MOOC Learning in Spontaneous Study Groups: Does Synchronously Watching Videos Make a Difference?

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Abstract

Study groups are common approaches for students to study together at schools. However, little is known about how this approach is suited to MOOC based learning, where learners watch and discuss MOOC lecture videos in a collaborative manner. Watching MOOCs with peers creates learning experiences that blend the way students learn in classroom with learning through a computer: Students get a chance to "pause" the professor as well as to discuss with other learners. In this paper, we explore this type of MOOC-based learning. Findings from our longitudinal study on spontaneous collocated MOOC study groups suggest that groups tend to stick to a certain kind of study style. A strong positive relationship was found between how often students pause and replay the videos and the synchronicity among groups. Further, synchronous groups tended to perceive better group learning experience, in terms of self-assessed quality and mutual participation. Future MOOC designers as well as schools that offer courses in a flipped classroom format can use the insights to provide guided support for group learners of MOOCs.

Introduction

Online education has boomed in recent years in the form of MOOCs, as the main initiatives such as Cousera and edX continue to embrace new partner universities worldwide. This new trend democratizes education, making high-quality education reachable for learners from all over the world. Most popular MOOCs are offered as xMOOCs that are built upon knowledge duplication model (Siemens, 2012). Traditional pedagogical approaches are augmented with digital technologies through video presentations and quizzes. Different from traditional classrooms, MOOCs attract a large number of learners, which poses many new challenges for education researchers (Yuan and Powell, 2013). One direct consequence of massiveness is the demolishment of the traditional way of instructor-learner interaction. MOOC learners do not acquire direct learning feedback from instructors (Kop, Fournier & Mak, 2011). Instead, automated processes of algorithm-driven as well as peer assessment are employed to grade one's work. Online forums are created in the MOOC platforms to allow learners to help each other, so that "the learner is the teacher is the learner" (Siemens, 2006). However, learners are diverse and loosely coupled; their discussions are autonomous and asynchronous. These facts limit the learners' potential of learning, so novel MOOC pedagogical or organizational approaches are required to improve their learning experience.

Research has revealed that the more open an online course is, the more the learners seek to engage in groups as opposed to an open network (Mackness, Mak & Williams, 2010). Groups have the potential of fostering discussion, argument and clarification of ideas (Gokhale, 1995). Traditional group-based learning has over the years received intensive investigation in the literature. Collaborative learning (Dillenbourg, 1999) and cooperative learning (Slavin, 1983), as its two major formats, can help students reach higher achievement (Tsay & Brady, 2010). Both group-learning formats in the literature are usually initiated and structured by teachers with designated activities. Actually, even without teachers' intervention, students commonly form spontaneous study groups in order to discuss courses and assignments. It may be true that not every student can benefit from such groups (Boud, Cohen & Sampson, 1999), but research has shown that the outcomes of spontaneous group students are generally better than individuals (Tang, 1993).

In the context of online learning, people naturally think study groups refer to asynchronous, remote collaborative groups. This group-learning format was explored by Curtis & Lawson (2001) in a small course (24 students). Students suffered from asynchronous discussion and collaboration with strangers of diverse background. Face-to-face group learning seems to be a theoretical solution to the aforementioned problems, though many may claim its impracticalness when applied to online courses. Considering the massive scale of MOOCs, geographical clusters are likely to emerge. This trend can be seen from the Coursera Meetup website, where students that are geographically close to each other have the opportunity to study together. Furthermore, many universities are offering MOOCs to campus students as their full/partial course schedule (Martin, 2012) in a flipped-classroom teaching format (Tucker, 2012). The proliferation of flipped-classroom teaching has opened even larger opportunities for students to form face-to-face MOOC study groups at school. Current MOOCs emphasize individualizing learning (Mazoué, 2013), so group activities are rarely designed and enforced.

However, as the central MOOC learning activities, watching lecture videos and solving quizzes can also be done in groups, fostering arguments and discussions that are potentially beneficial to the learners. Our research aims at exploring MOOC learning in the vein of spontaneous study groups. Traditional spontaneous study groups usually meet in public places such as cafeterias or seminar rooms. These places are also suitable for learning MOOCs together. MOOC learners usually have their own computers and may want to study at different paces. It is then a natural practice to allow students in a group to watch videos at their own paces, while group atmosphere remains to foster ad-hoc discussions. In this paper, we explore how students in groups study together, as well as the role of their study styles with respect to their perceptions towards group learning. In the upcoming sections, we will present our findings from a longitudinal study on 4 groups of flipped-classroom students at our institution.

Research Question

Spontaneous groups do not study with guided instructions. The MOOC videos regulate their collaborative learning processes. Therefore different study styles may emerge in terms of how videos are watched and when discussions are triggered in groups. An important aspect that reflects the different study styles is whether individuals in groups watch videos synchronously, given that each individual is allowed to watch at his/her own pace. The more the students in a group watch videos synchronously, the more chance they have to foster discussions.

Our research focus is not placed on comparing the learning outcome of different groups. Instead, we are interested to know how MOOC learners regulate their study styles in groups and how they feel about their learning styles. The main research questions in this paper are listed below:

(1) What group learning styles emerge with spontaneous MOOC study groups? Do they watch lecture videos synchronously?

(2) Do the study styles affect students' perception of their group learning experience?

Method

Participants

We recruited 18 undergraduate students at our own institute to participate the study between the 2nd and the 6th week of two engineering courses, Numeric Analysis (*NAS, in French*) and Digital Signal Processing (*DSP*). The recruitment of subjects was group-based. We randomly selected volunteered groups of 4-5 students that fitted our experiment schedule. Due to time and resource constraints, we managed to recruit 3 groups for *NAS* and 1 group for *DSP*. Each subject was compensated for 150 CHF plus a print textbook. Among the students, 13 (8 males/5 females) were attending *NAS* in their first year, the rest (5 males) were following *DSP* in their second year. Only 1 subject had MOOC experience before, and all subjects had group study experiences. Since we organize the study groups and the student subjects receive reimbursement for participation, the groups are not strictly spontaneous. Still, they shared several key "spontaneous group" properties including no teacher intervention, autonomy in choosing group members and how they study together.

Procedure

Each group met once a week to study the lecture materials in that specific week for at most 3 hours. Students could leave if they finished earlier. Each week, there were usually 6 videos for *DSP* (each of around 20 min) and 10 videos for *NAS* (each of around 10 min). They also have 3-4 sets of quizzes to complete. Students in a group gathered around a table and each student was given an iPad to watch videos independently within his/her group. Students were always free to decide when and how to watch videos and discuss problems. The quizzes were also done during the study sessions. Breaks were not granted for students, unless asked for.

Measures

Each session was videotaped. The iPads logged the students' video navigation events, including when and where the student play, pause, stop and replay which videos. At the end of each study session, we asked students to fill in a questionnaire to assess their perception of group learning. Responses were made on 5-point Likert-scales. Semi-structured interviews were also conducted at the end of each session.

Analysis

The Video Navigation Pattern

Visualizing how students played lecture videos is important for us to get intuitive impressions on how students worked in groups. We designed video navigation plots to parallel illustrate individual student's video interactions for each study group. From the plots, we found that some study groups watched videos more synchronously while others chose to work in a more individualistic manner. Two extreme examples are illustrated in Figure 1. The horizontal axis represents the timeline of a study group session, and the vertical axis denotes the timed positions within a video. Clearly, a straight line-segment with a non-zero slope indicates a video was played without interruptions; a straight horizontal line-segment is a sign of a pause; jitters depict jumps within a video, and the gaps between series refers to the between-video pauses (solving quizzes or having discussions). No students had ever asked for breaks, so the full series including gaps give us a full picture of their on/off video group study processes. The plot on the left shows NAS group 1 worked in almost perfect synchronization in the first week, and the right plot expresses that the DSP group was quite asynchronous in the fourth week – group participants were mostly at different video positions or even watching different videos.

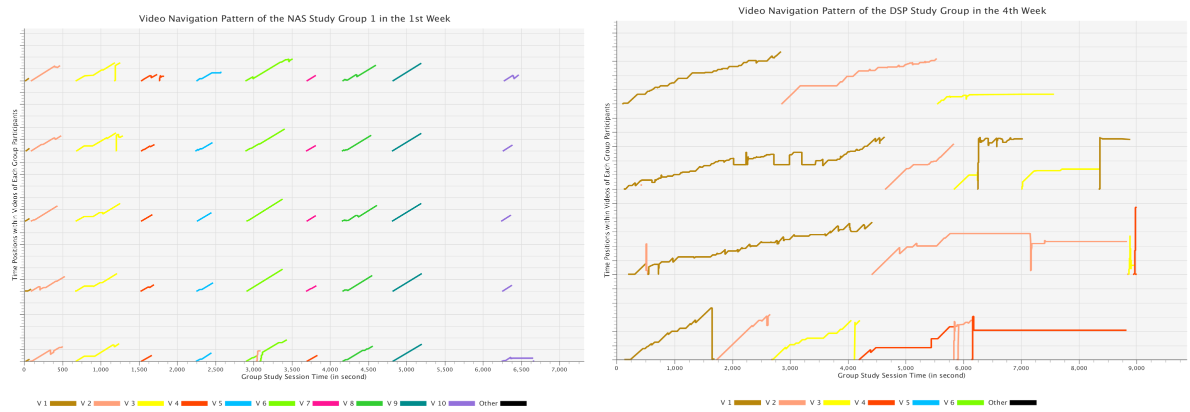

Figure 1. Sample video navigation patterns of the study groups from the two courses.

The Linearity and Synchronicity Indices

The two plots presented before visualized how group students interacted with videos and how synchronous and asynchronous group patterns look like. To quantify these patterns, we introduce linearity index and synchronicity index.

(1) *Linearity index*: it refers to the ratio between the total length of all video contents that are watched in a week and the amount of time spent on them. Possible values range between 0 and 1. An index of 1.0 indicates that the full videos were played exactly once without being paused or being replayed. This index gives us a rough idea of the video interaction intensity. Both pausing and rewinding videos decrease the value, while seeking forward and stopping in advance lead to an increase. So the less the values are, the more additional time has been spent on the videos, the less linear the video watching behaviors are. We are interested in an overall pattern of linearity. When we computed an index value for a certain week, all the videos in that week were taken into account as a whole. That being said, there is only one value per group per week. In case that a student did not finish all the videos, we only take into account the videos that have been watched. In our experiment, *NAS* students generally watched videos in a more linear way (M=0.832, SD=0.113) than *DSP* students (M=0.334, SD=0.125), indicating the potentially higher difficulty level of the *DSP* course.

```
GET TotalTime as the duration of a study group session
SET SynchronousTime to 0
FOR each second in TotalTime
    FOR each neighboring second ranges within ±T
        IF the state of student A is the same as student B THEN
           INCREMENT SynchronousTime
        END IF
    END FOR
END FOR
SET PairedSynchronicity to SynchronousTime divided by TotalTime
```

Figure 2. Pseudo code for Computing Paired Synchronicity Indices

(2) *Synchronicity index*: This index is another float number between 0 and 1. It quantifies how synchronously a MOOC study group watched video together. The higher the value is, the more synchronized the group was. We define *paired synchronicity index* as the proportion of time during which one student was

doing more or less the same thing compared to another student. The average of all possible paired synchronicity in a group is the *group synchronicity index*. If the average is made on the paired synchronicity with respect to the same student, it is called the *individual synchronicity index* for that student.

The *paired synchronicity index* is computed by dividing the accumulative synchronous time between the pair by the total length of the study session. Synchronous time actually means that two students are either simultaneously watching the same video content or not watching anything (e.g. they may have a discussion). Perfect synchronization accurate to a second is not necessary. We introduce a threshold value *T* (measured in second). For each second of a study session we look *T* seconds both ahead and behind to see if the pair of students used to be or will be watching the same thing. In other words, we are checking if one student can catch up with the other in *T* seconds. If yes, then they are synchronized. The algorithm is described in pseudo code in Figure 2.

Different *T* values result in different synchronicity indices. Figure 3 illustrates how synchronicity indices for all groups in each week change by varying *T* between 0 and 600 (10 min). As we see, the larger the *T* is, the larger the synchronicity indices are. The index values may converge to one with large *T*s. A close-to-zero *T* would only have theoretical meaning, because in reality we don't expect different people to watch the same video frame simultaneously. We finally chose *T = 50*, where the variances among all possible synchronicity indices of different sessions reaches maximum (0.088). The largest variance indicates that this *T* is the value that maximizes the differences among all the groups. This value also makes real sense. Within 50 seconds, the teacher usually explains the same topic, so students are synchronized on the same ground.

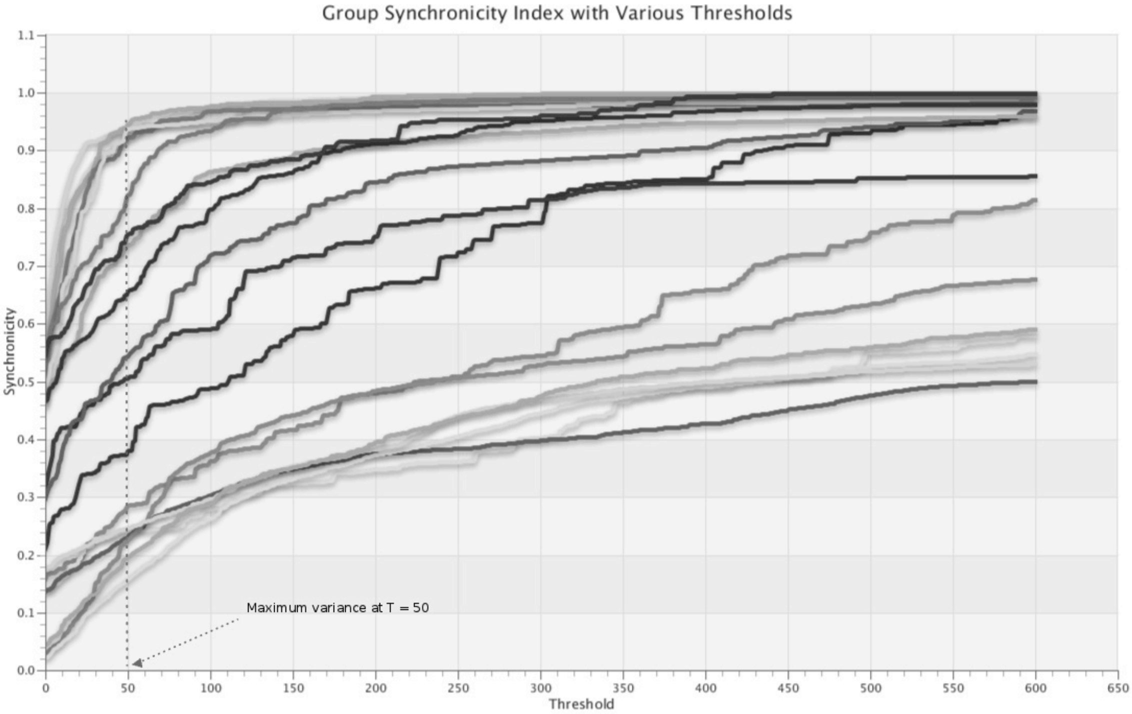

Figure 3. Computing Group Synchronicity Indices by Varying Thresholds

Results

The Group Learning Patterns

While the linearity indices suggest individual video interactivity, the synchronicity indices indicate group dynamics. The synchronicity indices for different groups over a 5-week period are illustrated in Figure 4. The data for *NAS* group 1 was missing due to technical problems during the study session. In this chart, four distinct time series stand out, each representing a different group. We can see that some groups always stayed synchronized, while others tended to work independently. A clear cut is seen in the middle range of the synchronicity index axis, which separates more synchronized groups from less synchronized groups. The series for each group fluctuates with relatively small ranges, and they almost don't intersect, indicating a stabilized pattern. To test it statistically, for each group we built a mixed-effect linear regression (*MELR*) model with time (in terms of weeks) as the predictor and group synchronicity indices as the response. The group variable introduces a random slope effect. No statistical evidence showed the synchronicity index for each group changes over time ($p>0.1$ for all groups). This suggests that the group learning style, once used by a group, roughly remains throughout the whole study sessions.

Predicting Individual Synchronicity

Group synchronicity indices tend to be stabilized, but the individual synchronicity indices may vary. What factors may affect an individual's attitude towards synchronous learning? Our first hypothesis is the difficulty level of the videos, since students might be more willing to keep synchronization for discussion. We have asked each student to rate how difficult the videos were on a 5 point Likert-scale. Considering only one *DSP* group was recruited, and they were least synchronized among all groups. All following statistical tests in this paper were conducted solely on *NAS* groups. We built a *MELR* model by adding another predictor variable, the video difficulty to a model that is similar to the previous model. The difference is that we use individual synchronicity instead of group synchronicity, and the data is from all *NAS* groups. As a result, no significant correlation was found, indicating that students react differently to difficult videos. There are no systematic reactions of individual students to difficult situations.

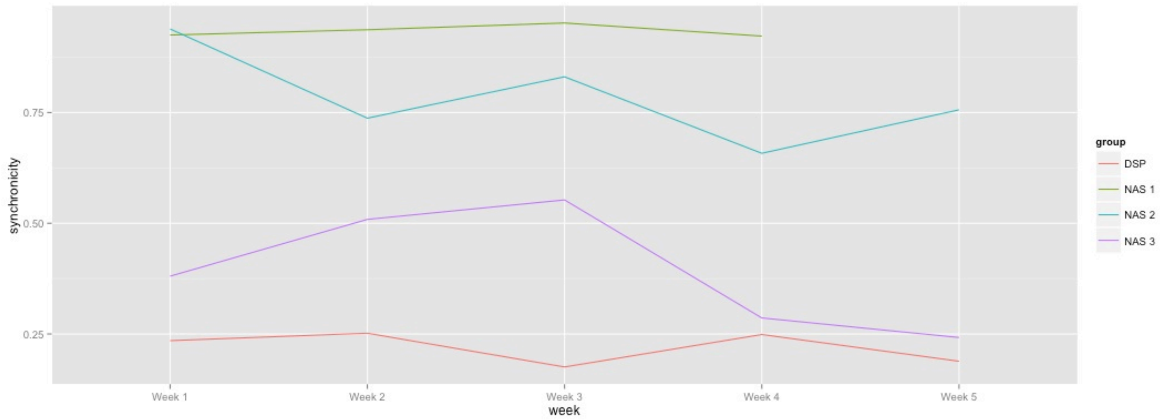

Figure 4. Group Synchronicity Indices Changes Over Weeks

A second hypothesis is the linearity index may influence synchronicity, since the less a student engaged in videos individually, the more chance they may have to keep synchronized. A *MELR* model, with both time and linearity index as predictor and individual synchronicity index as response variable was built to test the correlations between linearity and synchronicity. The student variable nested in groups introduces a random slope effect. The result is given in Table 1. Linearity indices showed a significant positive correlation with synchronicity indices. The Pearson's correlation coefficient value is large, indicating that the linearity index is a strong predictor of synchronicity. A smaller linearity value indicates that the student has spent more time on videos by means of pausing or replaying, which make it difficult for students to stay synchronized.

Table 1: Correlations between linearity and synchronicity index

	Estimated β coefficient with MCMC	95% HPD credible interval	Pearson's R	p-value
Linearity	0.3355	0.1408 ~ 0.5890	0.951	0.0005

Predicting Perception of Discussion

The next set of analysis aims at exploiting the relationship between synchronicity and perception of group discussion. We examined the perceived levels of equal contribution and quality of discussion, which were acquired from the questionnaire. For spontaneous groups, these are important measures for gauging the effectiveness of their study patterns.

Table 2: Correlations between synchronicity and perceived level of equal contribution and discussion quality

	Estimated β coefficient with MCMC	95% HPD credible interval	Pearson's R	p-value
Equal contribution	1.591	0.0962 ~ 3.3603	0.462	0.049
Quality of discussion	1.6323	0.0060 ~ 3.4530	0.667	0.021

Another two *MELR* models were built, with time and individual synchronicity as longitudinal predictor. Likert-scales of equal contribution and discussion quality were response variables in each model, respectively. Again, the student variable nested in groups introduces a random slope. The results are shown in Table 2. Synchronicity indices showed significantly positive correlation with both of the perceptional scales with moderate correlation coefficient values. It signifies that synchronous groups tended to perceive better group learning experience, in terms of discussion quality and balanced participation. However, the R^2 values (0.213 and 0.445) of the two correlations are relatively small, indicating that synchronicity do not contribute much of the variations in the respective measures. This is not out of our expectation, since many other factors may contribute to subjective perceptions.

Discussion and Conclusion

In summary, our first finding is that the linearity of video interactions is a strong predictor of synchronicity, which in turn correlates with the students' perceived balanced participation and quality of discussion in collocated MOOC study groups.

Less individual engagement in videos leads to higher synchronicity. This is simple to interpret, since fewer video interactions increase the chances for students to watch and digest the same topic at the same time, which offers a common ground for them to foster arguments and discussions. Linear watching does not always imply lack of independent thinking. Highly synchronous groups, according to our semi-structured interviews, reported that they usually noted down the problematic video moments while watching the videos, and brought out every question in the group discussion right after everyone finished watching. The groups were self-regulated, and students intentionally started and finished video watching more or less simultaneously.

Regarding the students' perceptions towards their group learning experience, though we've found that synchronicity correlates with students' perception towards the quality and even distribution of their discussion, causality is not assumed. Synchronicity itself is not a condition, but a result of many group processes. It turns out that synchronous groups perceived better group learning, in terms of self-assessed quality and mutual participation. The message behind this result is more important, i.e. we should encourage synchronous watching videos for MOOC study groups.

If we now revisit the results of the correlation between linear and synchronous video watching, we will find ourselves in an embarrassed situation. A deeper interpretation of this correlation indicates that interacting with videos on separate devices breaks synchronicity, or in other words, synchronous video watching hinders individual video engagement. Though we want to encourage synchronous video watching, we may not reduce their chance in navigating videos, which is a natural way for leaners to learn from the teacher. Perhaps a better way of forming MOOC study groups is to engage the learners with synchronized displays, if condition permits.

Another important finding in our research is that groups may work with different styles, but they were shown to stick to the initial pattern. This is perhaps because a unique group atmosphere was formed for each group in the first time, and participants got used to it. The stability of such group patterns in terms of synchronicity has a big implication for organizing MOOC-based study groups. Though groups can be spontaneous, good practices (e.g. explicitly asking learners to stay synchronized) should be suggested to study groups, preferably before their first session.

Massive courses, by its nature bring students with diverse background and skills to the same ground. Lack of structured support has made MOOC difficult for individuals to follow. On the other hand, the massiveness has its potential to create group study experiences for leaners that locates closely to each other. Therefore, understanding the behaviors of group learners is essential to the successful promotion of study groups in MOOCs. This paper studied MOOC study groups by analyzing a longitudinal study with real MOOC students from the university. The conclusions about synchronous group watching MOOCs provide an insight into how organizers of future MOOCs might address the design challenge.

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