1204	4%	775	64%	2.32	1796	334	19%	256	14%	311	17%	**203**	**11%**	276	15%	416	23%
7	1903	6%	**1311**	**69%**	**2.96**	3882	**763**	**20%**	**630**	**16%**	662	17%	**468**	**12%**	561	14%	798	21%
Total	29595	100%	17319	59%	2.31	38709	7085	18%	5778	15%	8528	22%	3302	9%	4674	12%	9342	24%
Kruskal-Wallis H Test							H(6)=36.9 p<0.01		H(6)=35.7 p<0.01		H(6)=39.4 p<0.01		H(6)=31.6 p<0.01		H(6)=29.6 p<0.01		H(6)=37.4 p<0.01	

Table 3: Total posts, posts with learning key terms, and number of learning post by level.

Week	Total Comments		Learning Posts		Learning Keywords Per Post	# of keywords	REMEMBERING		UNDERSTANDING		APPLYING		ANALYZING		EVALUATING		CREATING	
1	**7559**	**34%**	2457	33%	1.55	3798	791	21%	**517**	**14%**	**898**	**24%**	278	7%	371	10%	943	25%
2	3698	17%	1680	45%	1.79	3014	607	20%	389	13%	593	20%	222	7%	480	16%	723	24%
3	3343	15%	1726	52%	1.92	3318	629	19%	**449**	**14%**	608	18%	231	7%	597	18%	804	24%
4	2502	11%	1325	53%	1.92	2541	465	18%	**359**	**14%**	458	18%	194	8%	477	19%	588	23%
5	2007	9%	1092	54%	1.88	2058	406	20%	248	12%	341	17%	154	7%	372	18%	**537**	**26%**
6	2026	9%	**1158**	**57%**	1.99	2308	492	21%	285	12%	378	16%	**245**	**11%**	375	16%	533	23%
7	1031	5%	582	56%	1.96	1141	**254**	**22%**	142	12%	160	14%	**114**	**10%**	205	18%	266	23%
Total	22166	100%	10020	45%	1.86	18178	3644	20%	2389	13%	3436	19%	1438	8%	2877	16%	4394	24%
Kruskal-Wallis H Test							H(6)=23.9 p<0.01		H(6)=22,7 p<0.01		H(6)=33.3 p<0.01`		H(6)=14.9 p<0.05		Not Significant		H(6)=24.5 p<0.01	

Table 4: Total comments, comments with learning key terms, and number of learning comments by level.

DISCUSSION

With the analysis of pronoun usage in the forum discussion, we identify that the use of personal and indefinite pronouns in posts and comments share a similar pattern, except in week 7, which a substantially drop of pronouns in forum posts can be observed. A possible reason could be that several posts are created in the last week that focus on course discussion, such as providing feedback to the design of the course. From the study of affective terms used in posts and comments, the positive emotional terms decreased during the course while the negative emotional terms show an increasing tendency. In the first few weeks, a great number of posts are made for self-introductions, and many greeting terms are utilized in those posts; however, more and more complaints can be seen in the following weeks, which may lead to the divergent trends of using different affective terms.

Based on the analysis of messages posted to online discussion forum, explicit educational exchanges are occurring. Therefore, the engagement of students with forums in online courses appears to contribute to student learning. Results from the cognitive analysis illustrate what types of interactions take place on the forums and could be leveraged to refine MOOCs for future offerings. A great number of interactions dealt with techniques, as indicated by the learning level usages. By examining the forum messages, instructors are able to identify content areas that need to be expanded upon and relate these to learning objectives. Designers and instructors are able to refine the alignment of the course goals with what students expect to gain from the course.

CONCLUSON AND FUTURE RESEARCH

In this research, we examined more than 50,000 discussion forum messages, classifying them via a three-level hierarchy. This research introduces an approach using Bloom's taxonomy in analyzing the learning process occurring in a MOOC forum. We performed a content analysis on pronoun and indefinite pronoun usage that shows a similar use pattern in posts and comments. Additionally, affective terms used in the forum discussion are also studied. The result indicates that the use of positive emotion terms is decreased weekly; however, the increasing trend of negative emotion terms can be observed, also reflected in the votes received by posts and comments.

For future research, we will conduct a comparative analysis across multiple MOOCs. Furthermore, machine learning algorithms such as support vector machine (SVM) and naive Bayes could be applied to facilitate the cognitive-level identification process.

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