

# Attending to others' posts in asynchronous discussions: Learners' online "listening" and its relationship to speaking

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**Abstract** Theoretical models of collaborative learning through online discussions presuppose that students generally attend to others' posts. However, a succession of studies over the last decade has shown this assumption to be unwarranted. Instead, research indicates that learners attend to others' posts in diverse and particular ways—an activity we have conceptualized as online "listening." In this study, we take an important step forward in developing a robust theory of online listening by examining the relationship between how learners "listen" (access existing posts) and "speak" (contribute posts) in online discussions. Ten variables indexing four dimensions of students' listening (breadth, depth, temporal contiguity and revisitation) and five variables indexing three dimensions of students' speaking (discursiveness, depth of content and reflectivity) were calculated for 31 students participating in six week-long online discussions as part of an undergraduate educational psychology course. Multi-level mixed-model linear regressions indicated that responsiveness of students' posts was positively predicted by how often they revisited previously read peer posts, and negatively related to a greater number of posts in the discussion overall. The depth of posts' contents was predicted by the percentage of posts viewed that students actually read (as opposed to scanned). An exploratory follow-up analysis indicated that these listening-speaking relationships manifest differently over time for distinct subsets of learners (e.g., a decrease in variable pairs versus corresponding fluctuations around stable levels). Put together, results suggest that when students take the time to read and re-read their peers' posts there are related benefits in the quality of the posts they contribute.

**Keywords** Asynchronous Discussion Groups \* Online Learning \* Student Participation \* Computer Mediated Communication

## Introduction

Asynchronous discussions are often seen as a powerful venue for knowledge construction due to their affordances for thoughtful commentary and reflective responses (Lipponen, 2002). The core premise is that learners build their ideas collectively and individually through dialogue; thus, well-designed and supported online discussions can contribute to learning. Various mechanisms have been proposed to explain such learning, including the act of articulating one's ideas,

receiving feedback on these, the socio-cognitive conflict caused by exposure to divergent views, the taking of multiple perspectives into account, and the internalization of collaborative activity (Stahl 2005; Lipponen, 2002). In common, all depend on two basic interrelated activities that learners must engage in: contributing posts to the discussion, and accessing existing posts (Wise, Speer et al., 2013). When learning discussions are truly collaborative, these two activities are intimately related and inform each other. In contrast, if learners do not attend to others' posts (or do so in unproductive ways) the communication that results may be shallow and disjointed (Thomas, 2002; Webb et al., 2004) and more accurately characterized as a series of parallel monologues rather than a true discussion.

Many studies of computer-supported collaborative learning have examined how students contribute to online discussions, inspecting in detail the comments they make and how subsequent posts relate to prior ones (e.g., Hew et al., 2008; Suthers et al., 2010; Pena-Shaff & Nicholls, 2004). However, the other half of the process is often taken for granted – that is, it is assumed that students are generally attending to others' posts. This is important because it is a critical link in the logical chain by which the meaning of references between posts is interpreted. Specifically, there is a tacit presumption that the threads of conversation picked up and expanded on are chosen purposefully. In other words, the posts responded to are inferred to be *selected* for some reason out of the full set of existing posts.

However, a succession of studies over the last decade has shown these assumptions to be unwarranted (Hewitt, 2003; Peters & Hewitt, 2010; Palmer, et al. 2008; Dennen, 2008; Brooks et al., 2013; Thomas, 2002). Specifically, examination of overall student reading patterns has suggested generally limited and shallow engagement with previous discussion posts (Hewitt, 2003; Palmer et al., 2008; Brooks et al., 2013). Students often attend to their peers' posts very briefly, simply scanning the contents before moving on (Peters & Hewitt, 2010), and they rarely return to view a post a second time (Hewitt, 2005). Some messages posted to a discussion are never even viewed by any students at all (Thomas, 2002).

This evidence initially suggested the converse of the original presumption of attention to others' posts: that, in fact, students generally disregard their peers' comments. This would pose a serious problem for online discussions as a medium for computer-supported *collaborative* learning. However, the above-mentioned studies did not investigate differences across students; thus, instead of universally low attention, it is possible that some learners attend to others' posts more than others. Our recent work (Wise, Hsiao et al., 2012a; Wise, Marbouti et al., 2012; Wise, Perera et al., 2012; Wise, Speer et al., 2013) described in detail below, has documented that indeed students attend to each other's posts in diverse ways, many of which are not disregarding. More importantly, an online discussion is not a single entity to which a learner simply does or does not attend. It is an ever-growing collection of multiple posts, often related to each other in complex structures. Thus, the critical question to be concerned with is not simply *whether* students attend to others' posts in a discussion or not, but *how* they do so.

Over the past four years we have developed a research program examining the different ways students do (and do not) attend to others' posts in online

discussions. In considering this collection of behaviors as part of meaningful activity within online discussions and a critical part of the knowledge construction process, we have offered the term “online listening” to move the discourse away from prior language that is either overly generic (“reading”) or passive and pejorative in nature (“lurking”). A further explanation of how we conceptualize online listening and differentiate it from these prior terms is provided in the following section.

While our work examining students’ online listening behaviors has documented the rich and varied patterns of attention to existing posts that lie under the surface of online discussions (e.g., Wise, Hsiao et al., 2012a; Wise, Hsiao et al., 2012b; Wise, Perera et al., 2012), it has not yet connected such behaviors to the ways students contribute to the discussions. Some listening behaviors seem intuitively more desirable than others (e.g., attending to a large rather than small number of discussion posts); however, among the diverse patterns found it is not always clear which behaviors are most productive and should be encouraged. For example, is it more beneficial for students to log-in frequently but relatively briefly, or in a smaller number of extended sessions? Even when a listening behavior appears theoretically advantageous for discussion, it is important to specifically articulate how the particular behavior is thought to contribute to “better” discussion processes and to test these propositions empirically. Thus connecting students’ listening behaviors to their discussion contributions (i.e., “speaking” behaviors, as explained further below) is critical to developing a robust theory of online listening. In this paper we begin to bridge this gap by examining the relationship between students’ online listening and speaking activities.

## **Conceptualizing listening in online discussions**

### *Online listening: Definition and characteristics*

We have coined the term online listening behaviors in reference to the ways students attend to each other’s posts in online discussions in order to leverage the conceptual similarities between the act of attending to others’ comments in this digital context and that of listening (auditorily) in face-to-face discussions. We argue that this is useful because the purpose and many of the properties of the activity of listening in aural and written discussions are fundamentally the same. While there are certainly also differences (discussed below), using the metaphorical notion of listening to refer to the ways in which students attend to each other’s posts in an online discussion gives us a conceptual entrée to language that considers attention to others’ posts as an integral and productive part of discussion activity.

To begin, “listening” in a discussion, both online and face-to-face is the activity of attending to the ideas of another individual that have been externalized through language. Different from the physiological processes of hearing words that have been spoken or seeing words written on a screen (the biological mechanisms through which the externalizations of language are received), *listening* is a complex cognitive activity involving numerous mental processes and decisions (Strother, 1987; Burleson, 2011). That is to say, listening is an active, rather than passive

activity that includes elements of processing another's ideas. Importantly, prior experiences will influence how an individual listens to particular messages, thus different people can perceive the same message in different ways (Bodie et al., 2008). Additionally, the idea of listening to (as opposed to simply hearing) a message connotes a certain amount of openness to considering ideas, beliefs and values that may conflict with one's own (Garrison, 1996). Such dissonant views can be attended to in a variety of ways, such as simply attempting to comprehend the comment or critically examining what has been said. Importantly, in the specific context of a discussion (whether online or face-to-face), listening is not an isolated endeavor, but an integral component of the larger activity of giving, receiving, negotiating, building on, and challenging others' ideas. Thus, the purpose of listening and the way one engages in it go beyond the simple reception and consideration of others' ideas to that of formulating a contribution. In this sense, listening in a discussion makes an important contribution to speaking by supporting subsequent comments that relate to those already made. Particularly, for online discussions in an educational context, this is critical in supporting learning because it is through the exchange of ideas and negotiation of meaning with others that collaborative learning is thought to occur (Pena-Shaff & Nicholls, 2004).

We have detailed the ways in which the purpose and fundamental properties of listening are the same in discussions conducted face-to-face or online. However, there are also important differences. One of the main characteristics of online discussions that has notable implications for listening is their asynchronous temporality (Wise, Zhao et al., 2013b). Specifically, in online listening, learners are not constrained by the timeline in which comments are made (Jonassen & Kwon, 2001); thus they can attend to the text-based expressions of others' ideas when, for how long, and which order they choose. In addition, online discussions are generally threaded—meaning that a conversation can branch off in multiple directions. These features give learners a larger decision space related to listening and thus a greater range of possible behaviors. As learners choose to attend to different posts, at different times, and in varying orders, they each listen to the same conversation in different ways. In other words, contrary to a face-to-face discussion, online discussants each have their own unique listening timeline rather than a communal one (Wise, Zhao et al., 2013b). For example, a learner may choose to log-in to a discussion frequently, attending to single comments as they are made, or they might engage in fewer, but longer sessions, attending to a group of comments in a particular thread regardless of when they were contributed. Similarly, learners have control of for how long they attend to each post, practically manifested as reading or scanning posts (Hewitt et al., 2007). They are also able to take as much time as they need to consider the existing comments before composing a response (Harasim, 2000). In addition, asynchronous online discussions allow learners to easily re-attend to comments they found particularly interesting, important or confusing. However, as the listening decision space becomes larger, certain difficulties also arise. For example, students report feeling overwhelmed and not knowing where to start when they encounter a voluminous or heavily branched discussion (Peters & Hewitt, 2010). As a result, their listening decisions may be driven by efficiency,

coping strategies or superficial features of the discussion interface (Wise, Marbouti et al., 2012).

In summary, the notion of online listening is useful in conceptualizing how learners' attend to other's comments as an active, individually-driven and integral part of online discussion participation. In the following sections we highlight specific differences and advantages of the notion of online listening over previous terminology.

### *Why listening rather than "lurking" or "reading"*

Some prior work examining how people attend to others' contributions in online spaces has referred to this process as "lurking" and those who engage in it as "lurkers" (Nonnecke et al., 2004; Rafaeli et al., 2004). While such work has been useful in bringing to light previously unexamined online activity, we find the term "lurker" problematic in several ways when referring comprehensively to how people attend to other's posts in online discussions.

First, a lurker is generally thought of as someone who accesses an online discussion, but does not contribute or become "actively involved" (Preece et al., 2004). Immediately, this creates difficulties since it implies that attending to others' posts is a passive activity requiring little cognition or decision making. It also isolates the activity of accessing posts from that of making them, ignoring the important interdependencies between the two. There is a similar problem with several other terms such as "vicarious interactors" (Sutton, 2001) or "read-only participants" (Nagel et al., 2009); all of which focus only on those individuals who do *not* contribute to a discussion. This has given the term lurker a negative connotation (because of the lack of contribution); however as described above, the act of attending to others' posts in an online discussion can very much be a part of productive discussion activity. Practically, users who have the highest activity in accessing others' posts are often also the most active contributors (Muller et al., 2010); thus, looking at these behaviors for only non-contributors leaves out an important part of the picture. Finally, in the context of formal learning discussions where there is an expectation (and often a requirement) that learners contribute, the concept of lurkers excludes the majority of individuals involved.

The ways in which learners attend to others' posts in an online discussion has also been referred to as "reading" (Nagel et al., 2009; Hewitt, 2003). While the *physiological* processes of reading text in an online discussion and that of a book are the same, the *cognitive* processes involved in the activities differ due to the nature of the text. Specifically, reading often involves a static text that was written by a single author (or collaborative team) as a cohesive whole; examples include books, essays, newspaper articles etcetera. In contrast, online discussions are multi-authored, dynamic and consist of discrete sub-units (posts), which must be made sense of together (Wise, Marbouti et al., 2012). Due to these differences, participants in an online discussion need to engage with the text in particular ways to make sense of it. For example while we often read a book linearly from start to finish, knowing that we can take a rest and return to the same point we left off with nothing having changed, within a discussion there are multiple branches to choose from, comments

can be added to previously read parts of the text, and there is a need for the reader to mentally integrate (and evaluate) the ideas contained in posts made by different authors. While these efforts are particularly pronounced when posts are disjointed, even in a coherent discussion interrogating the relationships between posts is an important part of the sense-making that helps one determine where to position oneself in the conversation. Thus, the generic term reading has some of the same problems as the term lurking in that it refers to the taking in of the externalization of another's work without connecting it to the eventual process of contributing to the discussion. In sum, attending to others' comments is an important part of productive online discussion activity with qualities not well captured by the terms "lurker" or "reading."

#### *What we know about listening in online discussions*

Over the past four years we have explored students' online listening behaviors in a series of studies looking at the different ways students access others' posts in online discussions and their motivations for doing so. This work has informed our understanding of students' online listening behaviors in several ways. At the most basic level, the research consistently shows that listening activities make up a substantial portion of learners' participation in online discussions (Wise, Speer et al., 2013; Wise, Hsiao et al., 2012a). For example, looking across 95 students in a blended undergraduate business course, almost three-quarters of the time spent in the system (and an even greater percentage of the actions taken) was devoted to accessing existing posts (Wise, Speer et al., 2013). In addition, on average students viewed 65% of their peer's posts at least once. However, these figures vary greatly among individual students. For example, in a series of case studies of undergraduates in a fully online education class, the proportion of total time spent on listening activities ranged from 47% to 97% and the percentage of peer's posts viewed ranged from 38% to 100% (Wise, Hsiao et al., 2012a). Notably, even in the cases at the lower boundary, listening actions still accounted for a substantial portion of activity in the discussions. Thus while it cannot be generally said that students do or do not attend to each other's posts, we can assert that online listening behaviors are an extensive part of discussion participation. Equally important, students' listening behaviors are clearly diverse. We now move from the question of if students attend to others' posts in online discussion, to examine the different ways in which they do so.

#### *Common listening patterns*

In our research we have found several recurring patterns in how students attend to others' posts (Table 1).

Table 1. Listening patterns and their characteristic behaviors

Listening Pattern	Characteristic Behaviors
Disregardful	Minimal attention to others' posts (few posts viewed; short time viewing). Brief and relatively infrequent sessions of activity in discussions.
Coverage	Views a large proportion of others' posts, but spends little time attending to them (often only scanning the contents). Short but frequent sessions of activity in discussions, focusing primarily on new posts.
Focused	Views a limited number of others' posts, but spends substantial time attending to them. Few but extended sessions of activity in discussions.
Thorough	Views a large proportion of other's posts and spends substantial time attending to many of them. Long overall time spent listening; considerable revisitation of posts already read.

The first pattern is characterized by minimal attention to the posts of others; we refer to this as *disregardful* listening. Students exhibiting this pattern demonstrate shallow behaviors in attending to other's posts, viewing few posts overall and spending little time on those they do view (Wise, Speer et al., 2013; Wise, Hsiao et al., 2012b). These students tend to spend minimal amounts of time in discussions, often enacted through short and scattered visits (Wise, Hsiao et al., 2012a). Together, these behaviors denote a disregard for their fellow students' contributions. As an illustration, Student 37 in Wise, Speer et al. (2013), logged-in to the discussion few times, spending most of this time reading the discussion prompt and composing his own response. In total he viewed only 35% of his peer's posts in the discussion, spending a very short time on each.

The second pattern is characterized by viewing many posts in a discussion but spending little time on each; we refer to this as *coverage* listening. Coverage listening differs primarily from disregardful listening in that it has a greater quantity of discussion posts viewed (Wise, Hsiao et al., 2012a). However, attention to these is superficial as students spend limited time reading each post, often only scanning quickly before moving on (Wise, Perera et al., 2012). A coverage listening pattern demonstrates new post bias (Hewitt, 2003; 2005) where listening activity is directed primarily towards new posts in the discussion, and students commonly have short but frequent sessions of activity as they log in often to see if there are any new posts to view (Wise, Perera et al, 2012; Wise, Hsiao et al., 2012a). Some learners exhibiting a coverage pattern also spend time going back to their own posts to review and/or edit what they previously wrote (Wise, Hsiao et al., 2012a; Wise, Perera et al, 2012). A coverage approach to listening in discussions may be content-driven or socially-motivated. When content-driven, students seem to treat the discussions as an additional text for the class; viewing all posts but not referring to them directly in their own comments. For example, "Gigi" in Wise, Hsiao et al., (2012a) opened almost every post in her discussion, but only briefly. She often reviewed her own posts, toggling between them and other's posts in a seemingly comparative fashion, but took a formal academic tone in her posts, never mentioning anyone else's ideas. In contrast, when socially-motivated, a coverage listening pattern is associated with posts that repeatedly acknowledge others' comments with casual language ("nice

comment!”), but provide minimal engagement with their ideas (Wise, Hsiao et al., 2012a; Wise, Perera et al., 2012).

In contrast to a coverage approach, the third listening pattern is characterized by extended attention to a select number of posts (Wise, Perera, et al, 2012; Wise, Hsiao et al., 2012a). We refer to this as *focused* listening. Students exhibiting this pattern tend to have a limited number of sessions, but they are of greater length than those seen in disregardful or coverage patterns (Wise, Speer et al., 2013). Students exhibiting focused listening also have a higher percent of sessions where they integrate their listening with their posting (Wise, Hsiao et al., 2012a). As an illustration, “Ron” in Wise, Hsiao et al. (2012a) participated in the discussion in just several long sessions. In these he viewed only 38% of his classmates’ posts, but he spent an extended amount of time on those he did read and often contributed a post after reading those of his peers. Focused listening may be directed toward particular content or individuals in the discussion, or reflect a general selectivity in what is read. For example, “Isabel” in Wise, Perera, et al (2012) attended only to posts made by her instructor.

The final listening pattern is characterized by both attention to a high proportion of the posts in a discussion and also extended time spent on each post. We refer to this as *thorough* listening. Of the different patterns, thorough listening tends to spend the longest overall time in discussions (Wise, Hsiao et al., 2012a). Learners exhibiting this pattern often have a large number of sessions in which they come in to the system to view new posts but may also go back and revisit previous ones read (Wise, Perera et al., 2012; Wise, Hsiao et al., 2012a). As an illustration, “Tracey” in Wise, Perera et al. (2012) spent the vast majority (87%) of her time in the discussion reading others’ posts. She viewed every post at least once and took her time reading most of these. She often revisited posts previous read and when she replied, it was always to a post that she had revisited at least 3 times.

Taken together, these four listening patterns characterize the majority of listening activity we have observed across various studies. While most learners exhibit a single listening pattern throughout their discussion participation, at times learners may combine patterns. For example, Student 82 in Wise, Speer et al. (2013) followed a coverage pattern for most of their discussion week, but exhibited a focused pattern in their final, extended session. Because learners’ actions do not always neatly align with a single listening pattern, it is also useful to be able to describe specific characteristics of their listening behavior over time.

### *Dimensions of online listening*

As can be seen above, students attend to others’ posts in online discussions in distinct and varied ways. However, some unifying dimensions across patterns can be identified (Wise, Speer et al., 2013). In particular, the four patterns described above can be uniquely distinguished by their breadth and depth of listening (Table 2). Listening breadth refers to the extensiveness of listening and can be considered both in terms of the total quantity of other’s posts attended to (indicating the potential the diversity of ideas to which a learner is exposed) or their proportion out of the total number available (suggesting their ability to respond to the discussion as a whole).



Listening depth refers to the degree to which learners consider others' ideas. It is difficult to assess precisely the amount of attention given to others' posts but listening depth can be considered indirectly in terms of the amount of time spent on each post (a weak indicator of the amount of cognitive processing involved) or the proportion of occasions in which posts are attended to for long enough to allow for comprehension of the text (indicating if others' ideas are being generally considered) [Hewitt, et al. 2007]. Thus, the coverage listening pattern described above is characterized by high breadth, but low depth of listening, while the focused listening pattern exhibits high depth but low breadth. Disregardful listening is low across both dimensions, while thorough listening is high across both.

Table 2. Alignment of four listening patterns by breadth and depth

Depth	Breadth	
	Low	High
Low	Disregardful	Coverage
High	Focused	Thorough

In addition to breadth and depth, the four listening patterns can also be described in terms of their temporal contiguity, (how a learner manages and divides their time within a discussion) and listening revisitation (the extent to which a learner returns to posts made by themselves and others that they have attended to previously). With respect to temporal contiguity, learners in online discussions establish their own timelines of participation (Jonassen & Kwon, 2001); thus, they choose the number of times to log-in and if they spend these sessions primarily attending to others' ideas or also contributing their own. For example, coverage and thorough patterns are characterized by a higher number of sessions than focused and disregardful patterns; and many of these are devoted solely to listening. Revisitation refers to the frequency with which a learner re-attends to posts made by themselves and others. As mentioned previously, learners exhibiting a thorough listening pattern characteristically revisit posts made by their peers multiple times, while those exhibiting a coverage pattern often spend substantial time revisiting their own posts (Wise, Hsiao et al., 2012a; Wise, Perera et al., 2012). Both focused and disregardful patterns tend to have fewer revisitations of any kind.

### **Connecting listening to speaking**

Above, we described common patterns of listening behavior and their key characteristics. However, it is not yet clear if and how such behaviors contribute to "better" discussion processes. To address this question, in this study we proposed and tested connections between particular listening behaviors and the quality of comments made to a discussion.

### *Conceptualizing speaking quality*

The different characteristics, functions, and qualities of posts in online discussions have been theorized and studied by many researchers (for a selected overview see reviews by De Wever et al, 2006 and Hew et al., 2010). Given the wealth of established work in this area, it is neither expedient nor useful to develop yet another idiosyncratic scheme for assessing post quality in online discussions. However, there is always a danger in adopting a pre-existing model that may carry strong epistemological or conceptual assumptions. Thus, our approach to conceptualizing speaking quality was to look across the most commonly used models to identify the core components considered important and create a scheme that could be easily used across a variety of discussion contexts. Examined together, three common dimensions can be seen as important in a large number of models of discussion post quality: discursiveness (that learners' comments refer to each other in meaningful ways); content (that the learning material is thoughtfully considered); and reflectivity (that the learning process itself is taken as an object for examination).

To begin, for discussions to function as interactive dialogues rather than a series of parallel monologues (Boulos & Wheeler, 2007), posts need to contain discursive elements through which participants link their comments to each other. These elements can be responsive (e.g., expressions of social support, proposing consensus) or elicitative (e.g., asking questions). Responsiveness itself can take many forms; at a basic level a simple act such as acknowledging others may create the social support required for individuals to build trust, which is required in helping students take risks within a discussion (Cheung et al., 2008). At a deeper level, when students respond to the ideas in a post they may expand or challenge that student's (and others') existing thinking, and when they respond to multiple ideas synthetically they can initiate a process of developing collective understanding (Gunawardena et al., 1997). Similarly students may elicit responses from others by asking questions which can also contribute to the interactivity of the dialogue as it promotes further responsiveness.

In addition to discursiveness, the extent to which posts engage with academic content is central to learning through online discussions. A common way to assess this across multiple discussion topics draws on the argumentation literature and looks at the degree to which students make claims, and use reasoning, evidence, and theory to support them (e.g., Lin et al., 2012; Weinberger & Fischer, 2006). This is a more formal way of considering and connecting many elements of content quality long considered important such as engaging in critical analysis, expressing thoughts clearly, providing support for ideas, and drawing on sources (Rovei, 2007; Pena-Shaff & Nicholls, 2004, Hara et al., 2000; Wise, et al. 2010). The underlying notion is that richer argumentation structures (more content-related claims and the greater use of supporting evidence, and theory) indicate deeper consideration of the learning material. Finally, the opportunity for reflectivity has been cited as a particular advantage of asynchronous online discussion since time-unlimited review of earlier parts of the discussion is possible (Harasim, 2000; Knowlton, 2005). Within a discussion, a student may consider the process of the group's knowledge

construction (Knowlton, 2005), but also the development of their own ideas on a topic (Pena-Shaff & Nicholls, 2004).

Put together, these dimensions (discursiveness, content, and reflectivity) provide a useful framework with which to examine the contributions a post makes to a discussion. In the next section we describe theoretically predicted relationships between these aspects of speaking quality and dimensions of online listening.

### *How listening and speaking might relate*

Theoretically, speaking and listening are intimately interrelated activities in the process of constructing knowledge through online discussions; however, such connections have not yet been examined empirically. Considering first breadth of listening, as students attend to a greater proportion of their peer's posts they are exposed to a greater number and diversity of ideas. Thus, we would expect them to be more discursive in their own comments, responding to and eliciting ideas from others. In addition as they become aware of a greater number of perspectives and views on the discussion topic, they are also likely to create posts with more sophisticated argumentation that supports, and perhaps qualifies, their position with respect to these other views.

Depth of listening is also expected to support both discursiveness and argumentation. First, a richer understanding of peers' ideas should support more thoughtful responsiveness to others' ideas as well as elicitation of further elaborations. Increased depth should also lead to stronger argumentation as students support or qualify their ideas based on this understanding. Although it is certainly possible to compose a post with strong argumentation without reading others' posts, we argue that attending to others' posts provides a context and the need to argue for one's own perspective as well as potentially acknowledge its limitations in the face of another viable position.

Turning to revisitation, re-attending to already viewed peer posts suggests additional consideration of the ideas contributed by others, and thus would be expected to further support discursiveness and argumentation in the ways described above. Returning to ideas considered (or contributed) previously also can support the process of reflecting on group and individual learning processes by helping learners see how ideas have developed over time. Reflection may also be supported by temporal dispersion; if students distribute their participation across multiple days and sessions they may be able to notice changes in their own and others' views. In contrast the temporal contiguity of conducting listening and speaking actions in the same session may be needed as a foundation for relationships between the two activities to be established.

### **Research questions**

Our primary research questions probed the listening-speaking relationships described above:

1. What listening behaviors are associated with the discursiveness of a student's post in terms of responsiveness and elicitation?

2. What listening behaviors are associated with the depth of content of a student's post in terms of argumentation?
3. What listening behaviors are associated with the reflectivity of a student's post in terms of individual and group reflection?

In addition, we asked a follow-up question of a more exploratory nature:

4. How do listening-speaking associations manifest over time for learners exhibiting different listening patterns?

## Methods

### *Learning environment and participants*

Students in a fully online undergraduate course on educational psychology participated in six week-long small-group asynchronous discussions with 8-10 classmates. There were five discussion groups in total. For each discussion, students were given two contrasting perspectives on an authentic educational controversy taken from their textbook. They were asked to debate the merits of the two positions and by the end of the week come to a collectively agreed on position with rationale. Students were required to contribute at least two posts per topic on different days and given guidance for making high quality posts (explore and explain ideas, extend the existing conversation, give rationales and explanations, use supporting evidence from your textbook, compare the different arguments that have been made, identify areas of consensus and dissonance).

Discussions took place within Phorum, a basic linear asynchronous discussion tool with threading. Discussions were conducted in three two-week sets (weeks 3/4, 8/9 and 11/12); the instructor gave students feedback on their individual participation and their group's final consensus after the first two discussions (worth 5% of the course grade) and the latter four (worth 20%). Prior to the formal discussions, students were given the opportunity to get to know each other during an orientation week. Thirty-one of 52 students enrolled in the course consented to have data on their discussion participation collected for the study.

### *Listening variables*

Clickstream (log-file) data was collected on all actions students took in the system to assess listening activity; action types were "view" (opening others' posts), "post" (creating a post), "review" (revisiting previously viewed posts), and "edit" (making changes to one's previous posts). The log for each action contained the action type, a time-date stamp, ID of the student taking the action, and length (number of words) of the post acted on. Extracted data was filtered by user ID to separate participants, and times between subsequent actions were subtracted to calculate action duration.

Views were subcategorized as scans or reads based the ratio of post length to time spent compared to a maximum reading speed of 6.5 words per second (wps) [Hewitt et al., 2007]. Because log-file data is recorded as a continuous stream without a

formal system log-out, sessions of activity needed to be determined manually. Breaks between periods of activity can be detected by atypically long action durations (e.g. a “view” action calculated as lasting 16 hours suggests abandonment of the system). A maximum allowed action length of 60 minutes was set (Wise, Speer et al. 2013). Any action exceeding this threshold was taken to be the end of a session of activity, and the action’s duration was recalculated as an estimate based on the student’s average speed conducting the action and the length of the post acted on. Ten variables were calculated for the four different listening dimensions (Table 3).

Table 3. Summary of ten listening variables along four dimensions

Dimension	Variable	Definition
Breadth	% of others’ posts viewed	# of unique posts made by others that a student viewed divided by the total # of posts made by others
	% of others’ posts read	# of unique posts made by others that a student read divided by the total # of posts made by others
Depth	% of real reads	# of times a student read others’ posts divided by their total # of views
	Av. length of real reads (min)	Total time a student spent reading posts, divided by the number of reads
Temporal	# of sessions	# of times a student logged-in to the discussion
Contiguity	% of sessions with posts	# of sessions in which a student made a post, divided by their total # of sessions
	Participation range (days)	# of days between when a student first and last logged-in
Revisitation	# of reviews of own posts	# of times a student reread posts they made
	# of reviews of instructors’ posts	# of times a student reread posts made by the instructor
	# of reviews of other’ posts	# of times a student reread posts made by others they had viewed previously

### *Speaking variables*

All 479 posts made by participants were extracted from the discussion tool and coded by two researchers for the five speaking variables described previously to evaluate post quality. The post was used as the unit of analysis for both theoretical and practical reasons as this was the unit through which students expressed their ideas in interaction with others and it presented an unambiguous basis for segmentation. Coding was based on a combination and adaptation of prior schemes and models by Hara et al. (2000), Knowlton (2005), Pena-Shaff & Nicholls (2004), Weinberger & Fischer (2006), and Wise, Saghafian et al. (2012); see Table 4 for an overview of the scheme used and Cohen’s kappa for each scale.

Table 4. Overview of coding scheme and Cohen's kappa for speaking variables

Discursiveness	
Responsiveness ( $\kappa = 0.71$ )	Elicitation ( $\kappa = 0.91$ )
0 None	0 None
1 Acknowledging	1 Questions not clearly directed to anyone
2 Responding to an idea	2 Questions directed to one person
3 Responding to multiple ideas	3 Questions directed to the group
Content	
Argumentation ( $\kappa = 0.74$ )	
0 No argumentation	
1 Unsupported argumentation (Position only)	
2 Simple argumentation (Position + Reasoning)	
3 Complex argumentation (Position + Reasoning + Qualifier/preemptive rebuttal)	
Reflectivity	
Reflection on Individual Process ( $\kappa = 0.83$ )	Reflection on Group Process ( $\kappa = 0.75$ )
0 No individual reflection	0 No group reflection
1 Shallow individual reflection	1 Shallow group reflection
2 Deep individual reflection	2 Deep group reflection

### *Statistical analysis*

Multi-level mixed-model linear regressions for each speaking variable on predicted relevant listening variables were conducted to examine relationships. Because students' discussion behaviors may change across a series of discussions, aggregating data across the entire semester could obscure relationships between listening and speaking behaviors. Thus, models were based on variable averages calculated for each discussion week, the unit of activity in the course. For each model, the explanatory variables of interest were included as fixed effects (Table 5), as was Number of Posts per Group and Number of Posts per Student, while effects of group-membership, discussion-week, group-by-week interactions, students-nested-within-groups and student-by-week interactions were included as random effects.

We initially tested for random-effect student-by-predictor and group-by-predictor interactions, however the variation was non-significant, thus the interaction terms were discarded and the model was fit assuming the same relationships of predictors to dependent variables for all students. While Type II errors are possible given the small sample size, in the face of a lack of evidence that individual student or group slopes were significantly different, it was reasonable to assume parallelity. In fitting the model, backwards elimination was used to iteratively remove explanatory variables' main effects and refit equations; a 0.10 significance level was used for variable inclusion. The two post-count variables remained in the model regardless of their significance. Subsequent inferences on the models were performed at the .05 level. After the fixed-effect models were specified, we tested for variability in the estimated variance components for the random effects group, week, and student using Wald tests.

Table 5. Listening variables included in regression of speaking variables

Speaking Variables	Listening Variables			
	Breadth	Depth	Temporal Contiguity	Revisitation
Responsiveness, Elicitation, Argumentation	% of others' posts viewed	% of real reads	% of sessions with posts	# of reviews of other students' posts
	% of others' posts read	Av. length of real reads		
Individual Reflection, Group Reflection	-	-	# of sessions Participation range	# of reviews of: -own posts -instructors' posts -other students' posts

### *Follow-up exploratory analysis*

Learners were categorized by their dominant listening pattern across all six discussions using the breadth-depth matrix (see Table 2 and further explanation below). We then calculated and plotted weekly averages for learners in each category for all 15 listening and speaking variables to compare differences across categories with theoretical expectations. Finally, we plotted associated listening and speaking variables together for learners in each category to examine how their listening-speaking relationships manifested over time.

To categorize learners, Percent of Others' Posts Viewed and Percent of Real Reads were used for discrimination along the breadth and depth dimensions respectively. Division was initially performed using a median split on each variable; cut-off points were 85% of others' posts viewed and 45% real reads. This produced a distribution of 9 minimal, 7 coverage, 7 focused, and 8 thorough listeners. Because we could not presume equal distribution of learners across patterns, we verified this categorization by looking for clear separations in the data. This identified slightly different cut-off points of 80% and 50%; however group membership was substantially similar and the interpretation of listening and speaking patterns was indistinguishable. Because the median split categorization ensured an adequate number of learners in each group, we present those results below.

## **Results**

### *Summary statistics*

There was great diversity in listening and speaking behaviors in the discussions. All students logged into the forum at least once over the course of the discussions; however, some engaged in minimal participation with no posting and little attention to others' posts, while others logged-in multiple times and read every post in the discussion (Table 6). The number of posts in each discussion ranged from 13 to 52. The average level of Responsiveness was at the mid-point of the scale, while

Elicitation was low and Argumentation was high, though all varied substantially. Reflection on both individual learning and group processes was consistently low.

Table 6. Summary statistics for data aggregated by student and discussion

Variables	Mean	S. D.	Min	Max
<b>Speaking Quality</b>				
Responsiveness	1.51	0.78	0.00	3.00
Elicitation	0.52	0.72	0.00	3.00
Argumentation	2.17	0.81	0.00	3.00
Reflection on Individual Learning	0.27	0.34	0.00	1.67
Reflection on Group Process	0.33	0.33	0.00	1.50
<b>Speaking Quantity</b>				
Number of posts made (by group)	29.60	8.46	13	52
Number of posts made (by student)	2.57	1.60	0	10
<b>Listening</b>				
<b>Breadth</b>				
Percentage of others' posts viewed	0.72	0.31	0.00	1.00
Percentage of others' posts read	0.50	0.28	0.00	1.00
<b>Depth</b>				
Percentage of real reads (not scans)	0.44	0.21	0.00	1.00
Average length of real reads (in min)	3.85	3.21	0.00	17.35
<b>Temporal Contiguity</b>				
Number of sessions	6.96	5.23	0	29
Percentage of sessions with posts	0.40	0.26	0.00	1.00
Participation range (days)	4.08	1.87	0	7
<b>Revisitation</b>				
Number of reviews of own posts	2.56	3.21	0	18
Number of reviews of instructors' posts	10.30	11.23	0	93
Number of reviews of other students' posts	10.67	11.17	0	55

### *Multi-level regressions*

Modeling results indicated that the Responsiveness of students' posts was related both to the Number of Reviews of Others' Posts and the Total Number of Posts Made by the Group in a particular discussion week (Table 7). Number of Reviews of Other Students' Posts was a positive predictor (greater reviewing of others' posts in a discussion week by a student was associated with them making more responsive posts) while the Total Number of Posts Made by the Group was a negative predictor (a greater number of posts made by a group in a week was associated with lower average responsiveness in group members' posts). The level of Elicitation in students' posts was also predicted by the Number of Reviews of Other Students' Posts; however in this case the relationship was negative (more elicitive posts by a student in a discussion week was associated with less reviewing of others' posts). Richness of Argumentation was predicted only by the Percentage of Real Reads (the



percent of posts viewed that students actually read as opposed to scanned). This relationship was positive (a greater percentage of reading in a discussion week was associated with richer argumentation in the posts made). Neither Individual nor Group Reflection was significantly predicted by any of the listening variables; however Number of Reviews of Other' Posts met the  $p < .10$  threshold for inclusion in the Individual Reflection model.

Table 7. Summary of fixed effects standardized regression coefficients for speaking variable models

		Estimate	Standard Error	t value	p value
Responsiveness	# of posts per group	-0.018	0.009	-2.06	0.05
	# of posts per student	0.021	0.031	0.68	0.50
	# of reviews of other' posts	0.013	0.005	2.50	0.01
Elicitation	# of posts per group	-0.001	0.007	-0.19	0.85
	# of posts per student	0.047	0.035	1.34	0.18
	# of reviews of other' posts	-0.016	0.006	-2.65	0.01
Argumentation	# of posts per group	-0.003	0.009	-0.33	0.74
	# of posts per student	-0.041	0.024	-1.71	0.09
	% of real reads	0.522	0.257	2.03	0.05
Individual Reflection	# of posts per group	-0.000	0.004	-0.10	0.92
	# of posts per student	-0.024	0.017	-1.40	0.17
	# of reviews of other' posts	0.005	0.003	1.66	0.10
Group Reflection	# of posts per group	-0.003	0.005	-0.51	0.62
	# of posts per student	-0.017	0.015	-1.17	0.25

#### *Follow-up exploratory analysis*

Before exploring how listening-speaking associations manifest over time for different students, we first confirmed the presence of variability across learners. Among random effects in the model, there was consistent evidence that students exhibited substantial variability, although that evidence rose to statistical significance for only three of the five variables (Table 8). No other random effects showed significant variability.

Table 8. Summary of variance component estimates for speaking variable models

		Estimate	Standard Error	Z value	p value
Responsiveness	Group	0.000	.	.	>0.50
	Week	0.018	0.022	0.84	0.20
	Student	0.096	0.039	2.48	0.01
Elicitation	Group	0.042	0.060	0.70	0.24
	Week	0.000	.	.	>0.50
	Student	0.158	0.062	2.55	0.01
Argumentation	Group	0.021	0.028	0.72	0.24
	Week	0.017	0.017	1.00	0.16
	Student	0.023	0.018	1.29	0.10
Individual Reflection	Group	0.007	0.014	0.53	0.30
	Week	0.000	.	.	>0.50
	Student	0.020	0.012	1.72	0.04
Group Reflection	Group	0.019	0.018	1.08	0.14
	Week	0.007	0.006	1.05	0.15
	Student	0.008	0.006	1.36	0.09

Characterizing students into the four groups (Thorough, Coverage, Focused, and Disregardful) according to their listening and speaking behaviors, Percent of Posts Viewed and Percent of Real Reads clearly showed the theoretically postulated distinctions since these were the variables used for the categorization (see Table 2 and Methods section). Thus, Thorough and Coverage students exhibited broader listening than Focused and Disregardful ones (Figure 1a), while Thorough and Focused students showed deeper listening than did the Coverage and Disregardful ones (Figure 1b).

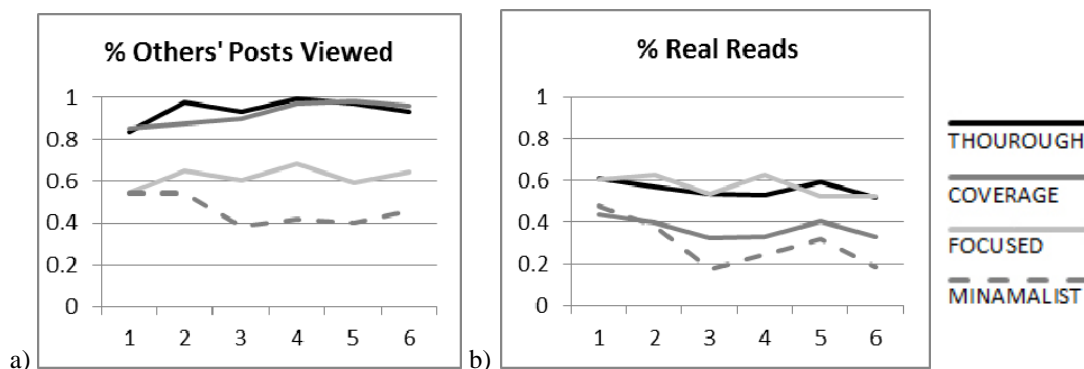


Figure 1. Differences in (a) breadth and (b) depth listening behaviors used to characterize learners by listening pattern

Secondary variables for each dimension not used in the categorization confirmed the expected patterns (Figures 2a and 2b); particularly notable is that while Coverage listeners had as high a Percentage of Posts Viewed as Thorough listeners (Figure 1a), their Percentage of Posts Read dropped dramatically to be

equivalent of that of Focused listeners (Figure 2a). This aligns with the Coverage characterization as outlined earlier.

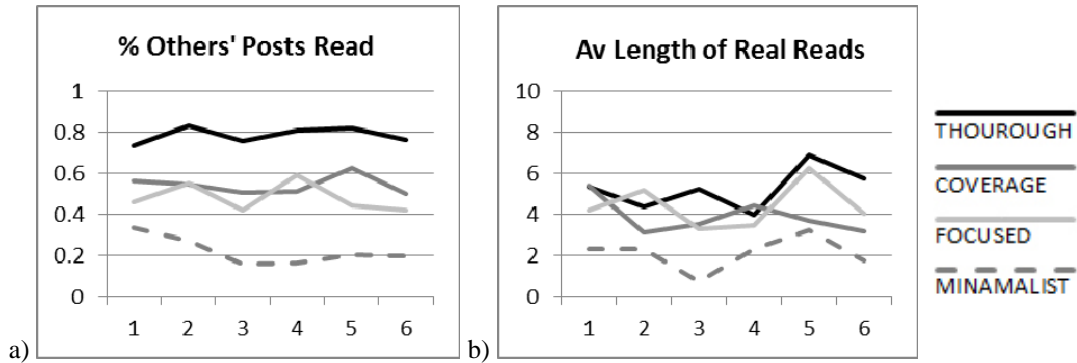


Figure 2. Differences in (a) breadth and (b) depth listening behaviors not used in the initial listening pattern characterization

Temporal contiguity measures also followed theoretical predictions with Thorough listeners having the most Number of Sessions and greatest Participation Range of days in the discussion followed by Coverage then Focused then Disregardful listeners (figures not shown). While Coverage listeners exhibited the anticipated greater Number of Self Reviews compared to Focused or Minimalist listeners, the high Number of Self Reviews by Thorough listeners was unexpected (Figure 3a). For Number of Peer Reviews, the ordering of different kinds of listeners was as anticipated for most weeks; but the high Number of Peer Reviews by Coverage listeners was unexpected since this pattern is theoretically characterized by many unique, shallow views (Figure 3b).

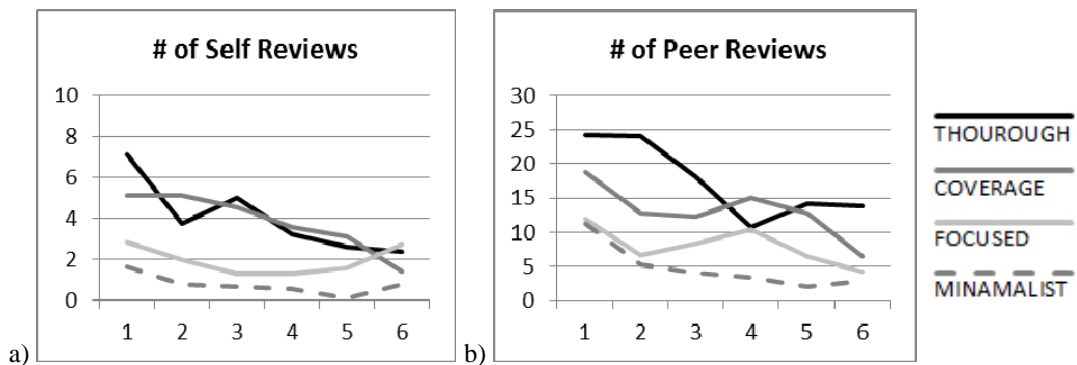


Figure 3. Differences in revisitation of (a) own and (b) peer posts for students categorized by listening pattern

Turning to speaking behaviors, the Number of Posts made by learners exhibiting each pattern followed theoretical expectations (Figure 4a), however the expected differences in Argumentation as a measure of content quality between Thorough, Coverage and Focused listeners were not readily apparent (Figure 4b). The pattern for Responsiveness was similar (figure not shown). For both of these variables Disregardful listeners' posts started off at the same level of quality as the

other groups but deteriorated over time (Figure 4b). No differences were seen for either of the reflection variables (figures not shown), possibly because values on these measures were uniformly low.

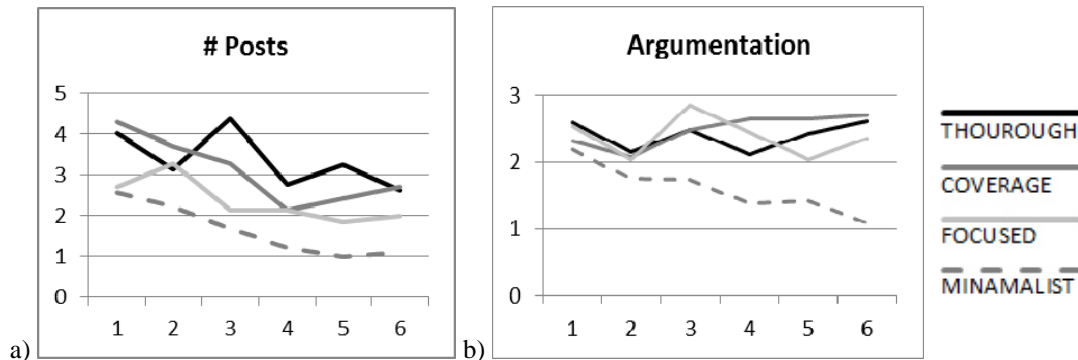


Figure 4. Differences in speaking (a) quantity and (b) quality for students categorized by listening pattern

We now examine differences in how listening-speaking relationships were manifest for students exhibiting each listening pattern; Responsiveness and Argumentation were examined as the respective primary indicators of discursiveness and content quality with significant predictors. As indicated by the overall predictive model, changes in the level of learners' Responsiveness corresponded with changes in the Number of Peer Reviews for all four groups (Figure 5); this also occurred for Argumentation and Percent of Real Reads (Figure 6). However the way in which these variables changed together differed across listeners.

For Disregardful listeners both speaking and listening variables show a downward trend over the six weeks of discussion (Figures 5a and 6a). In contrast, Focused listeners showed high week-to-week variation in all variables but little change in their overall values (Figures 5b and 6b). Speaking and listening variables for Thorough and Coverage listeners were relatively consistent across time, with the exception of some tailing off in the Number of Peer Reviews by Coverage listeners towards the end of the term (Figure 5c), and a substantial drop in the Number of Peer Reviews for Thorough listeners midway through (Figure 5d). As noted above, while Thorough and Coverage listeners were differentiated by their listening depth (56% versus 37% Percent of Real Reads overall), their Argumentation levels were indistinguishable (Figures 6c and 6d).

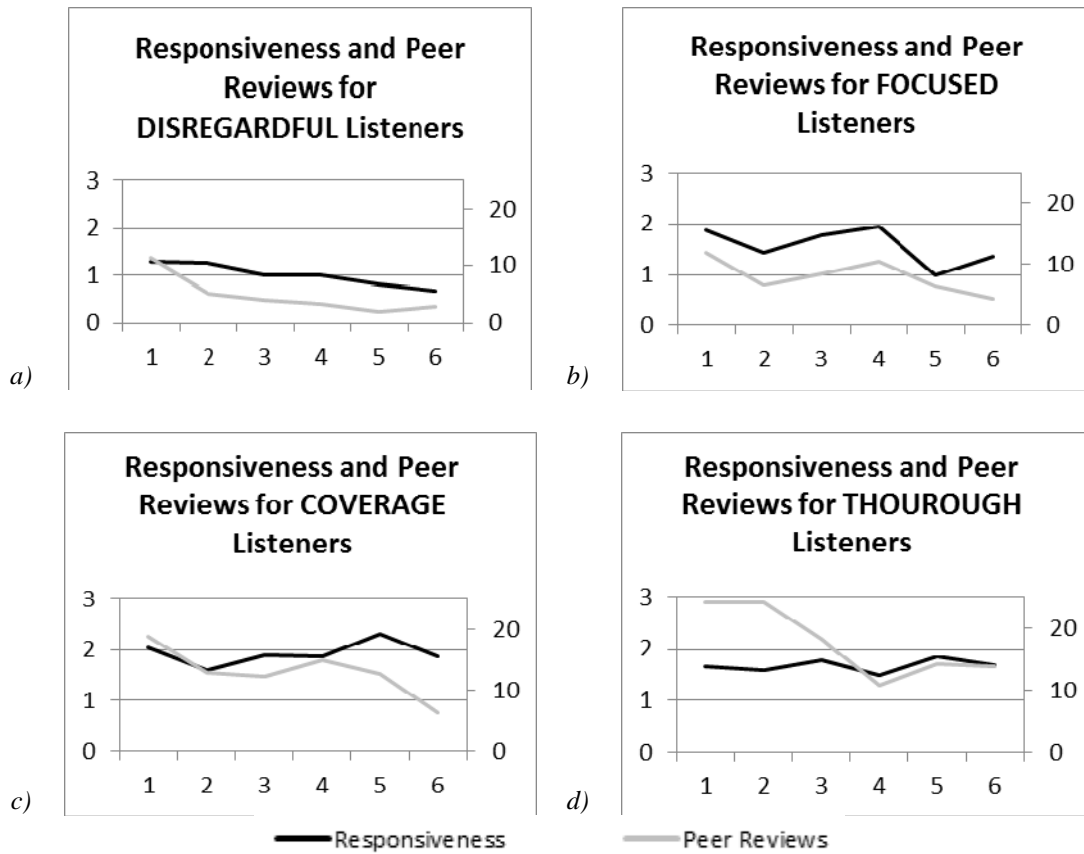


Figure 5. Weekly responsiveness and peer reviews for students categorized by listening pattern

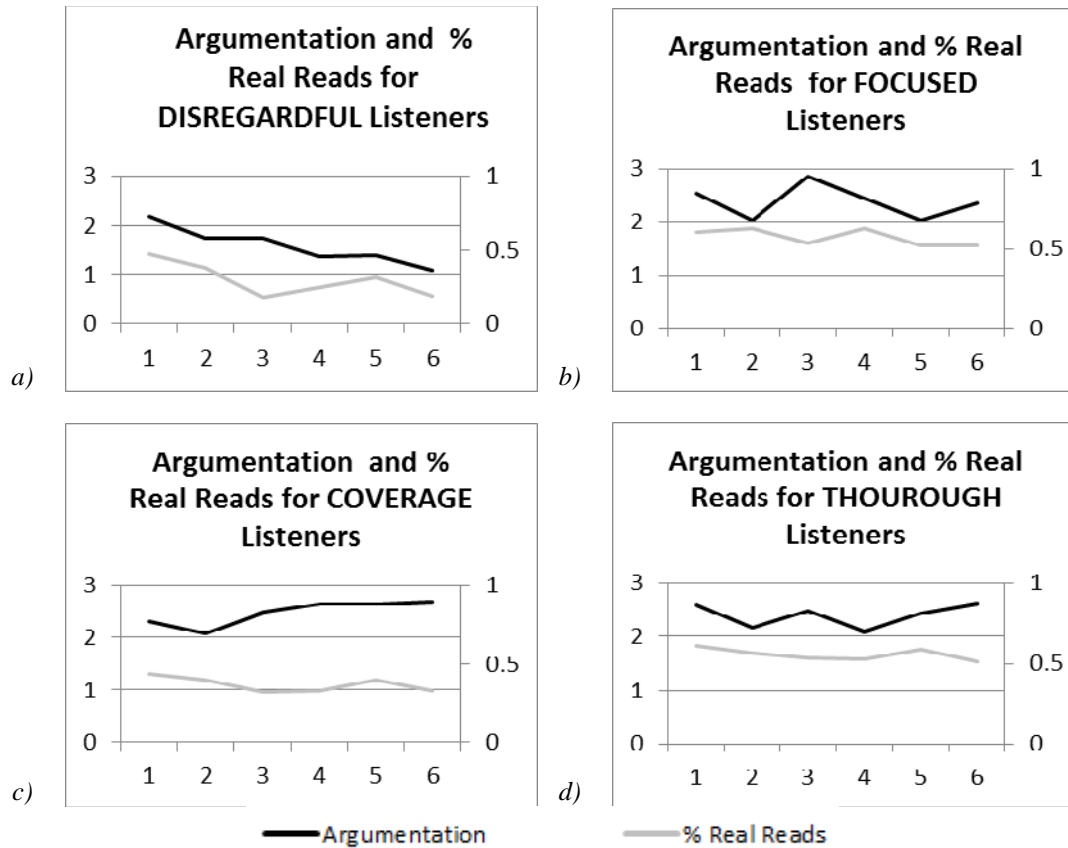


Figure 6. Weekly argumentation and percent of real reads for students categorized by listening pattern

## Discussion

The major finding of this study was a relationship between students' online listening (in terms of depth and revisitation of others posts) and the quality of their speaking (in terms of discursiveness and content quality) in the online discussions. While a connection between listening behaviors and speaking quality is implicit in much research on online discussions, this is the first work we are aware of that provides direct empirical evidence to support the connection. Additionally, we report an initial indication that while the relationships held for all learners, they could be expressed in different ways over time. It remains to be seen if the specific listening-speaking relationships found here exist in online discussions generally or if there is variation across different kinds of learning contexts. Below we discuss the relationships found for this setting and how they manifested for different kinds of online listeners, contextualizing our findings in the larger framework of prior research on online discussions.

### *Listening-speaking relationships*

Discursiveness is an important element of posting in online discussions because it is what links individual comments together as a dialogue. Responsiveness can vary from simply social acknowledgements to building on, or challenging individual ideas, to synthetically integrating multiple perspectives (Gunawardena et al., 1997). The positive relationship found between revisiting others' posts and responsiveness suggests that in this setting the richer end of this spectrum tends to occur when learners attend to posts repeatedly. Examples of such behavior have been found in previous research. In one study (Wise, Hsiao et al., 2012a) we found that a student characterized as interactive in her discussion participation always spent substantial time re-reading others' posts before making her own, highly responsive, posts. In another example (Wise, Perera et al., 2012) a student who often built on others' posts and synthesized the group discussion always located her post as a reply to a post she had viewed at least three times already. Put together, this research suggests that in some discussion contexts reviewing previously read posts is an important element of effective participation. It is reasonable that students may need to read others' posts multiple times to make sense of them in the context of the discussion before being able to respond to the ideas with a complex and thoughtful response. However, prior research has documented students' tendency to do just the opposite; that is to focus on only new posts (Hewitt, 2003). Recent work attempting to address this problem of new post bias through the design of a discussion forum interface that encourages students to read and re-read posts in a connected fashion (Marbouti, 2012) may thus prove particularly valuable.

In contrast to the positive relationship found between revisitation and responsiveness, a negative association was found between revisitation and elicitation. This can be interpreted in several different ways. It is possible that rereading previously viewed peer posts helped students clarify some of the questions or doubts they had when they viewed those posts the first time, leading them to ask fewer questions. However, elicitation was conceptualized to include not only clarification questions but also raising wonderings to the group. Thus, another possible interpretation is that when learners repeatedly set questions to the group, they were more likely to focus their energies on the new responses to these, rather than posts they had read previously. It is important to note that the overall levels of elicitation in the discussions studied here were low; thus, this relationship may not generalize to other discussions in which more vigorous questioning occurs. This is clearly an area that requires further investigation.

The final relationship found for discursiveness was that responsiveness was negatively predicted by a greater number of posts in the overall discussion. This is consistent with previous findings that a large amount of posts in a discussion lead students to feel overwhelmed (Peters & Hewitt, 2010) and suggests that it is beneficial to make groups small, thus keeping discussions at a manageable size which allows students to be responsive as part of an interactive dialogue.

Considering content quality, previous work has questioned whether it is breadth of listening, depth of listening, or a combination of the two that is important to support the richness of post content (Wise, Speer et al., 2013). The finding here of

a relationship between the percent of real reads and richness of argumentation, clearly indicated depth as the more relevant dimension for this learning context. This aligns with the finding of a relationship between rich responsiveness and post revisitation since returning to a previously viewed post to consider it again also conceptually indicates a depth of listening. Logically, it makes sense that deep attention to peers' posts can support a richer understanding of meaning, and thus stronger argumentation, as the understanding drives students to consider and support or qualify their own ideas more deeply. This may help explain part of the mechanism by which conscientious design of online discussion forums can encourage rich argumentation (Lin et al, 2012). In combination with the lack of findings for listening breadth, it provides initial empirical evidence to support our hypothesis that in at least some online discussion contexts, listening deeply to some of a discussion is preferable to listening shallowly to all of it (Wise, Speer et al., 2013).

Unfortunately, here again research shows us that students tend to do the opposite, focusing on breadth rather than depth. For example, in one of the prior studies mentioned above we found evidence of two students who viewed almost all the posts in their discussion, but did not draw upon any others' ideas in their own posts (Wise, Hsiao et al., 2012a). Such findings, along with work documenting students' use of widespread scanning as a strategy for coping with high-volume discussions (Wise, Marbouti et al., 2012; Peters & Hewitt 2010), suggest that students do not instinctively listen in the ways seen to positively relate to speaking in this study. There is thus potential benefit in providing students with specific guidance on online listening and how it can support them in making valuable discussion contributions. The strategy of guiding listening behaviors explicitly as a way to enhance the quality of online discussions is addressed further below.

Another factor exacerbating the problem of broad but shallow listening may be the use of conspicuous indicators of unread posts (e.g., red flags) in discussion forum interfaces. In a recent study scaffolding purposeful discussion participation, advanced graduate students and their instructor both described actively having to resist the temptation to "click away the red" even though they knew that it went against their discussion goals (Wise et al., in review). This highlights a challenging design problem: how to balance the useful aspects of tracking which posts have been read without calling undue attention to new unread ones (Marbouti, 2012).

Finally, while not reaching significance there was evidence that revisiting others' posts may be associated with reflection on one's individual learning process. This makes sense theoretically since returning to ideas considered previously could help learners retrace the process of how their ideas developed over time. However, overall levels of reflection were low in this study, thus such a relationship requires further investigation. To do so it will be important to identify or stimulate discussions in which substantial reflection occurs. Without this, reflection may remain a much praised but little utilized affordance of online discussions.

#### *Different expressions of listening-speaking relationships over time*

Our follow-up analysis showed differences between students, but not groups, in how listening-speaking relationships were expressed over time. This reinforces our prior



claim that certain aspects of online discussion activity are best considered in terms of individual behavior rather than group dynamics (Wise, Speer et al., 2013; see also Thomas, 2002). Compared with other learners in this study, disregardful listeners showed the most distinct expression of listening-speaking relationships over time. These listeners started off similar to others in their levels of discursiveness and content quality, but then declined along these dimensions as well as the corresponding listening dimensions of depth and revisitation. During this time, their behavior on additional listening dimensions (e.g., breadth) did not show such dramatic decreases. This is an unexpected finding suggesting that rather than simply being disregardful from the start, these listeners became that way over time. This raises important questions about why this occurred and how it might be prevented. One possible explanation for their behavior is that as learners' initial enthusiasm waned, they attempted to go through the motions of discussion participation with less effort. Ironically, our finding suggests that if students in this learning context have limited time to devote to online discussions, they would be better off focusing on depth rather than breadth. Because prior work documenting disregardful listening has not observed a decreasing pattern over time, the extent and generalizability of this phenomenon of progressive disengagement needs to be investigated further.

Other kinds of listeners were less clearly distinguished in their listening-speaking associations. Focused listeners showed substantial week-to-week variation in both listening variables and their corresponding speaking variables. This may be because their activity is more concentrated, thus adding or omitting a single session of activity may have a large impact on their variable values. Both coverage and thorough listeners showed relatively uniform levels of speaking and listening variables, with the key difference being that coverage listeners appeared to achieve similar levels of content quality with a lower overall depth of listening. However, an important caveat in interpreting this finding is that coverage listeners' breadth of listening may be masking some of their depth. In a previous cluster analysis of students' listening behaviors (Wise, Speer et al., 2013) we found that "broad" listeners actually spent a short period of time surveying the whole discussion, while the majority of their listening efforts were dedicated to deeply examining a small subset of the overall posts. If such initial inspection informs the purposeful selection of posts to which to direct one's attention, then it may be a productive prelude to focused listening. Alternatively, it may be an unnecessary expenditure of effort that diverts students' time away from deeply engaging with posts. More work is needed to unpack the different ways in which learners enact coverage listening patterns in particular learning contexts and how these relate to speaking activity.

Importantly, while differences between focused, coverage and thorough listeners were not always well-defined, the explanatory model of listening-speaking relationships held across them. Thus, regardless of what overall listening pattern a learner seemed to exhibit, a greater depth of listening was associated with better content quality and more revisitation was associated with richer responsiveness. This is encouraging since in practice it may be difficult to change students' global approach to online discussions, but the concrete changes of additional depth and revisitation within each pattern can be usefully promoted. In particular an emphasis

on depth over breadth (if appropriate for the learning context) may be helpful to the many students who report experiencing online discussions as overwhelming (Peters & Hewitt, 2010).

### *Limitations and implications for future work*

While click-stream data is useful in tracking how students attend to others' posts in online discussions, it also has some important limitations. We can detect if and when students open a post, but we cannot determine whether they are actually attending to it for the full time it is on their screen. Controlling for scanning activity and setting a maximum allowed action length in the calculation prevents extreme examples of off-task behavior from being counted, but will not catch shorter breaks in activity. The inverse problem occurs when learners engage in on-task activities outside of the discussion environment; for example, printing off posts to read in hard copy or composing a post in an external tool. Both of these limitations add noise to the time-based data. For this reason we have found count data generally more helpful than duration data in crafting useful listening measures.

Another important issue in creating listening measures is the unit of analysis. In the current study we aggregated listening and speaking measures over each discussion week. While this makes sense as a unit of activity in the course and is more precise than aggregating over the whole course, even more fine grained units of analysis (e.g., listening and speaking within a single log-in session) may provide additional insights. Similarly, the categorization of learners in the follow-up analysis was based on their dominant listening patterns across all discussions; however, characterizing each learner's listening pattern by discussion (or even session) might produce a somewhat different picture.

The research design used in this study enabled us to document naturally existing listening-speaking relationships; however, we cannot make claims about causality. While in some cases there is a theoretical rationale for why we might expect listening behaviors to influence post quality (e.g., increased listening depth -> richer content), in other cases the reverse is also possible (e.g., greater elicitation -> less revisitation of previously read peer posts). It is also possible that more conscientious students engage in greater listening and speaking behaviors, but there is no direct relationship between the two. Further research using an experimental, interventionist design is needed to tease apart these possibilities.

Finally, this study examined the relationship between listening and speaking in one particular learning context, that of a fully online undergraduate education course. Listening and speaking relationships may vary for different subjects, environments, course structures, or learning tasks. In addition, research has shown important connections between the culture of collaboration in a class and how students engage in online discussion activities (e.g., Hakkarainen et al., 2002; Scardamalia & Bereiter, 2006). It will thus be useful in future research to examine relationships between listening and speaking in a variety of discussion contexts. These should include both blended and online settings, as well as different subject areas, student levels, discussion group sizes, and kinds of discussion tasks. It will also be important to study how online speaking and listening behaviors (and the

relationships between them) change when discussions are embedded in different learning cultures; for example comparing classes where collaboration is engaged in regularly and intentionally versus those where it is not, and situations where it is a voluntary, rather than compulsory, part of the learning experience.

## Conclusion

This study is the first empirical work that we are aware of that examines the connection between listening and speaking in online asynchronous discussions. This is an important area for research since such interrelationship is presumed by most models of learning through online discussions, but had previously been untested. As shown in this study, patterns in listening can help explain and predict patterns in speaking. Specifically, in this context when students took the time to read and re-read some of their peers' posts, there were related benefits in the quality of the posts they contributed. Importantly, these relationships held across the different kinds of overall listening patterns that learners exhibited.

The connection between these listening behaviors and post qualities is particularly important given the existing research base showing weak student listening behaviors and tendencies to focus on reading only new posts or using scanning-only as a strategy for coping with high-volume discussions. Since the bulk of current guidance for students' participation in online discussions focuses on the qualities of a good post but not the process through which it is generated, understanding what listening behaviors are associated with what speaking qualities can provide new ways to support students in effective discussion participation. This may be done in a variety of ways, including giving students explicit listening guidance, designing innovative discussion forum interfaces, and providing learning analytics to students on their listening behaviors. Current research in each of these areas is underway (Marbouti & Wise, in review; Wise, Zhao et al., 2013a). Importantly, constructive support for listening must connect it to the larger activity of building ideas through responsive and reflective dialogue; otherwise students may rotely comply with the entreated listening behaviors without the intended effects on speaking. The direct study of how learners attend to others' contributions is still a relatively new area of research in computer-supported collaborative learning; in conjunction with current advances in data collection and analysis techniques we expect it to contribute strongly to both our understanding of and ability to support student involvement in online collaborative learning experiences.

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