Learning through experience: Using design based research to redesign protocols for blended synchronous learning environments

Janet Mannheimer Zydney[a],[*], Zachary Warner[a], Lauren Angelone[b]

[a] University of Cincinnati, PO Box 210022, Cincinnati, OH 45221-0022, USA
[b] Xavier University, 3800 Victory Parkway, Cincinnati, OH 45207, USA

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ABSTRACT

Blended synchronous environments offer benefits to learners in terms of flexibility, but there are technological and pedagogical challenges in implementing this approach. Protocols, which are highly structured discussion strategies designed to promote trust, equity, and diversity, have the potential to address some of these challenges. This exploratory study used a design based research methodology to iteratively design, implement, and assess a blended synchronous learning environment leveraging the use of protocols in a graduate education course. Across three iterations, a combination of qualitative data collection and analysis procedures were used to examine the influence of protocols on the experiences of the instructor and students in a blended synchronous environment. The findings included several assertions. Students appreciated taking on greater leadership roles through facilitating protocols when they perceived the outcome of their facilitation successful. Students became hyperaware of the time when the technology caused timing issues with the protocols. Trust of the protocol was hindered by the unpredictability of the blended synchronous learning environment. And, deep connections to texts were unachievable due to the multitasking required in blended synchronous settings. These findings resulted in a set of contextualized design propositions that contribute to the literature on both protocols and blended synchronous environments. The propositions included: (a) enabling active participation through distributed roles, (b) creating equity through flexible structures, (c) fostering trust through re-norming, and (d) prompting connections with texts by reducing task complexity.

1. Introduction

Technological advances have allowed educators to rethink the traditional asynchronous model of online education by incorporating blended elements (Roseth, Akcaoglu, & Zellner, 2013). For example, teachers can now host blended synchronous sessions, which allow online and on-campus students to participate in activities together in real time (Bower, Lee, & Dalgarno, 2017). These types of sessions have also been referred to in the literature as synchromodal (Bell, Sawaya, & Cain, 2014), HyFlex (Para & Abdelmalak, 2016), and synchronous hybrid (Butz & Stupnisky, 2016). By enabling students to participate in classes in a mode that best suits their needs, blended synchronous instruction goes beyond blended instruction, which simply combines face-to-face activities with online instruction (Boelens, De Wever, & Voet, 2017). This innovative approach is gaining attention among higher education institutions due to its flexibility and increased access to more students (Bell et al., 2014; Wang, Huang, & Quek, 2018). The

inclusion of blended synchronous sessions may offer a solution for students who miss the social experience of on-campus courses (Bower, Dalgarno, Kennedy, Lee, & Kenney, 2015). And, the benefits may not be limited to just students attending on campus. Szeto and Cheng (2016) reported that both online and on-campus students attending blended synchronous sessions had an enriched learning experience from feeling a sense of connection to one another.

However, questions remain regarding how to design blended synchronous instruction in a way that leads to quality learning experiences. Studies indicate that technology can become a hindrance for teachers and students if not utilized properly (Bower et al., 2015; Park & Bonk, 2007), and many teachers may need to develop additional skills and digital pedagogies in order to be successful with this type of environment (Hastie, Hung, Chen, & Kinshuk, 2010). One digital pedagogy that has not been explored with blended synchronous learning environments is protocols, defined as highly structured discussion strategies designed to promote trust, equity, and diversity by clearly defining participant roles and rules for interaction (McDonald, Zydney, Dichter, & McDonald, 2012). The authors speculated that the inherent structure of protocols might help with many of the communication and equity issues between online and on-campus participants noted in recent studies (e.g., Bower, Dalgarno, Kennedy, Lee, & Kenney, 2014; Wang et al., 2018). For example, protocols may alleviate some communication issues caused by lag times by structuring when and for how long each person should speak (McDonald et al., 2012). Moreover, protocols may help address equity issues by prompting everyone to contribute to the discussion and encouraging different perspectives (McDonald et al., 2012).

Given the possible fit between protocols and blended synchronous learning, this study sought to understand how a protocol pedagogy could be integrated into a blended synchronous learning environment. Thus, the goal of this research was to iteratively design, implement, and assess a protocol pedagogy within a blended synchronous learning environment with the specific intent of answering the question: How can protocols be redesigned to enhance learner experiences within blended synchronous environments?

2. Background

The background for this study describes a protocol pedagogy, explains how online protocols evolved from this pedagogy, and the potential for the use of protocols within blended synchronous learning environments.

2.1. Protocol pedagogy

A protocol pedagogy is a student-centered method of teaching that uses structured discussions with the intention of fostering meaningful interactions. This pedagogical framework consists of four design principles: (a) enabling active participation through varied roles, (b) creating equity through structure, (c) fostering trust through establishing norms, and (d) prompting connections with texts (McDonald et al., 2012). This pedagogical framework is enacted through a protocol that includes a well-defined goal for the discussion, clearly identified roles for participants to play, structured rules for how participants should interact, and set timeframes for each step of the discussion (McDonald et al., 2012). The sections that follow describe how each of the design principles are implemented through a protocol.

2.1.1. Enabling active participation through varied roles

A key feature of a protocol pedagogy is to promote active participation in the learning environment. By doing so, protocols are designed to help participants learn and socially construct knowledge together (McDonald, Mohr, Dichter, & McDonald, 2003). In the first book on protocols, McDonald et al. (2003) write:

> When the facilitator encourages participants in a protocol to "hear all voices," it is really a call to highlight a sufficient number of perspectives on the issue or problem at hand such that everyone can gain the possibility of new insight. It is also a call to pool knowledge and thus become smarter in the aggregate, to cultivate what Laura Resnick (1987) calls shared cognition (p. 16).

One way in which protocols ensure participation is by having participants play different roles within the discussion. For example, protocols require that there be a facilitator and, as a result, prompts those facilitating the protocols to take on a more active, leadership role. In addition to facilitators, protocols may require that participants take on other roles, such as listeners, presenters, critical friends, etc. – each with a different purpose in making an active, deliberate contribution to the conversation. These roles may create a kind of "participatory stretching" where participants are asked to participate in a way that may take them out of their comfort zone (McDonald et al., 2012, p. 25). They press quieter participants to contribute their ideas and more talkative participants to listen. For example, the Tuning Protocol, which structures how participants provide feedback to one another, has a rule that the presenter remains silent and listens to the feedback from the critical friends without reacting (School Reform Initiative, n.d.). Compelling participants to really listen without reacting can be a powerful tool for reflection. See online supplement for resources on this protocol and others.

2.1.2. Creating equity through structure

Another important feature of protocols is that they help create equity by creating a structure that make everyone accountable for participating in the discussion. Many protocols do this through a structure called a Go Round, which creates a strict speaking order where each person takes a turn talking. Most protocols also include timeframes so that each person contributes to the discussion for about the same amount of time. For example, in the Tuning Protocol, the critical friends pause for 2–3 min to reflect on their feedback before sharing it, and then are given 10–15 min for a Go Round where each person shares "warm" (i.e., positive) or "cool" (i.e., constructive) feedback. This structure helps constrain individuals that may dominate the discussion and provides a space for others

whom have difficulty jumping into a discussion to add their ideas (School Reform Initiative, n.d.). By ensuring equitable participation, a "joint responsibility" emerges that makes everyone accountable for learning from the group (McDonald et al., 2012, p. 23).

2.1.3. Fostering trust through establishing norms

Another fundamental aspect of protocols is that they help to create a safe environment by establishing trust in the process. By creating specific rules for interaction, protocols help to create feelings of safety in contributing one's ideas (McDonald et al., 2012). "The immediate goal is not that every participant will trust every other participant *as an individual*, but rather that all will come to trust in the situation that has been collectively designed and developed and will find it productive" (McDonald et al., 2012, p. 27). These rules often feel artificial and, as a result, are sometimes initially met with resistance. As noted by McDonald et al., 2012:

> Participants new to protocols sometimes ask, "Why can't we *just talk*?" But their facilitators typically urge them instead to tolerate awhile their discomfort. "It's like a game," they may say, echoing Douglas Thomas and John Seely Brown (2011), who write that the boundaries of a game are not just constraints but also potential catalysts for innovation. This is the allure of both games and protocols, and also, as we say, their payoff. … protocols tend to move things along—simply because they often *structure in* movement (p. 4).

Over time, as participants gain experience with using protocols, they begin to see that these constraints are what provide the means for a productive conversation (McDonald et al., 2012).

An example of these constraints can be seen in the rules for interaction described in the Tuning Protocol. This protocol gives the participants, playing the role of critical friends, sentence starters to help them craft feedback in a constructive way, such as "I wonder if …. " or "One way to more closely align the goal/purpose is …" (School Reform Initiative, n.d.). The rules also allow the presenter to choose what feedback to react to after he or she has listened to all feedback – both warm and cool. Both these rules help the presenter to really listen and absorb the feedback without becoming defensive, potentially shutting down helpful advice.

2.1.4. Prompting connections with texts

The last significant element of protocols is that they draw attention to reflecting on and making connections to texts or "renderings of thought and experience in any medium" (McDonald et al., 2012, p. 25). Protocols provide a collaborative tool to help participants with "collective interpretation" of texts they read together (McDonald et al., 2012, p. 26). They promote these connections through thought-provoking prompts or by giving participants a time period in which to reflect on the text. In the Tuning Protocol, critical friends are given time to read and reflect upon the presented text prior to providing their feedback to the presenter. The presenter is given time at the end to reflect on the notes he or she took on the feedback received and select what feedback to respond to. Other protocols are specifically designed for participants to do textual analysis. For instance, in the Save the Last Word for Me protocol, participants are asked to select a quote from the text that they would like the group to help them interpret (McDonald et al., 2012).

2.2. Evolution of online protocols

Protocols originated for in-person settings to help participants problem solve, diffuse potential conflicts, consider new perspectives, or reflect deeply (McDonald et al., 2003). More recently, they have been successfully adapted to online settings, ranging from small graduate classes (Zydney, deNoyelles, & Seo, 2012) to large enrollment undergraduate courses (Chen, deNoyelles, Zydney, & Patton, 2017). Online protocols are likely successful because they encompass several other effective asynchronous discussion strategies, such as role-based discussions that assign students specific roles to play during the discussion (Hou, 2011; Olesova, Slavin, & Lim, 2016); participation or posting protocols that specify frequency, length, and timing of postings (Gilbert & Dabbagh, 2005); and structured prompts that stipulate the types of responses desired (Schindler & Burkholder, 2014). One common feature shared by all of these strategies is that they are highly structured, which has been noted by several literature reviews as an important characteristic in creating effective online discussions (deNoyelles, Zydney, & Chen, 2014; Hung, Flom, Manu, & Mahmoud, 2015; Schindler & Burkholder, 2014).

2.3. Blended synchronous learning and the potential for protocols

Because blended synchronous learning is relatively new, the literature has uncovered a number of challenges that need to be resolved before this can be considered a productive way of teaching. Protocols may offer a much-needed solution to some of the persistent issues noted.

One frequent issue reported in the literature on blended synchronous learning is that the technology does not always work properly. The most common technology problems include audio issues (Bell et al., 2014; Bower et al., 2015; Para & Abdelmalak, 2016; Park & Bonk, 2007; Wang et al., 2018; Wang & Huang, 2018), network issues (Park & Bonk, 2007), and lag times (Wang et al., 2018). Resolving these issues can result in delays of instruction (Wang, Quek, & Hu, 2017). Although protocols themselves can't fix the technology issues, they can alleviate some issues caused by lag times. For example, one issue raised in the research on blended synchronous learning is that it is hard for students to know when to speak because of limited non-verbal cues (Bower et al., 2017). Similarly, students sometimes have issues with talking over one another due to latency issues (Bower et al., 2014). Protocols address this by providing "directions for who should speak at a particular time and for how long, and who should listen at a given time" (Zydney et al, 2012, p. 77).

Another issue that is often noted in the literature is participants feeling overloaded due to technology issues (Bower et al., 2015; Popov, 2009). Some solutions in the blended synchronous learning literature have been to utilize technology support personnel (Bower et al., 2017) or teaching assistants (Bower et al., 2014; Cunningham, 2014; Park & Bonk, 2007; Wang et al., 2018; White, Ramirez, Smith, & Plonowski, 2010). However, these solutions may not be practical or cost effective to implement on a larger scale. One promising solution is the use of "tech navigators," which are tech-savvy students assigned to the role of providing technical support during class (Bell et al., 2014). Protocols may build upon this idea through their requirement of having facilitators take on a leadership role. Although protocol facilitators to date have focused solely on the discussion and haven't taken on the role of facilitating the technology, this study sought to examine whether this role could be expanded upon within blended synchronous settings.

Although most of the research on blended synchronous learning has focused on figuring out solutions to the technology issues, there have been a handful of studies that have examined learning. These studies found that students learned similarly regardless of their attendance mode (Butz & Stupnisky, 2016; Szeto, 2015; White et al., 2010). One of the pedagogical advantages of blended synchronous learning environments is that they can bring in more perspectives because they open the classroom up to more students (Bower et al., 2015). These potential benefits may be better realized when coupled with the protocol design principle of enabling active participation through multiple roles.

Some pedagogical design recommendations for blended synchronous learning are to redesign activities to promote active learning (Bower et al., 2014), to ensure equity in participation (Wang & Huang, 2018; Wang et al., 2017; 2018), and to provide sufficient scaffolding for students (Park & Bonk, 2007). These suggestions align well with the design principles of protocols, such as enabling active participation by establishing clearly defined roles, ensuring equity through the use of Go Rounds and time constraints, and fostering trust through structured rules for interaction.

In summary, protocols may help address some of the communication issues and enhance some of the pedagogical benefits of blended synchronous environments. Through an iterative methodology described in the next section, this study sought to understand how a protocol pedagogy could be integrated within a blended synchronous learning environment.

3. Methods

The methodology used in this study was design based research (DBR), which is defined as "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang & Hannafin, 2005, p. 6–7). DBR, also referred to as educational design research, is a common approach for studying blended synchronous learning as the research community tries to assess the most effective design for this type of environment (e.g., Wang & Huang, 2018; Wang et al., 2017). DBR studies consist of a series of iterations, referred to as a cycle or phase. This current study included one cycle with three iterations, as illustrated in Fig. 1. The goal of this cycle was to develop an initial set of design propositions – guidelines that specify the characteristics of a design based on theory, empirical findings, and experience (McKenney & Reeves, 2012) – for blended synchronous protocols. Future studies will include additional cycles to iteratively assess the resulting design propositions in other contexts.

Although the overarching structure of DBR studies is similar, the methods used can vary depending on the research questions. The subsequent sections describe the context of the study, data sources, and analysis procedures.

3.1. Context of the study

This study sought to address a local issue at a midwestern university. The education program had been moved entirely online in
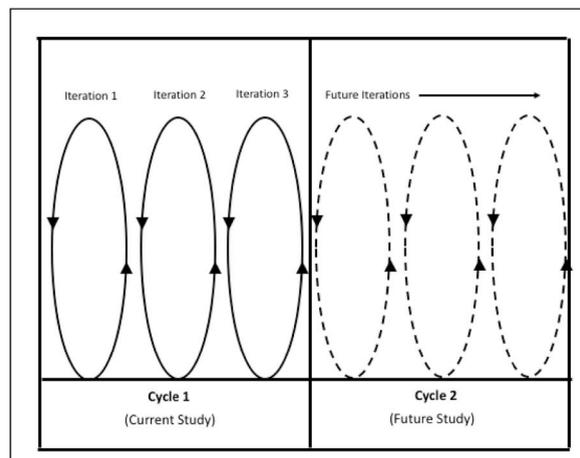

Fig. 1. Illustration of cycles and iterations in the current and future DBR studies.

Table 1
Alignment of initial design propositions to learning environment.

Initial Design Propositions	Alignment to Learning Environment
Enable active participation through varied roles.	Active learning created by small groups that include varied roles, such as student facilitators, presenters, and participants.
Create equity through structure	Equitable participation created through protocol structure of Go-Rounds and set time limits.
Foster trust through establishing norms.	Norms established through protocol rules.
Prompt connections with texts	Protocol questions prompted connections with texts.

an attempt to increase enrollments; however, many students enrolled still lived locally and could easily get to campus to attend classes. Many students close to campus complained that they missed the social interactions of in-person classes and desired to have on-campus classes. Moreover, the instructor of the class (also the first author) felt something was missing from teaching completely online and wished to have the opportunity to interact with at least some students face-to-face. Blended synchronous sessions offered a solution for these issues, but given the documented technological challenges and pedagogical demands of implementing this type of environment, additional design elements were needed if the sessions were to be meaningful for students.

Given this need, the instructor developed a graduate course using a blended synchronous format that incorporated protocols. Four session dates and times were listed on the registrar. The course was organized into eight learning modules that alternated every two weeks between discussions and projects. The project modules helped students apply their learning from the discussions. The first week and a half of each discussion module was conducted in an asynchronous format, and the last part occurred in a blended synchronous format. Each blended synchronous session used the same general structure: an introductory lecture or whole-class activity followed by small breakout groups that utilized different protocols to facilitate the discussion, ending with a debrief of the group discussions. The initial design of the first session was grounded in the design principles of a protocol pedagogy. The alignment of these design principles and the initial design is described in Table 1. Only the first three sessions were included as part of this study because there were no further iterations to the design after the third session. For additional course details, please see the student facilitation approach described in Zydney, McKinney, Lindberg, & Schmidt, 2018.

The research team included the instructor of the course, a research assistant, and a consultant with expertise in qualitative research. The instructor was both the principal investigator and a participant in the research. The class consisted of 17 students. The instructor informed all students that the course was part of a research study, and then the research assistant followed up with additional information about the study and how students could participate in it. Eleven females and four males agreed to participate in the study. The participants' professions included K-12 teachers (8), higher education administrators (4), higher education faculty (1), a corporate manager (1), and a full-time doctoral student (1). This breakdown is representative of students in this graduate program. Race data was not collected. Students were queried on their experience with blended synchronous sessions and the use of WebEx, the video conferencing tool used in this study. No students had taken a blended synchronous class previously. Five students rated themselves as novice and two students rated themselves as expert users of WebEx, and the remaining rated themselves somewhere in between. Table 2 indicates the breakdown of participation across the three iterations. Participation remained fairly consistent across the study with most students choosing to either participate on campus or online. However, there were three students who participated at least one time in both modes.

3.2. Data sources

The research team employed the use of multiple qualitative data collection methods, including a survey, classroom observations of all participants in the sessions, notes from debriefs between the instructor and research assistant after each session, and both student and instructor interviews. Though the sample size is small, data from all students who agreed to participate is included in the study through at least one of the collection methods, and the multiple types of data collected were sufficient to reach theoretical saturation in this context-dependent DBR study (Charmaz, 2006; Twining, Heller, Nussbaum, & Tsai, 2017). The use of multiple methods in qualitative research allows researchers to triangulate findings, which guards against the potential threats to validity of any one method (Creswell, 2013; Maxwell, 2013).

Data from the first iteration included field notes taken by the research assistant while observing the session, survey responses from 13 students, and notes from a debrief meeting with the researchers following the session. Data from the second iteration included field notes, survey responses from 10 students, notes from a debrief, and a mid-point interview with the instructor. The last round of data after the third iteration included field notes, survey responses from four students, notes from a debrief, and interviews with four

Table 2
Numbers of students in each iteration.

	Iteration 1	Iteration 2	Iteration 3
Online Students	7	8	8
On Campus Students	7	7	6
Total N	14	15	14

(one online and three on-campus) students. The research assistant conducted all interviews. A member-check, which generally refers to "taking ideas back to research participants for their confirmation" (Charmaz, 2006, p. 111), was completed by a fifth student who participated both online and on campus. This student read the initial draft of findings and provided feedback both through written feedback and a follow-up interview.

The data collection tools were designed collectively to assess learner experience. "Learning experiences can be defined as learners' perceptions, responses, and performances through interaction with a learning environment, educational products, resources, and so on." (Huang, Spector, & Yang, 2019, p. 94). For example, the survey and the interview were designed to elicit learners' perceptions and responses to the blended synchronous environment; whereas, the observations documented how students worked within the environment in real time. Taken together, these data sources were designed to holistically assess the core element of learner experience, which is whether learner needs are being met (Huang et al., 2019, Hung, Flom, Manu, & Mahmoud, 2015) and how to improve the environment to better meet those needs. The survey, created by the instructor and research assistant, inquired about what supported the students' needs, as well as the challenges they faced and suggested improvements for the next iteration. The research assistant conducted the classroom observations during each iteration, using a classroom observation template derived from the work of Merriam (2001). Student and instructor interviews were then conducted using an interview script based on the stimulated recall method (Dempsey, 2010). This method helps prompt students' stories, which is a common approach for understanding learner experience (Huang et al., 2019). The survey, observation template, and interview script can be found in the online supplemental materials.

3.3. Analysis procedures

The data collected was analyzed using an interpretive methodology as described by Erickson (1986). First, the interviews were transcribed and anonymized. The research team reviewed the data, generating assertions by induction in a quasi-grounded theoretical approach (Charmaz, 2006). This grounded theoretical approach is well-suited for the type of design theory building necessitated by DBR. Through each iteration, the design decisions were tested to improve the underlying design propositions. The research team came together multiple times throughout the analysis. In the first phase, the researchers coded the data and made assertions on a small piece of data intensively, checking and narrowing assertions collaboratively. In the second phase, the agreed upon assertions were tested using the entire data corpus. Each researcher combed the data for warrants and disconfirming evidence to either substantiate or disprove the assertions, and then the team came together again to review and agree upon those warrants and disconfirming evidence. The assertions that were substantiated from this interpretive process were then used to inform the design propositions.

The next section provides details regarding these design decisions and the effects, both intended and inadvertent, they had on the experiences of the instructor and students. Themes of these experiences that emerged from the data analysis process are then connected to specific recommendations for the design of protocols within blended synchronous learning environments.

4. Results

After each iteration, immediate feedback was collected from students and design changes were made based on that feedback. See Table 3 for a detailed description of the various design elements and rationale for the design changes made after each iteration. As shown in the table, there were four main elements that changed over the iterations: the protocol, the facilitator role, the use of the web-conferencing tool, and the audio set up.

Two main aspects of the protocol changed: the timing and the structure of the rounds. Based on feedback after the first iteration that students felt rushed by the time constraints, the timing of each protocol step was extended, and time ranges were offered, instead of time limits, to give groups greater flexibility. The structure of the rounds was also changed over time. In the first and second iteration, the protocol rounds were focused on a topic, with each student taking a turn contributing his or her idea. In the next round, students applied what was discussed during the first round. However, students had difficulty remembering information from one round to the next, often citing the other stimuli of the blended synchronous environment as distractions. To address this, a different protocol was used in the last iteration wherein each round focused on a particular person, instead of a topic. One participant shared their ideas and then the others took turns reacting to what was shared, with the next round moving on to a different person. This type of protocol structure allowed the conversation to flow more easily.

Student roles and the use of technology also changed throughout the iterations. Based on student feedback after the first iteration about delays relaying information from the instructor to the student facilitators, the role of the student facilitator was changed to give them much more control over the discussion. Giving facilitators more control allowed them greater flexibility to adjust the pacing to meet the needs of their group, alleviating communication issues. The use of the web conferencing tool changed in accordance with this shift in role. Based on feedback after the first iteration that students needed to be able to see one another and work at their own pace, separate breakout sessions run by student facilitators were used, which allowed for the use of webcams and for groups to work independently. Along with the changes to the tool, the audio set up was changed so that on-campus students did not need to use headphones which reduced the audio noise interference prevalent during the first and second iterations. By reducing the technology in the classroom, the number of technology issues decreased, and the instructor felt less overwhelmed.

At the end of the cycle, the researchers completed an extensive qualitative analysis of the data to see what assertions emerged from the data. These assertions are described in detail in the sections that follow.

Table 3
Description and rationale for each design element and resulting feedback for each iteration.

Iteration	Design Element	Design Description	Rationale	Feedback
First	Protocol	Marvin's Model - Purpose: To quickly get as many ideas out as possible. Students each take about 30 s to share initial thoughts on several prompts. - Roles: Facilitator and Participant - Timing: ~3 min per prompt; 15 min total - Rules: Strict speaking order; No dialog.	- Aligned with objective to help everyone get to know one another and to introduce a topic	- Students felt rushed - Discussion structure flowed well without intervention
	Facilitator	- 3 on-campus volunteered - Received list of responsibilities ahead of time - Passed along directions from instructor to group - Facilitated logistics (e.g., note taking, discussion order, timing)	- Gave instructor greater control over discussion prompts, pacing, and troubleshooting	- Time delays when facilitators relayed information
	Tool	- Instructor hosted whole group and breakout sessions	- Gave instructor greater control	- Students wanted to be able to see one another but there was no video with WebEx breakout functionality - Students appreciated ability to chat
	Audio	- Headsets for everyone	- Allowed online students to hear on-campus students during breakouts	- Issues with audio interference from students forgetting to turn off microphones
Second	Protocol	Provocative Prompts - Purpose: To encourage different perspectives on thought provoking quotes, images, or media. Groups choose one prompt to discuss and shared their reactions, connections, and applications of the prompt. - Roles: Facilitator and Participant - Timing: ~5–10 min per prompt; 45 min total - Rules: Strict speaking order. Open sharing after each round.	- Aligned with objective to reflect on content - Gave more time to each discussion round and overall discussion	- Students appreciated flow and organization - Students had challenges making connections because of difficulty remembering what was shared in earlier rounds.
	Facilitator	- 2 on-campus and 1 online student volunteered - Received list of responsibilities, PowerPoint with facilitation notes to guide group, and directions to host WebEx ahead of time - Hosted WebEx session - Facilitated content and pace of discussion	- Gave facilitators more control of the discussion so information didn't need to be relayed and pace of instruction could be adjusted	- Only one student reported feeling rushed
	Tool	- Instructor hosted whole group and students hosted breakout sessions	- Allowed students to use video during breakout sessions - Allowed groups greater flexibility to move at their own pace	- Fewer technical issues - Students disliked signing in and out of main session into student-hosted sessions - Instructor felt overwhelmed by technology
	Audio	- Headsets for everyone	- Allowed online students to hear on-campus students during breakout	- Less audio interference as students gained experience in the environment

Table 3 (*continued*)

Iteration	Design Element	Design Description	Rationale	Feedback
Third	Protocol	Charette - Purpose: To give students feedback. Presenter would share their ideas and get feedback from the other participants. - Roles: Facilitator, Presenter, and Participant - Timing: ~8–10 min for presentation/feedback per Presenter; 50 min total - Rules: Presenter shares, followed by feedback from each participant, and then reflection on feedback. Repeat for next presenter.	- Aligned with objective to give students' feedback on final projects - Provided more flexibility in timing - Made focus of each round separate so students didn't need to remember what was shared in earlier rounds	- Better timing and flow - Students had easier time making connections since they didn't have to remember what was shared in previous rounds.
	Facilitator	- 2 online and 2 on-campus students volunteered - Received list of responsibilities and PowerPoint with facilitation notes to guide group - Online students received directions to host WebEx ahead of time - Facilitated logistics (e.g., note taking, discussion order, timing)	- Allowed on-campus students to focus more on discussion - Chose online students with expertise in hosting web conferences	- Difficulty keeping online students engaged
	Tool	- Instructor hosted whole group and students hosted breakout sessions (only for online students)	- Provided a more natural way for students to communicate	- Students expressed improved comfort level with tools - Transitioning between different technologies remained a challenge
	Audio	- Headsets for online students	- Limit technology to reduce technology issues	- Audio issues were resolved because no headphones in classroom

4.1. Student facilitation is desirable when perceived outcome is successful

A key aspect of protocols is creating an active learning environment by putting students in the role of facilitators of the discussion (McDonald et al., 2012). However, students' desire for this leadership role varied based on whether students perceived the outcome of their facilitation as successful. Sometimes there was tension within students themselves over whether they wanted to take on this facilitation role. The same student would sometimes prefer the instructor facilitate and at other times want to facilitate.

Students reported feeling unsuccessful facilitating for various reasons. Some students felt ineffective because they had too many tasks to pay attention to simultaneously. For example, George, an online student facilitator, stated: "If you are the timekeeper or the facilitator, you aren't even listening to what the people are talking about, you are just watching the clock." This sentiment was echoed by Mike, an on-campus student facilitator who noted: "I was a timekeeper rather than a person involved in the conversation." One on-campus facilitator, Annie, who facilitated during the third iteration, preferred when the instructor facilitated because facilitating made her feel like a "dictator," telling her peers when to move on in the discussion. Other facilitators felt unprepared. For example, Mike explained an issue when facilitating in the second iteration:

> There was a problem with a few prompts or questions that we had as facilitators that we had to ask our members of the team and that wasn't included in the PowerPoint she [the instructor] gave us, so that was a problem because even though she went over it right before we broke out, it was [a problem] remembering what those prompts … particularly were.

When Mike's facilitation did not go well, he attributed his perceived failure to the fault of the instructor, lessening his accountability for the problem he had facilitating. The instructor concurred with this need for additional facilitator preparation: "the facilitators weren't as prepared as they could have been … and had we [the instructors] not been there to intervene, I think that things wouldn't have run as smoothly."

Despite the challenges noted above, students appeared to enjoy the facilitator role when they perceived their performance leading the group discussion as successful. This was most obvious in an interview with Annie who preferred being able to lead the discussions because:

> As facilitator I was able to sort of be less facilitating of the time I guess because I could see when our group was really playing off each other's ideas and giving each other a lot of feedback that was helpful or had more suggestions of what to do.

Annie felt successful in facilitating the discussion because it gave her the ability to adjust the timing to meet the needs of the group; thus, she appeared to appreciate the opportunity to facilitate, reversing her initial preference of having the instructor facilitate.

4.2. Hyperawareness of time

A protocol pedagogy ensures equity and promotes multiple perspectives by making sure everyone has a chance to talk for about the same amount of time. To do this, protocols use Go Rounds and impose specific timeframes for each piece of the discussion (McDonald et al., 2012). However, when these timeframes are too constrained or when other factors, such as technology problems, limit the time available for the protocol, students become hyperaware of the time. This can cause negative feelings, such as nervousness or frustration, that can be counterproductive to the discussion.

Students seemed very conscious of the time, which took away from the quality of the discussion. George explained: "I think if you're under a time limit like 2 min or 1 min or whatever some of those Go Rounds were, I think it can be tough putting it under time constraints like that to get quality discussions." Some students seemed aware that they weren't getting the full benefit of the protocol when they felt rushed. For example, Mike noted:

> If you have time to purposefully … to actually do the protocol in its entirety the way they were actually designed to work, then they work. When you don't have time to do them, they feel rushed and they just feel like you're forcing people to do things.

Mike, who had experience with protocols from previous classes with the instructor, seemed to understand that the protocols were being used in a different context than intended and that this had an effect on their use.

Although this hyperawareness of time persisted throughout the iterations, the comments seemed most prevalent in connection to the first iteration. The research assistant observed after the first iteration: "Although the protocol is meant to impose a time limit to the students' discussions, there was some rushing and not in a good way." This was likely due to a variety of factors. First, the protocol used in the first iteration required each person to speak for 30 s. Although brief sharing may work well in face-to-face settings for which this protocol was originally designed, it may not have translated well to a blended synchronous space in which transitions take more time. Later iterations used protocols that allowed each student more time to speak, which was noted as an improvement in the survey after the second iteration. Second, there were fewer technology issues with each successive iteration which gave more time for the discussions. This relationship of technology and time was noted by Mike after the first iteration: "The protocol itself seemed rushed because the technology was so new and there were some bumps in the road. I don't think that the protocol was probably given the time it needed to be effective." Third, time may have become less of an issue as students became more used to using protocols, which was pointed out by Lucy, who noted: "I don't remember having the nervousness about the time constraint so maybe we were better at following the protocol – the second one."

4.3. Trust hindered by unpredictability

A key element for protocols to work properly is to establish a set of norms for discussion that promote a sense of trust in revealing one's thoughts and perspectives (McDonald et al., 2012). However, building trust becomes more challenging in a blended synchronous classroom because the foundation of the classroom itself feels unpredictable as a result of frequent technology issues. While it takes time, student comfort increases with greater experience and familiarity.

The instability of the technology was observed throughout the iterations. Some of these issues were a result of the technology not working properly. For example, one student's computer froze right before the instructor started the breakout groups. Instead of being able to simply add the student to the correct group, WebEx required the instructor to stop and restart all of the breakout sessions to troubleshoot the problem. Other technology issues were likely due to the students' lack of familiarity with the tools. For example, audio issues were mainly the result of students needing to get used to turning on/off the microphone when speaking. George explained: "The microphone thing is always a big part. People forget to mute themselves or people forget to unmute themselves. You get the background noise." Lucy concurred, "I had a big learning curve just knowing when my headphones or my microphone was on or off, just using WebEx was a pretty big learning curve for me."

The number of technology issues were unexpected by some students who thought that the experience would be more familiar. Lucy explained:

> I thought it would be more like a, what do you call that, a Skype meeting, you know when you just have a meeting in a conference room and the person is there on the screen the whole time and you can see them and they can see you and it wasn't that smooth and that was surprising to me, I thought it would be more smooth.

The anticipation of technology issues made some students feel insecure. For example, Mike commented about his difficulty starting up his session, "I guess the trust factor there, is this going to work or is this not going to work? I was somewhat anticipating something to happen, but we got through it." Gaining experience with the environment and the tools helped students become more comfortable in later iterations, as noted by George: " I think the biggest problem was just getting everyone comfortable with the technology because I don't think everybody had used WebEx yet so I've had experience with that in the past so I was fairly comfortable."

4.4. Deep connections unachievable when multitasking

Protocols help draw attention to reflecting on and making connection to texts (McDonald et al., 2012). However, it is more difficult in blended synchronous learning environments to keep everyone focused on the content of the discussion because attention is split between different locations, multiple communication channels, and a variety of technologies. This multitasking made it challenging for students to fully engage.

Online students faced unique challenges with multitasking, especially managing outside distractions. George reflected on the distraction of one online student who was trying to participate from the airport: "Every time we went back to the one student she was in an Uber car and then she got to the airport and she … had her video on and she's walking through the airport." He noted that this was probably not a typical case, but he felt in general that this type of issue was a distraction. Although some online students acknowledged multitasking as a challenge, one anonymous online student missed the ability "to 'tune in' using my phone while I commute." Blended synchronous sessions appear to demand more focused attention from students than other types of online sessions.

The format of the protocols seemed to exacerbate this issue. In the first two iterations, the protocol structure required that students remember what was said from one round to the next, which students found difficult. This was noted by one online student in the survey after the second iteration: "I struggled to remember what everyone had said by the time we got to round x." Another issue with the protocol format is it requires the help of student facilitators, who have even more tasks to pay attention to than other protocol participants, as noted earlier in Section 4.1.

5. Discussion

Each of the sections that follow describe the design propositions in relation to this study's assertions as well as to the literature on protocols and blended synchronous learning, ending with practical implications of this study's findings and suggestions for future research.

5.1. Enabling active participation through distributed roles

The first design proposition enhances the original design principle of a protocol pedagogy from *enabling active participation through varied roles* to *enabling active participation through **distributed** roles*. In blended synchronous environments, it is not sufficient to simply vary roles as there are so many tasks that need to be completed within this type of learning environment. Within blended synchronous settings, it is important to distribute roles and responsibilities among participants so that no one is overwhelmed, and everyone feels successful in his or her role. This proposition is related to the assertion that student facilitation is desirable when the perceived outcome is successful. Student facilitators at times felt unsuccessful either because they had too many tasks to pay attention to or because they felt they needed additional preparation. The design proposition to distribute roles in this study builds upon the "tech navigator" approach described by Bell et al. (2014) by engaging more students in the process and involving them to a greater extent.

Another contribution that this study adds to the protocol literature is that specialized training needs to be provided to the student facilitators in order for them to feel successful leading discussions that leverage protocols within blended synchronous learning environments.

There are several practical implications of this design proposition. First, to enable participants to feel successful in their assigned role, instructors can query students on their interests and experience with various tasks (e.g., troubleshooting technology, facilitating discussions, monitoring chat messages, etc.), and assign students to roles in which they can excel. Providing specialized training on these roles may also help students feel more prepared to succeed. Additional research is needed to determine the exact specifications for this training. Second, to further allocate the responsibilities so that facilitators don't get overwhelmed, the student facilitator role can be divided into two separate roles: one focused on the discussion and another on the technology. More research is needed to see whether further distribution of the roles and responsibilities allows students to more fully participate and feel successful.

5.2. Creating equity through flexible structures

The second design proposition expands upon the original design principle from *creating equity through structure* to *creating equity through **flexible structures**.* Since structure is needed within blended synchronous learning environments to ensure that students participating in different modes have equitable experiences (Wang & Huang, 2018; Wang et al., 2017; 2018), it was speculated that the protocol structure (i.e., set timeframes and Go Rounds) might help by making sure everyone has a chance to participate for about the same amount of time (McDonald et al., 2012). However, the unpredictability of the environment requires that this structure allow for some flexibility. Creating a flexible structure may help instructors accommodate the inevitable timing issues noted by others, such as delays to instruction (Popov, 2009), downtime due to technology troubleshooting (Cunningham, 2014), and difficulties associated with transitions (Bell et al., 2014). This proposition is related to the assertion of hyperawareness of time. When protocol timeframes were too constrained, the students became hyperaware of the time, creating a negative atmosphere.

The practical recommendations for creating more flexible structures when utilizing protocols within blended synchronous environments are to expand the suggested timeframe for in-person protocols for use in blended synchronous settings as well as to offer a wider range of time for each step of the protocol. Although the timing of protocols needs to be expanded in this context, more research and experience is needed to determine how much more time is required.

5.3. Fostering trust through re-norming

The third design proposition builds on the original design principle for a protocol pedagogy of *fostering trust through establishing norms* by acknowledging that additional norming is needed beyond what is typically required for protocols. Protocols require that special norms for interaction be established to create a sense of security in sharing one's ideas (McDonald et al., 2012). However, this is more challenging because the classroom norms associated with blended synchronous learning are not what students expect (Bower et al., 2014; Cunningham, 2014), so norms are needed for both the blended synchronous classroom as well as the use of protocols within that classroom. The resulting design proposition became *fostering trust through **re-norming***. Going through a re-norming process addresses the assertion that trust is hindered by the unpredictability and unfamiliarity of the environment. This re-norming process concurs with suggestions made by other researchers on the importance to set group rules and expectations in blended synchronous environments (Bower et al., 2014; Park & Bonk, 2007). One contribution that this study adds to the literature is that additional norms are needed to adjust expectations for both blended synchronous learning environments as well as protocol-driven discussions within those environments.

The practice of re-norming can be done through training, providing informal experiences, and setting clear expectations upfront. First, training, such as providing a demo of the technology, may help prepare students for potential technology issues, as was also noted by Bower et al., 2014. Modeling how to use protocols as a class prior to having students use protocols in groups may also be helpful. Second, giving students informal experiences to explore and play with the tools may help them become accustomed to this new environment, as other researchers have also recommended (e.g., Bower et al., 2014). Limiting the use of the technology at first may help students become more confident in the environment before introducing more complex features. Third, explaining upfront to students what they may expect during a blended synchronous session may reduce some of the unfamiliarity of this new environment (e.g., Bower et al., 2014; Park & Bonk, 2007). In addition, setting expectations on the reasoning behind the protocol constraints may help students adjust to these new ways of interacting. Additional research is needed to determine if this re-norming process is sufficient for using protocols within blended synchronous settings.

5.4. Prompting connections with texts by reducing task complexity

The fourth design proposition enhances the protocol design principle of *prompting connections with the text* by recognizing the additional challenges of getting students to focus within blended synchronous learning environments. Although protocols provide a collaborative tool to help participants co-construct their interpretations of the text (McDonald et al., 2012), this becomes more difficult because students are trying to focus on too many tasks at once – either within the environment or managing outside distractions (Wang & Huang, 2018; Wang et al., 2017; 2018). The resulting design proposition for using protocols within blended synchronous environments became *prompting connections with text **by reducing task complexity***. This design proposition was related to the assertion that deep connections were unachievable when multitasking. In order for students to be successful in using protocols to collaboratively interpret text together in blended synchronous learning environments, it is critical to reduce the number of

competing demands for attention that create distractions in these settings (Wang & Huang, 2018; Wang et al., 2017; 2018).

Although there are some limits for instructors in reducing the number of communication channels that students need to attend to within blended synchronous environments, there are a few practical suggestions that may help offset the issue. One recommendation is to establish a norm for attending online, potentially limiting outside distractions and better enabling full participation. The last recommendation is to adjust the format of the protocol to reduce memory issues. Students found it helpful when the rounds were distinct from one another and didn't require them to remember what was said in earlier rounds. A format that seems to work particularly well in blended synchronous environments is when a round consists of everyone sharing feedback or ideas that focuses on one particular person. Given the high task demand and number of things to pay attention to simultaneously (Bower et al., 2015; 2017), it would be useful for future research to assess the cognitive load demands on students. It would be helpful to investigate whether any of the design recommendations from this study assist in reducing the demand on working memory when trying to integrate information in from multiple sources (Van Merriënboer and Sweller, 2005), which has been noted as problematic in other research on blended synchronous learning environments (Bower et al., 2015; 2017).

6. Limitations

Although the research team followed the guidelines for conducting and reporting qualitative studies to ensure its rigor and credibility (Twining et al., 2017), this study was not without its limitations. First, the timeframe for the study was a semester long and there were only four weeks between iterations, which left little time for in-depth analysis between iterations, resulting in potentially ill-conceived, in-the-moment design decisions. Second, the repeated, frequent surveys resulted in a drop-off in survey response rate with each iteration, which may not have provided as complete a picture of students' experiences by the end of the course. The use of multiple data sources, including classroom observations, debriefs following each session, and interviews of both students and the instructor, was utilized to mitigate this issue. Third, more on-campus students volunteered to be interviewed, so the findings may be more reflective of an on-campus student perspective. To lessen this issue, the research team asked a student who participated in both online and on-campus modes to provide a member check on the findings. Fourth, although the long-range goal of DBR studies is to create generalizable results through multiple cycles across various settings, any specific cycle of a DBR study is context specific and the results, like in many qualitative studies, are not generalizable because of both the context and small sample size.

7. Conclusion

Blended synchronous learning has the potential to improve upon the flexibility and accessibility of course offerings if designed well. However, prior research has found both technological and pedagogical issues with creating quality learning experiences within this type of setting. One possible design solution to enhance learner experiences that has not been tested previously within blended synchronous learning environments is the integration of a protocol pedagogy. The first cycle of this DBR study began to answer the question of how to redesign protocols to work within blended synchronous learning environments. The findings help contribute to both the theoretical and practical implications of implementing blended synchronous protocols.

From a theoretical perspective, this DBR study expanded upon design principles from the literature on protocols (See Fig. 2). The original design principles (McDonald et al., 2012) were enhanced to create a set of design propositions for using protocols within blended synchronous learning environments. The resulting set of contextualized design propositions include: (a) enabling active participation through distributed roles, (b) creating equity through flexible structures, (c) fostering trust through re-norming, and (d) prompting connections with texts by reducing task complexity. Although the results from this first cycle of the DBR study cannot be generalized, later cycles will test the resulting design propositions across multiple settings, with the intention of developing a set of generalized design principles for implementing blended synchronous protocols.
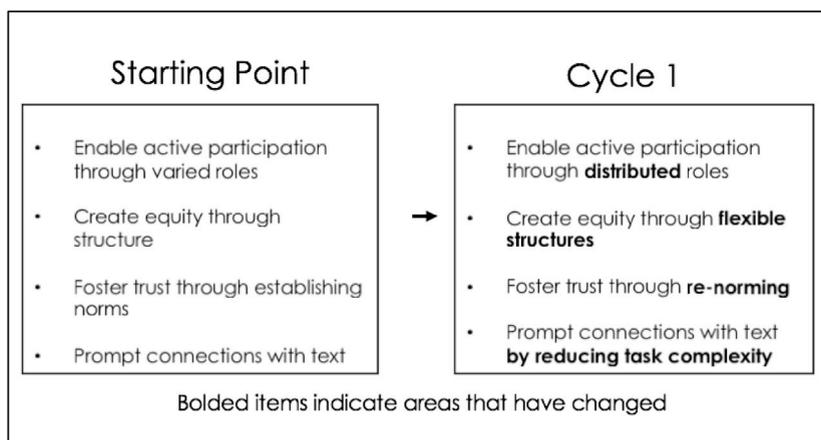

Fig. 2. Enhanced design propositions after first cycle of DBR study.

From a practical standpoint, this study provided recommendations on protocol design changes, classroom modifications vital for supporting the use of protocols within blended synchronous settings, and the technology requirements needed when using protocols in these settings. First, adjustments to the protocols themselves are needed when used within blended synchronous settings. Timeframes of protocols need to be expanded upon to accommodate the ever-present timing issues found in these settings (Bell et al., 2014; Cunningham, 2014; Popov, 2009). In addition, the structure of the protocols needed to be adjusted. While the use of the Go Round technique helped to address the awkward silences and talking over one another prevalent in blended synchronous discussions (e.g., Bower et al., 2014; 2017), this study found that a specific type of Go Round technique works more effectively. The flow of communication was improved when each round focused on sharing ideas in response to one particular person. Second, the classroom can be configured to help support the use of protocols within blended synchronous settings. Extra time should be allocated upfront to set norms for both the classroom setting as well as how to use protocols within that setting. The roles within the classroom need to be distributed according to students' interests and experiences to allow participants to be fully engaged. This may also help address the issue of students getting distracted – a problem noted in several studies (Wang & Huang, 2018; Wang et al., 2017; 2018). And specialized training needs to be developed to help students feel successful in those roles. Third, this study helped to articulate the technology requirements needed for using protocols within these settings. For example, tools are needed that enable small groups within a single meeting but still provide the flexibility to manage the groups individually. Although just a first step, this study provides a path forward for exploring a pedagogy that may help to realize the potential of blended synchronous environments.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.compedu.2019.103678.

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