Knowledge Building Ratios

Possible new measures of knowledge building

Donald N. Philip and Danielle Truswell
don.philip@utoronto.ca danielle.truswell@utoronto.ca

Abstract

Following Nagel et al. (2009), we introduce the concept of the *Reply Ratio*–the number of replies (build-ons) divided by the number of original posts (new notes.) Extending this work, we introduce the *Build-On-to-Note Reading Ratio* (number of build-ons divided by the number of notes read,) and the *Disproportion Ratio*, an evenness parameter that is the ratio of the highest number of contributions divided by the lowest number of contributions for a given knowledge building activity.

We apply these ratios to the knowledge building work of SCI396, a third-year undergraduate science education class. Using these data, and triangulating them with social network the pattern of note contributions, we find that the Reply Ratio and the Build-on-to-Note Reading Ratio are not as easy to interpret as they appear. The Disproportion Ratio proved to be easy to interpret, but could be sensitive to students with extreme behaviour.

The Reply Ratio, Build-on-to-Note Reading Ratio, and the pattern of note contributions enabled us to find maladaptive knowledge building strategies: one strategy in which students replied frequently but created few new notes; a strategy in which students created many new notes, but replied to few; and a strategy in which read many notes, but built-onto few; and a strategy of posting notes too late for other students to read. None of these is entirely desirable, and students in the middle of these ratios may be exhibiting more adaptive strategies.

The Disproportion Ratio allows us to see quickly when students are tending to extremes in behaviour. Low values for this ratio indicate evenness; high values, extremes in behaviour. We find that for note reading and building-on the disproportion values are quite even, but disproportionate for annotating others' notes.

The Class

The class consisted of third-year undergraduate science students at the University of Toronto Mississauga campus. The course was SCI396, a third-year level pre-professional course for students considering science teaching careers. Of the 24 registered students, 20 (83%) agreed to participate in this study. Ranging in age from 20-23 years, the class was 80% women and 20% men. Most students had one term of experience using Knowledge Forum, but some had no previous experience. The majority of the students had never taken an online course nor used a bulletin board system or other groupware for online educational work. Most students found Knowledge Forum easy to use; similarly the majority found Knowledge Forum enhanced their learning (with only one student disagreeing.)

The Ratios

Nagel et al. (2009) examined community formation in a course run using the WebCT online course management system (which is now owned by Blackboard, http://www.blackboard.com/). Using built-in tools in WebCT, they tracked the following factors: *Hits* (the number of times a student visited the online site,) *Posts* (the number of note postings made by each student,) the *Reply Ratio* (a ratio of the number of replies [build-ons] divided by the number of new notes,) and a *Collaboration* metric that was assessed quantitatively using a rubric they created. Nagel et al. (2009) believed that the Reply Ratio was a measure of the student's style of participation, either peer- or self-focused, noting that this is independent of participation quantities (p. 45).

We found the concept of the Reply Ratio interesting because Knowledge Forum already collects these data via the Analytic Toolkit (ATK), because of the ease of calculation, and because of its potential use as a metric to measure the type of participation among the students. Additionally, we realized that other metrics based on data collected by the ATK might be useful.

The additional two metrics we propose are the *Build-on to Note Reading Ratio*, and a *Disproportion Ratio*. Therefore three metrics were considered:

Reply Ratio (Build-on Ratio): The number of build-ons divided by the number of new note postings over the period being considered.

Build-on to Note Reading Ratio: Based on the idea that the number of notes read should in some way relate to the number of build-ons created this is calculated by dividing the number of build-ons by the number of notes read over the period being considered.

Disproportion Ratio: The previous two metrics were individual measures; the Disproportion Ratio is a group measure related to evenness of participation. It is calculated by dividing the highest number of note contributions in the group by the lowest number of contributions in the group.

Purpose and Methodology

Carnevale (2001) notes that distance educators have yet to demonstrate, "… that they can accurately assess anything" (p. 1). Carnevale (2001) also notes that online assessment is held to a higher standard than traditional assessments and that therefore there it is necessary for online assessment to demonstrate its effectiveness. Consequently we decided to triangulate the ratios under consideration with other data and analyses from the SCI396 class to see if the ratios were really measuring what we think they are measuring. In addition to the ratios therefore, we considered the *raw data*, a social network measure of *importance* to the group based on eigenvector centrality, and *class participation data*. We then compared these results to the results obtained from the ratios when considered in isolation. Additionally, we used feedback from the instructor to triangulate the Disproportion Ratio findings.

Results of the Ratios when Considered in Isolation

Figure 1 shows the Reply Ratio results as sorted data. Nagel et al. (2009) considered this a measure of collaboration: the more peer focused students would score higher, while the more self focused students would score lower.

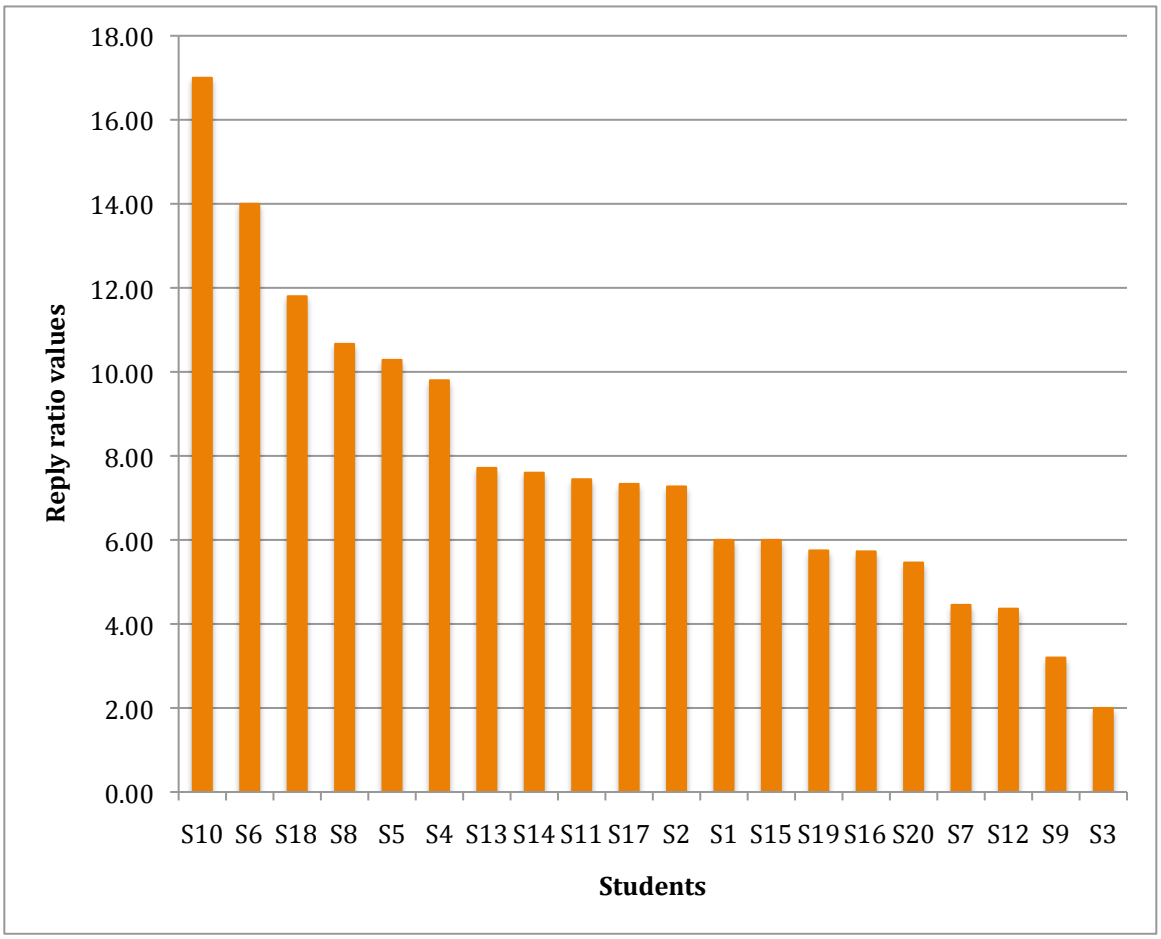

Figure 1. The Reply Ratio results for SCI396. The "S" preceding the numeral stands for "student."

Following Nagel et al. (2009), and using the results in isolation, we would say that students 10, 6, and 18 are the most peer focused (collaborative) in the group, while students 12, 9, and 3 are the most self focused.

Figure 2 shows the Build-on to Note Reading Ratio results, sorted highest to lowest.

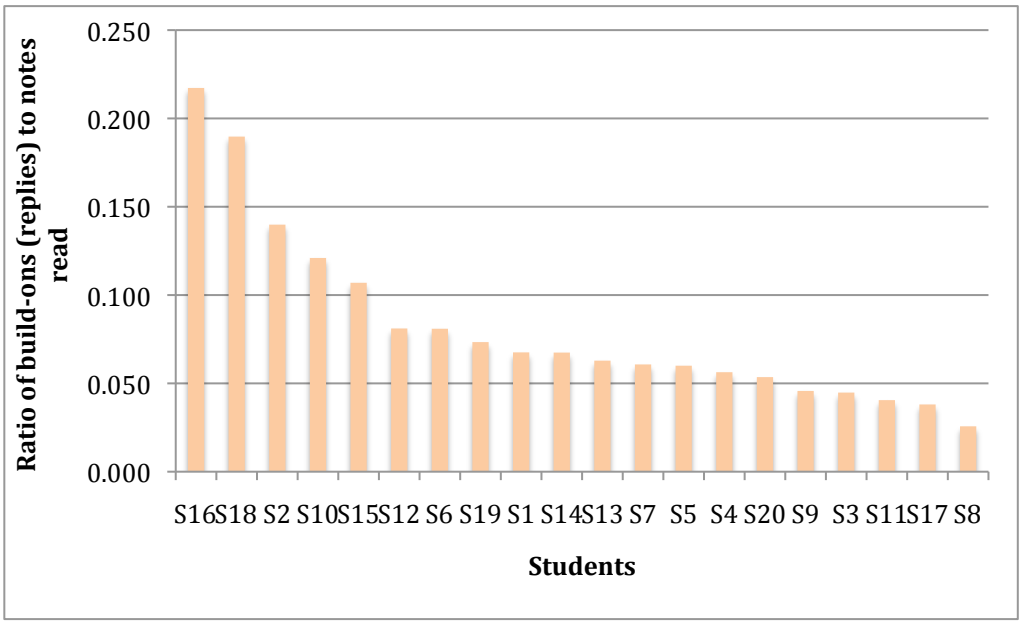

Figure 2. Results of the Build-ons to Note Reading Ratio calculations.

Using reasoning similar to that used by Nagel et al. (2009), we would conclude that the students with the highest Build-ons to Note Reading ratio would be more engaged in the community by virtue of creating a higher number of build-ons, while the students at the low end are tending to lurk–to read without participating much in the discourse. Thus students 16, 18, and 2 would be the most engaged in the community, whereas students 11, 17, and 8 have the strongest tendency to lurk.

Figure 3 shows the results of the Disproportion Ratio calculations for note reading, building-on, and annotations.

Figure 3. The Disproportion Ratio calculation results.

Recalling that the Disproportion Ratio looks at the group highs and lows and is intended to show the degree of evenness of participation, we would consider that there was considerable evenness in building-on, some unevenness in note reading, and considerable unevenness in annotations creation.

Triangulating Data: The *Importance* Social Network Results

Figure 4 shows the results of the eigenvector centrality or *importance network* analysis for all manner of links in Knowledge Forum for the SCI396 class.

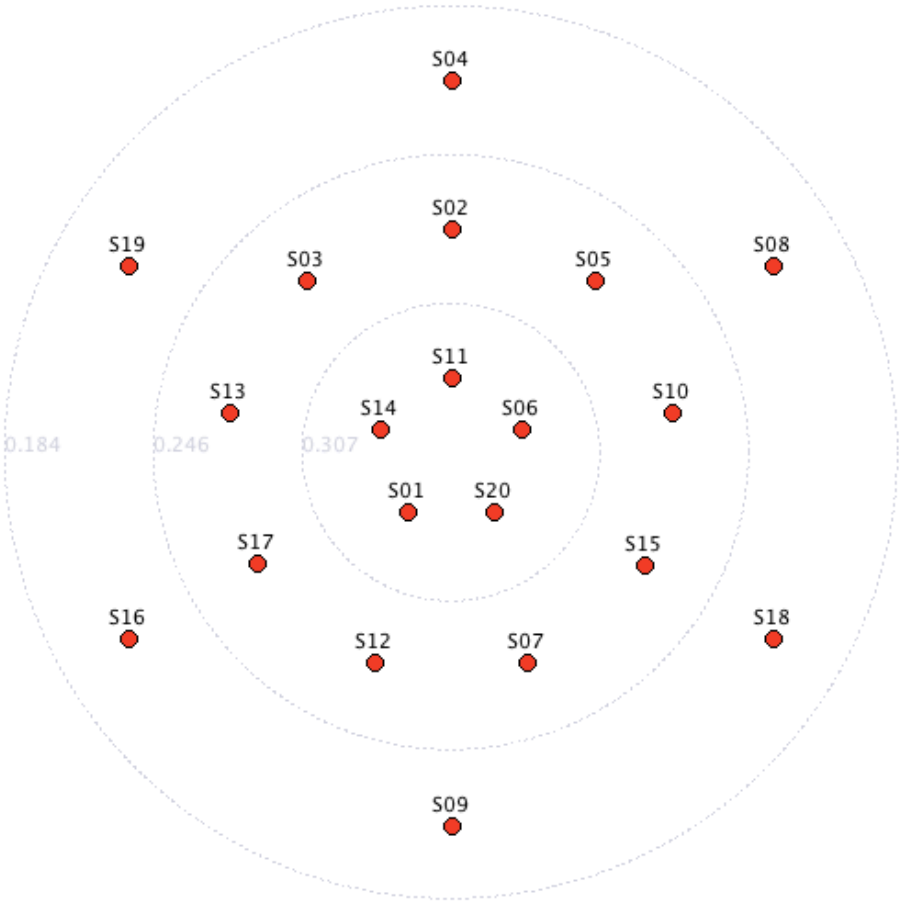

Figure 4. *Importance* results for the Knowledge Forum linkage network in SCI396.

In Figure 4, students in the central ring are considered to be the most important to the group, students in the middle ring are middle in importance, and students in the outer ring are peripheral in importance to the group.

Triangulating Data: Note Contributions over Time

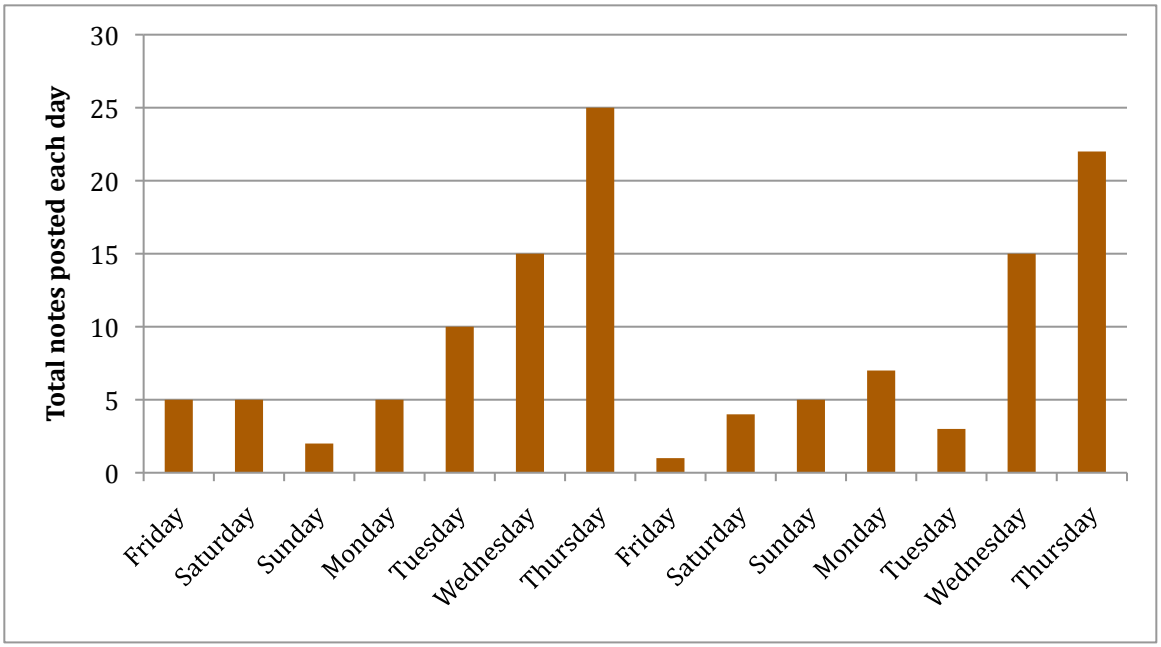

Figure 5. The graph shows the daily note contributions by SCI396 students over a two week period.

Figure 5 shows the number of notes of all types contributed daily by SCI396 students. As can be seen, there is a rhythm to the contribution pattern. The SCI396 class was held between 4:00 p.m. and 6:00 p.m. on Thursdays. Contributions are lowest on Fridays, and rise fairly steadily to a crescendo on Thursdays–with many of the Thursday contributions being in the hour or so before class (following the time-honoured undergraduate tradition of waiting until the last minute to do the work.)

Triangulating Data: Raw Data

We will not here consider the raw data for all students, but will instead focus on the data for the top student and bottom student in the Reply Ratio.

- Student 10, the highest scoring student on the Reply Ratio created 68 build-ons, but only 4 new notes.
- Student 3, the lowest on the ratio created 64 build-ons, but also created 32 new notes, substantially more work.

Discussion of the Triangulating Data in Light of the Reply Ratio

Recall that the Reply Ratio had students 10, 6, and 18 in the top three positions–theoretically the most peer centred members of the group. However the raw data analysis casts doubt on this. Student 3 created considerably more new notes and almost as many build-ons as students 10, 6, and 8, which should indicate that they are peer centred. It appears that the Reply Ratio is sensitive to the number of new note contributions.

The social network *Importance* results also prove interesting. Student 5 does show as central (important) to the group, but student 10 is medial, and student 18 is peripheral in importance. Student 3's position is also odd: student 3 is medial, but Nagel et al. (2009) would interpret that they should be peripheral to the group.

The Note Contributions data hold a possible answer for this: if students follow a pattern of contributing notes and build-ons late on Thursday afternoon, it would be too late for the other students and the instructor to read them. Very late posters are less likely to be linked to, making them less important in the linkage analysis.

Therefore, we would say that rather than showing peer- or self-focus in online work, the Reply Ratio is actually showing us *maladaptive strategies* being used by the students: (1) posting few notes, but building-on frequently; and (2) posting notes and build-ons too late in the week to be of any use to other students. Students at the low end of

the Reply Ratio are showing considerable commitment to the community, and students in the middle are showing balance between new note creation and building-on.

Discussion of the Build-on to Note Reading Ratio in Light of the Triangulating Data

The results of the analysis of the Build-on to Note Reading Ratio with the triangulating data prove to be almost identical to that of the Reply Ratio. Here, students 16, 18, and 2 were theoretically the highest (active participants); students 11, 17, and 8 were the lowest (mostly lurkers). However, the data do not support this: Students 16 and 2 are peripheral in importance, and student 2 is medial. Student 11 is central in importance, student 17 medial, and student 8 peripheral. We conclude that the Build-on to Note Reading Ratio is also sensitive to the raw data and to the rhythm of posting.

Here we can identify some more maladaptive patterns: (1) reading few notes, and building-onto most of them (resulting in a high ratio); (2) reading many notes and building-onto relatively few (resulting in a low ratio–lurking); and (3) posting replies too late in the week to be of any use to other students. (resulting in these notes not being read.)

Discussion of the Disproportion Ratio

Unlike the other ratios, the Disproportion Ratio cannot be triangulated with the social network data, and is based on the raw data. However the instructor's input is useful here.

Neither note reading nor building-on would seem to be a concern here, as the ratios are low compared to the annotations ratio. This would mean that there is relatively little difference in contribution rates among the students as regards reading and building-on. However the high Disproportion Ratio for annotation creation is of concern.

The instructor reports that about mid-term, a number of students began to use annotations instead of build-ons, possible because it's

faster to create an annotation (that does not need a title) than to create a build-on. Space does not permit a full discussion of this here, but the work-load increased at the same time that annotation use became common, and the instructor had to post a note telling students to use annotations only for short comments–which instruction was largely ignored.

Conclusions

- We find that the Reply Ratio does not indicate peer- or self-focus in the community, but rather that it indicates the students were using maladaptive strategies.
- Likewise the Build-on to Note Reading Ratio also indicates maladaptive strategies were in use.
- The Disproportion Ratio can be used to indicate to the instructor that there is a possibly maladaptive difference in levels of contribution for a given function (annotations in this case.)
- All of these ratios therefore could be used to indicate to the instructor where an intervention with certain students, or the entire class is in order.

This was a preliminary study, and we would need to have more data on other classes to validate these conclusions. Nonetheless, these ratios could prove useful diagnostically for teachers working in online knowledge building environments.

References

Carnevale, D. (2001). Assessment takes center stage in online learning. *The Chronicle of Higher Education, 47*(31), A43-A45.

Nagel, L., Blignaut, A. S., & Cronjé, J. C. (2009). Read-only participants: a case for student communication in online classes. *Interactive Learning Environments, 17*(1), 37-51.