Designing for and facilitating knowledge-building discourse in online courses

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Abstract

Purpose – Founded in sociocultural theories of learning, the authors argue that engaging learners in collaborative knowledge building is critical. When responding to others’ ideas, research shows that learners in online settings more frequently focus on surface-level aspects of colleagues’ contributions – sharing, comparing and praising – rather than engaging in knowledge building. Collaborative, knowledge-building discourse includes generative interactional practices that feature disagreeing, negotiating meaning, testing and reflecting on co-constructed ideas, summarizing conversations and making metacognitive contributions to discussions. The purpose of this paper is to review studies that show evidence of key design features and pedagogical practices that support collaborative knowledge building by promoting generative interactional practices and particular patterns in interaction.

Design/methodology/approach – This conceptual paper presents pragmatic design and instructional guidelines for online course discussions. The purpose is to synthesize existing research and share a detailed framework for supporting generative discussion in asynchronous online work.

Findings – The authors review studies that show evidence of key design features and pedagogical practices that support collaborative knowledge building. Design features to promote generative discourse include using the asynchronous nature of online settings to have students work privately, share their work, discuss their work with the class and then revise; providing instructions/discussion criteria that scaffold knowledge building; and using appropriate digital tools that mediate interaction around content. The pedagogical practices that affect patterns of interaction include modeling generative discourse, promoting increased interactions by and between participants and using opportunistic grouping strategies.

Originality/value – The authors include examples from one of their existing online courses that include these design features and pedagogical practices and discuss results from their ongoing work regarding the generativity of learner interactions in this course.

Keywords Social network analysis, Design, Scaffolding, Sociocultural, Online teaching, Knowledge building

Paper type Viewpoint

This paper is part of the special issue, “A Response to Emergency Transitions to Remote Online Education in K-12 and Higher Education” which contains shorter, rapid-turnaround invited works, not subject to double-blind peer review. The issue was called, managed and produced on short timeline in Summer 2020 toward pragmatic instructional application in the Fall 2020 semester.
Objectives
Participating in a learning community where all learners contribute to collective knowledge building – which we define as participation in generative and productive communities – can be an enjoyable and empowering educational experience with positive implications for the trajectories of learners’ lives. Educational institutions all over the world are currently undergoing a shift from face-to-face to distance learning, making community building that might have been possible for educators in face-to-face classrooms may seem unreachable in online settings. Sociocultural and situated learning theories indicate that learning is collaborative in nature and highly dependent on the context in which it occurs, particularly when using technology (Barab and Plucker, 2002; Siemens and Tittenberger, 2009; Zhao et al., 2002). In addition, Borba and Villarreal (2005) argue that technologies mediating learner interactions (e.g. chalkboard, pencil and notebooks or online discussion boards) shape collaborative knowledge building. This implies that designing instruction that supports the emergence of community is fundamentally different in online and face-to-face settings.

Given the sociocultural learning theory that undergirds our work, we focus on the use of online asynchronous discussions via threaded discussion boards to cultivate generative and productive communities. A key feature of such communities is learners engaging in collaborative knowledge building. While research indicates the challenges of promoting interactions productive for knowledge building in online settings (Lantz-Andersson et al., 2018; Macia and Garcia, 2016), our past work has shown promise in moving learners in these settings beyond sharing and comparing ideas and engaging in what we refer to as generative interactions for knowledge building (Matranga et al., 2018; Matranga et al., 2020). This success has been guided by past research showing that the affordances of threaded discussion boards, especially asynchronous collaboration and archival of interactions, create opportunities to support generative interaction by slowing down the fast pace of teaching and learning that is so familiar in face-to-face settings (Borba et al., 2018; Gao et al., 2013; Ke and Xie, 2009).

The current paper presents two design principles for supporting the emergence of generative and productive community. Then we synthesize existing research through the lens of these principles to introduce a detailed framework, including design features and facilitation strategies for using online asynchronous discussions to build community.

Design principles
This section presents two design principles grounded in sociocultural theories of learning for designing for the emergence of generative and productive online learning communities:

1. engaging learners in generative interactions; and
2. supporting the emergence of a highly connected social network.

The ultimate instructional goal is maximizing access to, and productive engagement with, different perspectives in the community by scaffolding the quality of, and pattern in, learners’ interactions.

The first principle draws from the communities of practice framework (Wenger, 1998) and components of knowledge-building communities (Bereiter and Scardamalia, 2016). Key features of a community of practice include mutual engagement in common practices, collective goals and a common set of tools. Knowledge building includes engagement in particular discourse practices that allow groups of learners to use discussion to mediate the development of collective understandings. Taking this perspective on discourse includes focusing on the function of an interaction rather than the content of the discourse itself. Synthesizing past works (Gunawardena et al., 1997; Lotman, 1988; Scardamalia, and Bereiter, 2014), we classify
the function of an interaction as either *sharing and comparing* or *generative*, where the former can be thought of as the conduit metaphor for knowledge transmission, while the latter includes wondering, exploring dissonance of ideas, negotiating, openly interpreting, critiquing and reasoning through ideas, synthesizing ideas and summarizing knowledge advancements (see Table 1 for a sample of generative talk). These generative interactional practices are essential for knowledge building (Gunawardena *et al.*, 1997). Therefore, learners engaging in generative interactional practices can have the effect of building community by bringing them together around common practices, which is an important component of a community of practice (Wenger, 1998). One implication of this principle is that building generative and productive communities should include focus on scaffolding the quality of learner interactions.

As learners participate in a community and come together around common practices, they engage with new perspectives and make new connections. This process has implications for evolution of the community’s practices and the pattern of connections in the social network. There are certain social network structures that are more conducive to community formation. Haythornthwaite (1996, 2007) suggested that a highly connected network of learners creates opportunities for strong relationships to form around practice, while Jan and Vlachopoulos (2018) argued that a highly connected network can suggest the presence of a community of practice. Research also indicates the importance of maximizing explicit and productive peer-to-peer interaction through reading and commenting on colleagues’ posts in online asynchronous discussion to build community (Silverman, 2011). In addition, Gunawardena *et al.* (2018) highlight the importance of tapping into each community members’ assets and culturally rich knowledge, which enhances the knowledge-building potential of a community. Thus, it is not enough for online learning to focus solely on promoting generative interactional practices. Indeed, doing so might result in a “cliquey” social network, limiting the full potential of access to, and engagement with, peers’ ideas. Therefore, we argue that generative and productive communities have highly connected social networks (see Figure 1 for example networks). One implication of this principle is the importance of focusing on the pattern of instructor–learner and learner–learner interactions in online discussions.

Taken together, we suggest that online instruction should focus on two dimensions of collaboration:

1. the quality of interactions; and
2. the pattern of interactions.

Facilitating such instruction is enhanced by the asynchronous collaborative opportunities and the archival of interactions afforded by learning mediated by the internet.

**Designing for and facilitating the emergence of generative and productive learning communities**

In this section, we will connect our design principles with practical approaches to designing an online course. We view the design of learning experiences as a combination of tools, materials and teaching strategies. The following design features (see Table 2 for an overview) emerged from our synthesis of existing research and frameworks.

**Designing for high-quality, generative interactions**

*Structuring collaboration*

Structuring collaboration is important when designing for productive learning in any setting. In face-to-face settings, this might include a “think-pair-share” activity or group
<table>
<thead>
<tr>
<th>Author from</th>
<th>Author to</th>
<th>Post</th>
<th>Type of interaction: description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen and Juan</td>
<td>Jill</td>
<td>Initial solution</td>
<td></td>
</tr>
<tr>
<td>Jill</td>
<td>Karen</td>
<td>Nice work! I like how you approached this problem with the basics of algebra. Also, when this assignment is seen with different focuses, the way a teacher would explain it to their students changes as well.</td>
<td>Share and compare: Jill praises Karen’s use of algebra to solve the problem and then shares an idea about how teachers might explain the solution. Generative: Preston appears to be expressing dissonance with Karen’s explanation of how she derived the function from the problem.</td>
</tr>
<tr>
<td>Preston</td>
<td>Karen</td>
<td>I appreciated how you approached this problem by first listing your quantities. One of the things that I felt that might be missing is how you came to the function ( h(x) = -(3/2)x + 30 ). Maybe if your diagram included where you see these quantities being represented in the problem scenario would have helped clarify your description. I am having a hard time figuring out how you came about the ( 3/2 ) ratio.</td>
<td>Generative: Chloe appears to propose a different approach for how Karen should organize the quantities to better reflect the problem scenario.</td>
</tr>
<tr>
<td>Chloe</td>
<td>Karen</td>
<td>First of all, I really like your diagram because when I first read the problem I had no idea what they meant by an A-frame barn. The list of relevant quantities is exactly what I would focus on in this particular problem, but I may have even separated the quantities into two categories: those for the A-frame barn and those for the rectangular room. I’m not sure if this is maybe too repetitive since the values for the A-frame barn are constant, but the quantities for the rectangular room do depend on the quantities of the A-frame barn.</td>
<td>Generative: Juan identifies areas of agreement in his and Chloe’s ideas (e.g. having an “A-frame barn quantities category”) and he openly shares additional reasoning for how he came to determine the three halves ratio for the function (likely prompted by Preston’s wondering).</td>
</tr>
<tr>
<td>Juan</td>
<td>Chloe</td>
<td>Chloe, I like you had no idea what an A-frame barn really was until I did some research, and even then I wasn’t positive. After we worked through that difficulty the problem became a lot easier. I also agree with you about the A-frame barn quantities category, I too felt like it could have been added, but didn’t think it was key. Although it is what put limits on the size of the room, so it probably should have been adapted into the solution to some extent. For the equation we came up with, we broke the base of the triangular shaped roof in half to be able to find the height of the triangle, which would give us the height of the room. Then by knowing that an A frame barn is an isosceles triangle we knew that as the height decreased for one of the right triangles it would for the other to keep the room the right shape. It’s fairly complicated to explain,</td>
<td>(continued)</td>
</tr>
</tbody>
</table>
but basically as our width of the room got larger as the height shrank, because we were moving further from the center of the triangle to create a room of that size. As a result, the max height would decrease, and the decrease is by \( \frac{3}{2} \) of the change in the width.

With everyone's responses we could have brought out the idea of the relationship between quantities more, especially relating the variation of the height of the room and width of the room, but also how those two vary with the volume of the room. I think I'll modify that in our revision.
work followed by student presentations. Silverman and Clay (2010) introduced the online asynchronous collaboration (OAC) model that capitalizes on the affordances of asynchronous communication to engage learners in knowledge building (Figure 2). The OAC has four phases and supports individuals in engaging privately with a task, posting a response to that task in a public space and then examining and reflecting on their own and their colleagues’ work and reflections. Research has shown that the OAC-created context for mathematics teachers resulted in a shift from sharing and comparing ideas to engaging in generative interactions (Matranga et al., 2020). Gunawardena et al. (2018) presented a structure for collaboration that is similar to the OAC called the collaborative inquiry cycle, which outlines a similar approach for designing online learning that is also sensitive to learners’ cultural backgrounds. A commonality in these models is that learners have access to all of their peers’ thinking because it is posted on a discussion forum. Further, a cycle might take a week or longer, giving learners time to engage in data-driven reflection on their peers’ responses to a task and then synthesize their noticing into a revision. Iterating through this cycle multiple times throughout the course can result in interactions that move beyond simply sharing ideas into true transformative knowledge building.

Providing instructions that scaffold knowledge-building discourse
While structures for collaboration such as the OAC can create opportunities for knowledge building (solve a problem, give feedback), learners also need support engaging in generative peer-to-peer feedback and discussion. Fu et al. (2016) suggested that there are distinct discourse patterns for different modes of discourse, including knowledge-building and that sharing prompts that support such discourse can shape the quality of student interactions. Chen et al. (2017) reported that consolidating instructions for discussion, among other things, increased student engagement and learning. As an example, Yücel and Usluel (2016) found that using knowledge-building prompts (e.g. “my theory,” “putting our knowledge together,” “I need to understand,” “this theory cannot explain”) can increase learners’ engagement in generative discourse. In addition, Shumar (2017) argued that the discourse practice of “noticing and wondering” is effective for opening up reflective and evidence-based conversations between learners. Finally, Borba et al. (2018) discussed how online discussion forums can serve as an interactive textbook, where archives of learner conversations in discussion forums support learners engaging in data-driven reflection and integrating community discourse into subsequent discussions. Because of this, providing scaffolds that shape the quality of discourse can impact the generativity of peer-to-peer feedback and discussion and the community archives that can be the foundation for reflection and future collaboration. Table 3 is an example of discussion response guidelines from the course we based our research on, along with a description for how they promote...
### Design principle | Design features | How
--- | --- | ---
Quality of interactions | Structuring collaboration | Provide multiple opportunities for learners to engage in inquiry-oriented tasks that provoke a problem to solve within this cycle (Gunawardena et al., 2018; Silverman and Clay, 2010):
- Phase 1: engage in individual problem solving;
- Phase 2: share problem-solving work in a discussion forum and critique and provide feedback on peers’ work;
- Phase 3: reflect on the results of this problem-solving and discussion; and
- Phase 4: Revise initial solutions:
  - (See Figure 2 for additional detail)

Providing instructions that scaffold knowledge-building discourse | Developing criteria and assignment descriptions that (Chen et al., 2017):
- emphasize quality of posts, including elements such as:
  - noticing and wondering (Shumar, 2017);
  - negotiation;
  - interpretation;
  - synthesis; and
  - summary of discussions;
- provide example sentence-starter prompts for responses (Yücel and Uşuel, 2016); and
- share examples of high-quality posts (Renkl, 2016)

Using appropriate digital tools to mediate interaction | Through the lens of Bielaczyc’s (2006) social infrastructure framework, appropriate tools in this context:
- are interactive;
- elicit learner thinking; and
- allow for revision

Patterns of interactions | Instructor as an experienced colleague | Monitor the extent of interaction and with whom those interactions are with (An et al., 2009);

(continued)

**Table 2.** Overview of design features.
generative interactions. Often, online courses give very general directions about responding to other learners. By providing more specifics, an instructor can emphasize qualities that make for better discussions.

Using appropriate digital tools to mediate interactions
Digital tools can also be used to scaffold generative peer-to-peer feedback and discussion. The specific tool is less important, ultimately, than thinking about how and why you will use it. One example of a framework you can use to guide these decisions is the social infrastructure framework (Bielaczyc, 2006), which has four categories that can assist with the design of technology-enhanced learning environments:

(1) cultural beliefs;
(2) practices;
(3) socio-techno-spatial relations; and
(4) interactions with the outside world.

Particularly relevant to the current paper is practices – generative interactional practices. Specific questions to consider when reviewing technology tools to promote generative interaction:
Q1. Does the tool support student–student and/or instructor–student conversation?

Q2. How does the tool elicit student thinking?

Q3. Does the tool allow learners to return to and revise their work?

Recent research points to the potential of tools that support evidence-based feedback (Matranga et al., 2018), pruning ideas to identify those that are most promising for future learning (Chen et al., 2015) and consolidating and summarizing discussions (Resendes et al., 2015) for promoting generative interaction. It is also important to note that when working with younger students, it is worth discussing digital citizenship and considering issues of equitable access (Donohue and Schomburg, 2017). Focusing on these issues and questions of how and why a certain tool fits into the course can create more authentic and engaging experiences for the learners, resulting in higher quality collaboration.

**Designing for a highly connected social network**

*Instructor as an experienced colleague*

A common interactional pattern in face-to-face settings that is not productive for knowledge building is referred to as IRE, where instructors Initiate a question or interaction, the student Responds and then the instructor Evaluates the response. This interactional pattern can constrain learner-to-learner discourse because it can position the instructor as an authoritative figure who “has all the answer.” In contrast, an instructor engaging with course participants as an experienced colleague (Table 4) can have the dual benefit of decentralizing herself as the authority in the course and modeling generative discourse practices. Drawing from the work of scholars focusing on informal educational settings such as virtual affinity spaces (Gee, 2004), there are studies indicating that informal, interest-driven virtual environments have less of an expert-novice divide, which can positively impact knowledge-building discourse (Ito et al., 2019; Jenkins, 2009; Steinkuehler and Squire, 2014). Indeed, too much instructor interaction in a formal online course discussion forum can impact the extent of learner–learner collaboration (An et al., 2009), and our work suggests that the instructor should gradually reduce her participation in course discussions (Matranga et al., 2020) to enhance opportunities for learner–learner interaction. Furthermore, Ouyang and Scharber (2017) showed that an instructor who initially took on a supportive role through frequent interaction with students before transitioning to a collaborator and observer role repositioned herself as a colleague rather than an authoritative figure. On the

<table>
<thead>
<tr>
<th>Instructor post</th>
<th>Description</th>
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<tbody>
<tr>
<td>I’d push to unpack this ‘increase.’ For example, you might think, as the car moves along the straight road from exit 1 to exit 2, the distance from the car to exit 1 increases; to track this increase on an x-y coordinate graph, I drew…</td>
<td>This post is an example of the instructor of an online course supporting a learner in thinking about how to generate a graph according to how the linear distance between a moving car and an exit changes with time. This post offers the learner with a framework for how to engage in this way of thinking about generating graphs. Thus, rather than evaluating the learner’s post, the critique is subtle and the post, itself, becomes a scaffold for reflection and further thinking about the problem.</td>
</tr>
</tbody>
</table>

Table 4. Example of instructor responding as an experienced colleague
other hand, modeling generative discourse practices (Choi et al., 2008) work hand-in-hand with the design of discussion criteria, providing students a “live” example of the course expectations and perspective of what knowledge building “sounds” like. Modeling also further reinforces the instructor as an experienced colleague by engaging in discussions as a learner rather than by evaluating learner responses. With the archival of interactions in online discussions, these live examples emphasize expectations for collaboration as participants engage in and reflect on their course discussions. Taken together, these studies suggest that the instructor should foreground the modeling of knowledge-building posts early on in the course and then fade out of a central role in the conversation to deconstruct the IRE pattern and allow for more organic interactions between learners to occur.

**Instructor interaction strategies**

In our experiences with collaborative, face-to-face classrooms that have reduced the IRE pattern of interaction and increased student–student collaboration, a subgroup of learners tends to more frequently talk in class discussions. Our research shows the same phenomenon occurs in online settings (Matranga and Silverman, 2020). The pattern by which an instructor interacts with learners can cultivate more inclusive learning communities. As an example, Wise and Cui (2018) showed that there emerged differences in the pattern of learner collaboration when the instructor responded primarily to initial posts in threaded discussion versus child posts (responses to the initial post) in the thread. The latter approach allowed for increased interactions between students, while the former resulted in increased interactions between students and the instructor (see Figure 3 for a sample diagram). Similarly, Matranga and Silverman (under review) showed that an instructor who equitably distributed his participation across subgroups of participants who engaged more or less in course discussions appeared to contribute to the emergence of a more collaborative environment where learners from the subgroups began to talk to one another more frequently. Fu et al. (2016) studied online knowledge building and argued that it is important for instructors to shift focus away from the content of individual messages to the relationship between multiple messages. In face-to-face settings, learners with contrasting ideas often engage in generative talk (Dobie and Anderson, 2015). An online course enables instructors to be strategic about who and how they interact with learners while highlighting potential discussion points in ways that a classroom discussion might.
Using opportunistic and dynamic grouping strategies
The use of small groups for course tasks can afford focused, learner–learner collaboration that is not reliant on the course instructor’s consistent engagement in the discussion. However, students consistently collaborating in the same groups can result in a setting where cliques emerge and learners feel comfortable engaging with their small group yet apprehensive to engage with peers in other groups. This “cliquey” pattern of interaction can constrain knowledge building to particular cliques (Jan and Vlachopoulos, 2019). Research has found that establishing small groups, but allowing for dynamic grouping opportunities, is effective for increasing the extent to which learners engage in discussion with peers and knowledge building. Zhang et al. (2009) reported on a three-year project using various grouping strategies with an online learning tool. They found increased knowledge building as they shifted the design from a fixed-small-group approach to a small group approach that supported cross-group collaboration to an opportunistic approach in which the learners formed and re-formed their own groups based on classroom goals. In another study, Ouyang and Scharber (2017) reported that groups based on similar interests and professional groups, along with frequent movement between small group and large group discussions, resulted in an interactive online learning community. Taken together, there is evidence that suggests forming initial groups around commonalities but also shifting group membership to foster discussion around different points of view as they arise during whole-group discussions. In addition, allowing for learners to dynamically reform their own groups as the course progresses can impact the extent to which learners have access to and engage with the different perspectives in the class. Ultimately, this approach can lead to higher interaction.
among learners who might otherwise not connect with each other, making for a more collaborative and inclusive learning community.

**Conclusion**

Learning theory indicates that design for collaborative knowledge building is fundamentally different in online settings than it is in face-to-face settings. Our goal was to highlight two general principles: high-quality posts along with specific patterns of learner interactions can result in greater communal knowledge building. The six design principles we discussed – structures for collaboration, explicit discussion criteria and examples, appropriate supplemental tools, instructor disposition, instructor interaction strategies and grouping considerations – are offered here as practical ways to apply these principles. Online environments offer two key affordances that are not available when teaching face to face, namely, asynchronous opportunities for reflection and discussion, along with automatic archival of these activities. By designing courses that maximize this potential, we can create a better learning experience for our students.

While we have outlined specific design features and facilitation strategies that have led to success in our own courses, our hope is that this paper provides strategies that can be easily adapted for other educators’ local social and cultural contexts. Moreover, we hope that educators will – grounded by social theories of learning – begin to innovate their own strategies that follow our principles and take advantage of the affordances of the internet.

Even when moving back to face-to-face models of instruction, these affordances of technology that we have mentioned can still positively impact learning. Incorporating digital tools and using these principles as a hybrid approach to learning can slow down the fast pace of face-to-face learning environments.

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