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CPSX: A Tool for Online Collaborative Problem-Solving in Open edX

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Abstract

This research memorandum describes the development and operation of an extension to Open edX (XBlock) called CPSX, designed to enable small-group synchronous discussion alongside any instructional or assessment media in the Open edX platform. The CPSX XBlock provides a size-limited chat session to content authors as one of the elements of a typical course unit. Chat transcripts are stored using the same MySQL server as the Open edX instance. This work was supported by the Center for Academic and Workforce Readiness and Success to enable simple experiments on collaborative performance; however, the tool is fully usable as an instructional affordance in online courses built using Open edX.

Key words: online learning, computer-based testing, collaborative assessment, formative assessment

Acknowledgments

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The use of pairwise or small-group discussion is a well-established and highly valued classroom practice (Smith et al., 2009; Topping, 2005; Webb, 1989). When education content is provided online rather than in classrooms and when students are not likely to meet in person, computer-mediated discussion may replace face-to-face interaction. In many, if not most, learning management systems (LMSs) to date, this discussion affordance has been asynchronous through forums. While computer-based, synchronous communication technology exists in many forms, from text-only chat services to audiovisual applications like Skype, Google Hangouts, and Zoom, the integration of such synchronous channels with LMSs is still in its infancy. Without such integration, collaborative learning activities must either be designed around asynchronous communication or rely on tools external to the LMS. In the latter case, the transcript or record of the interaction might not be collected along with other learner data, sacrificing opportunities for analytics and feedback. It should be noted that the affordance of small-group discussion is relevant not only for learning activities but also for assessment research regarding collaboration and collaborative problem-solving constructs (von Davier & Halpin, 2013).

Open edX is the open-source codebase for the massive open online course (MOOC) platform edX.org, which supports dozens of partner organizations, has served more than 500 courses, and has awarded more than 500,000 completion certificates since 2012. At its core, Open edX comprises an LMS and a content management system (CMS), with other services to support the highly scalable platform. Open edX is free to use and modify by independent providers, that is, without any commitment to join the edX consortium. Stanford University, George Washington University, and McKinsey Academy, for example, have built custom content platforms based on Open edX. Content authors using the Open edX CMS (called Studio) may choose from a wide selection of existing assessment item types, from basic multiple choice, drop-down, numerical, and text response to interactive circuit builders and Python code interpreters. Moreover, because Open edX is extendable through XBlocks, new functionality may be created and shared with the community of users of Open edX. Examples of other XBlocks are a Poll and Survey XBlock developed by McKinsey Academy and a Google Drive XBlock.[1]

The intended use of Open edX that motivated the present development was to carry out experiments with collaborative assessment using crowd-workers and student populations. Aside from the many useful features already programmed in Open edX, building on an existing open-

source platform was judged to have several advantages over developing new software from scratch. The development work would be a valuable contribution to the open-source community, published results would be readily reproducible, and many instructors and students would have access to the product. With support from the Center for Academic and Workforce Readiness and Success, CPSX was developed to add real-time collaboration functionality for Open edX.

The purpose of this document is to describe CPSX and explain how it can be used in a research or classroom setting. Design considerations are described in the next section, including a discussion of how this tool differs from pre-existing alternatives. The use of CPSX is then illustrated with a basic walkthrough of the interface, followed by a suggested list of enhancements for future development. A brief glossary of terms is provided as an appendix.

Related Tools and Design Goals for CPSX

Beyond the basic affordance of synchronous chat, there were some specific considerations in the design of the CPSX XBlock that distinguish it from alternatives, of which three are mentioned. The first alternative is the chat tab developed by a Berkeley team (Coetzee, Fox, Hearst, & Hartmann, 2014) as an add-on to Open edX. The chat tab, when enabled for a course, appears next to the courseware, wiki, discussion, and other tabs in the top-level navigation. It is not connected to particular content, and in fact, navigating to it means leaving the content page.[2] Moreover, it is a single open chat room for everyone who is logged in to the server at a given time. Because the present purpose of the communication tool was small-group discussions in targeted contexts, the chat tab was not able to fulfill the desired functionality.

MOOCchat (Coetzee, Lim, Fox, Hartmann, & Hearst, 2015) is a standalone application specifically designed for small-group discussions around assessment items. It automatically queues users into unique sessions of a preselected size. MOOCchat, however, was designed combining the development of the assessment item with a chat interface. The only item type built into MOOCchat is one in which a multiple-choice question is answered first individually, followed by a discussion for some length of time (which users may terminate early by consensus), and finally followed by a chance for each individual to revise his or her initial response. Items must be authored inside of the MOOCchat application (running on a separate Heroku server), although they can be embedded in a MOOC inside an HTML frame. For our purposes, it was important that chat could be used alongside any Open edX item available to an instructor or assessment developer. As such, the chat should not be attached to items.

Bazaar (Adamson & Rosé, 2012) is a collaboration tool with automated dialogue support. Like MOOCchat, it runs on a dedicated external server, and the assessment is designed within the application. Bazaar has been integrated with Open edX through a Learning Tools Interoperability (LTI) interface that transmits the user credentials to the external application.[3] Bazaar offers different functionality from MOOCchat in the intelligent support layer, and the look and feel are also quite different. But the requirement of a separate service and presentation of the chat on a separate screen once again ruled it out for our purposes.

In sum, the features that necessitated development of new tool were as follows. First, chat sessions should be limited to small groups. Second, it was important that chat could be used alongside any Open edX item available to an instructor or assessment developer. As such, the chat should not be attached to development of items. Third, ideally, the use of the chat should not require operating a remote server in addition to Open edX.

Using CPSX

CPSX is an XBlock, and as such, it requires some version of an Open edX platform. Open edX typically requires Ubuntu Linux 12.04 either on a local or cloud-based server. Publicly available Amazon machine images enable one to provision an Open edX server as an EC2 instance in minutes. Once an Open edX server has been set up, the XBlock is loaded onto the server, typically by remote connection to a Github repository.[4] The chat is an Ajax and PHP-scripted dynamic Web page accessed via virtual host on the server. Installation requires configuration of the virtual host as well as creating the required MySQL databases (these steps are covered in the installation documentation). Finally, the XBlock is installed using a special command line version of Python pip.[5] Once installed, the XBlock may be attached to courses created in the CMS (Studio) by adding “cpsx” to the list of advanced modules under Settings > Advanced Settings.

While populating a unit with content in the CMS, the installed CPSX module should now appear under advanced modules, as shown in Figures 1 and 2.

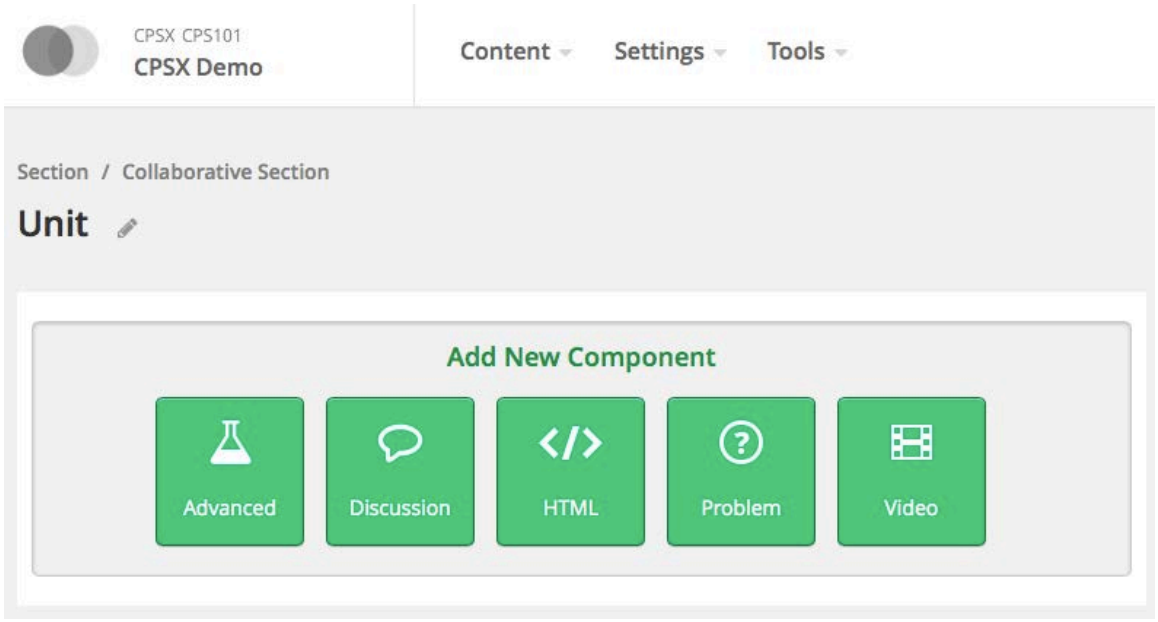

Figure 1. Advanced components must be enabled in settings ("cpsx"). Then the choice will appear as shown.

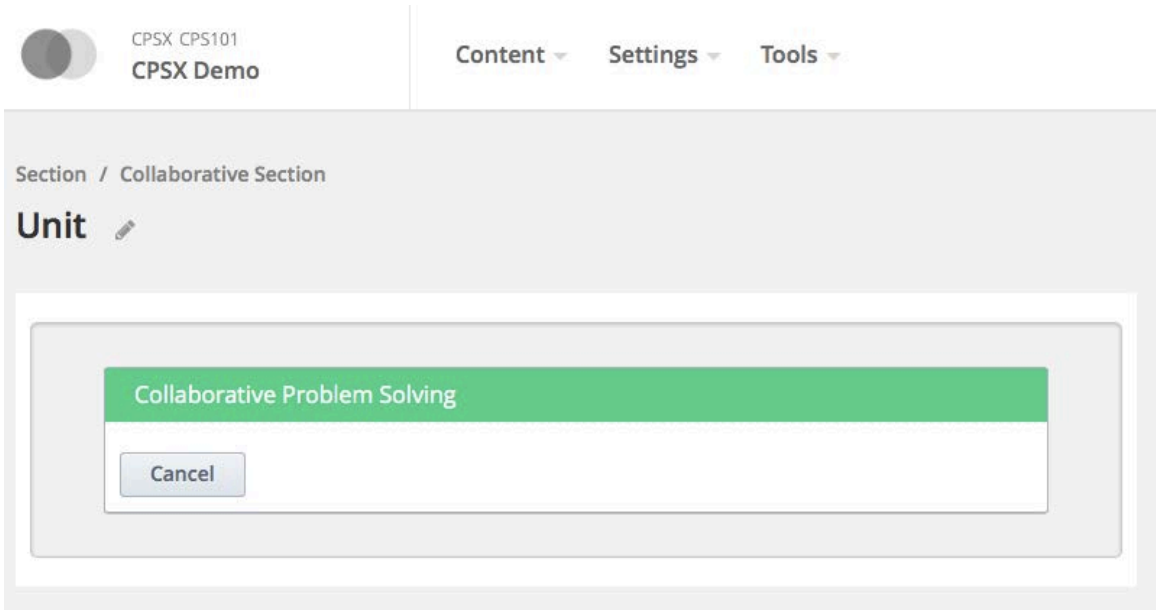

Figure 2. The CPSX component appears as an advanced component.

As shown in Figure 3, the instructor or developer may edit each specific instance of the CPSX module to give it a unique name, decide on the number of participants required (group size), and specify a wait time (timeout provision, in the event that the required number of participants is not simultaneously available). The session name allows a chat session to be carried over across multiple pages of content. One must insert a new CPSX module on each desired page, reusing the same name.

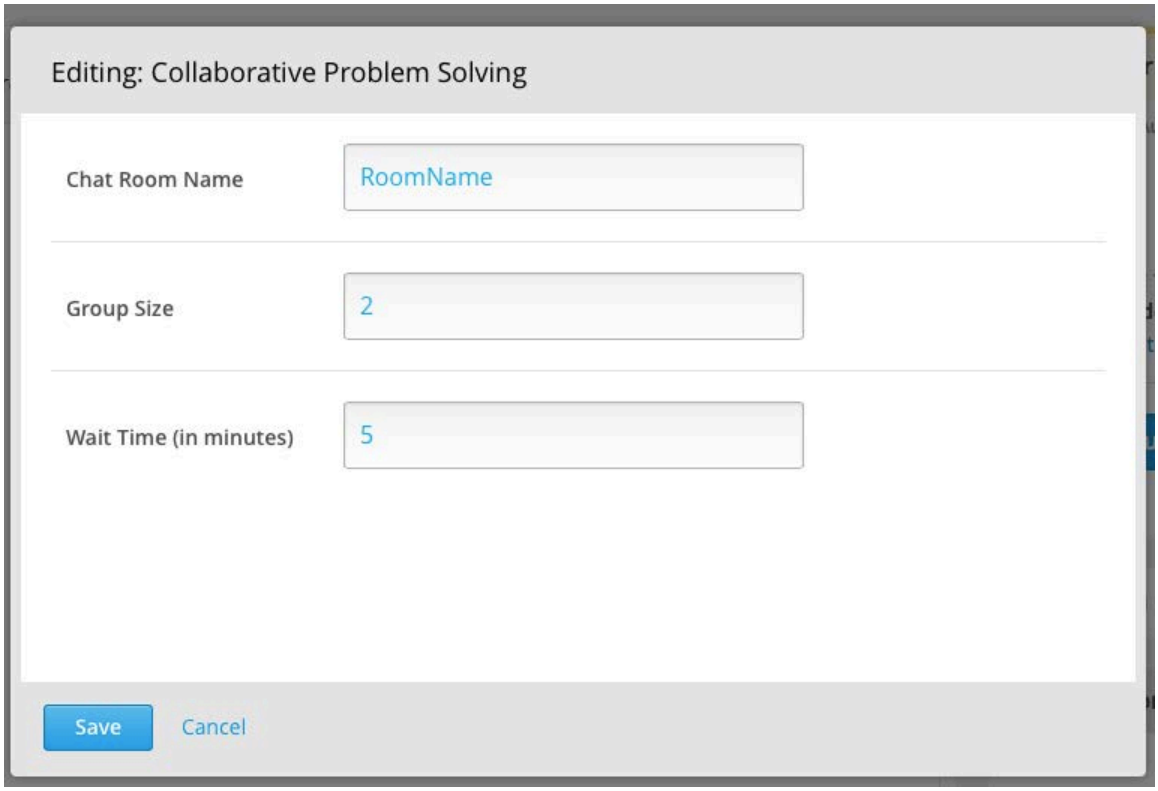

Figure 3. Once selected, the author may configure the following choices for the collaborative problem-solving component. The chat room name allows a single session to be replicated across different items.

The user experience is illustrated in Figures 4–7, where a blank placeholder problem has been used in lieu of an actual assessment item. Users of the chat module will first be prompted to initiate the session by clicking a button (“Click Ready to start”). A countdown will appear while pairing is attempted. If the requisite number of participants is available, this button will change to “Begin.” However, if the countdown timer reaches zero without filling the session, the process is reset and the user must explicitly initiate a new countdown. Once a user is part of a chat

session, his or her membership remains active until the user presses the button to log out at the bottom of the chat buffer. Logging out of the Open edX platform or losing a network connection will not eject the user; thus the session will still be active if the user returns to it.

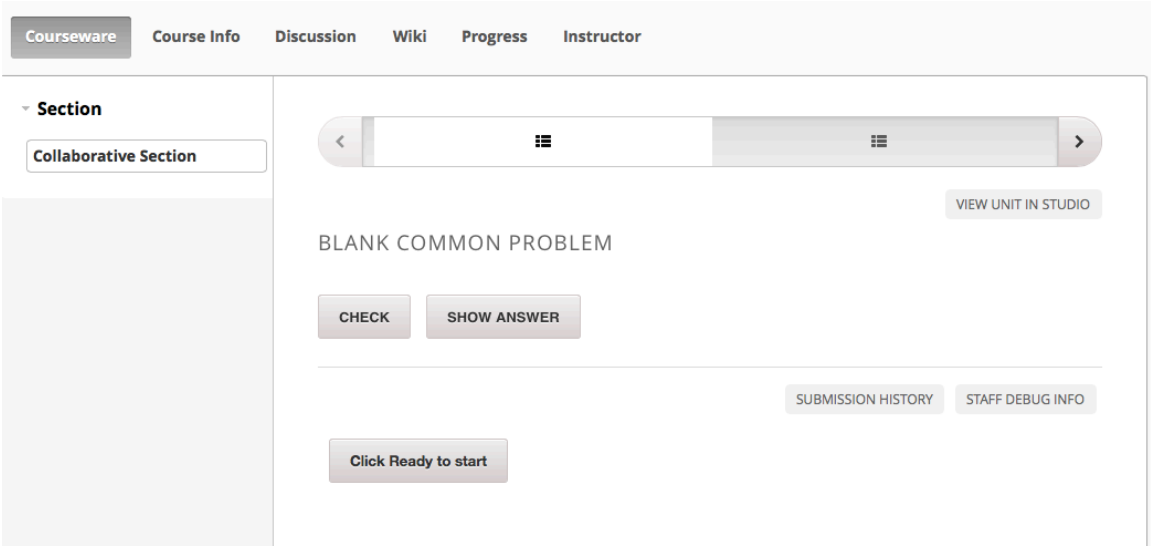

Figure 4. Appearance of the CPSX component upon first access.

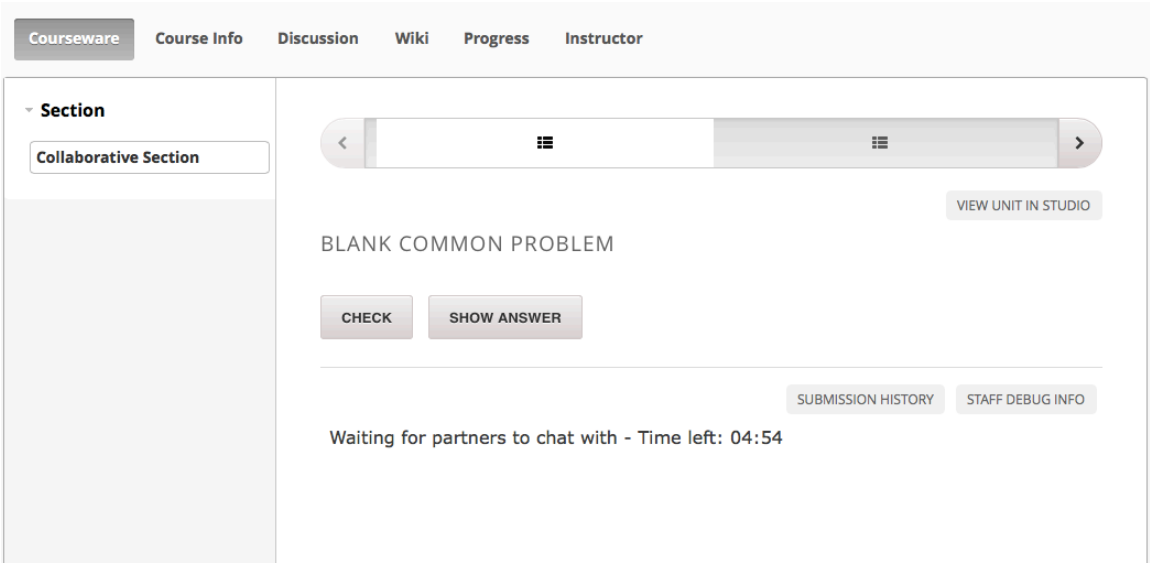

Figure 5. Appearance of the CPSX component while waiting for partners.

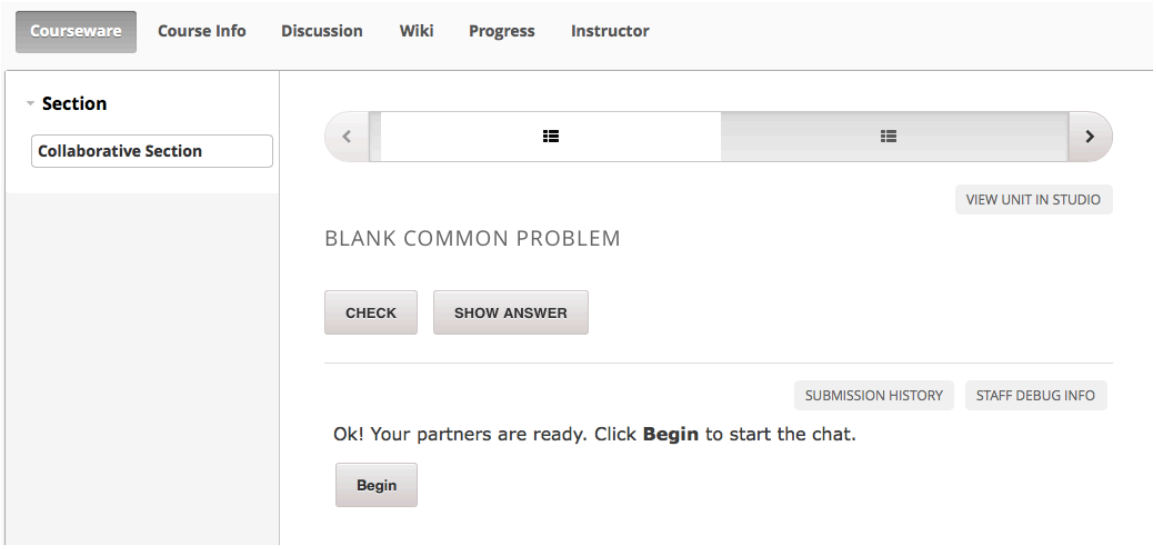

Figure 6. Appearance of the CPSX component once a cohort has been formed.

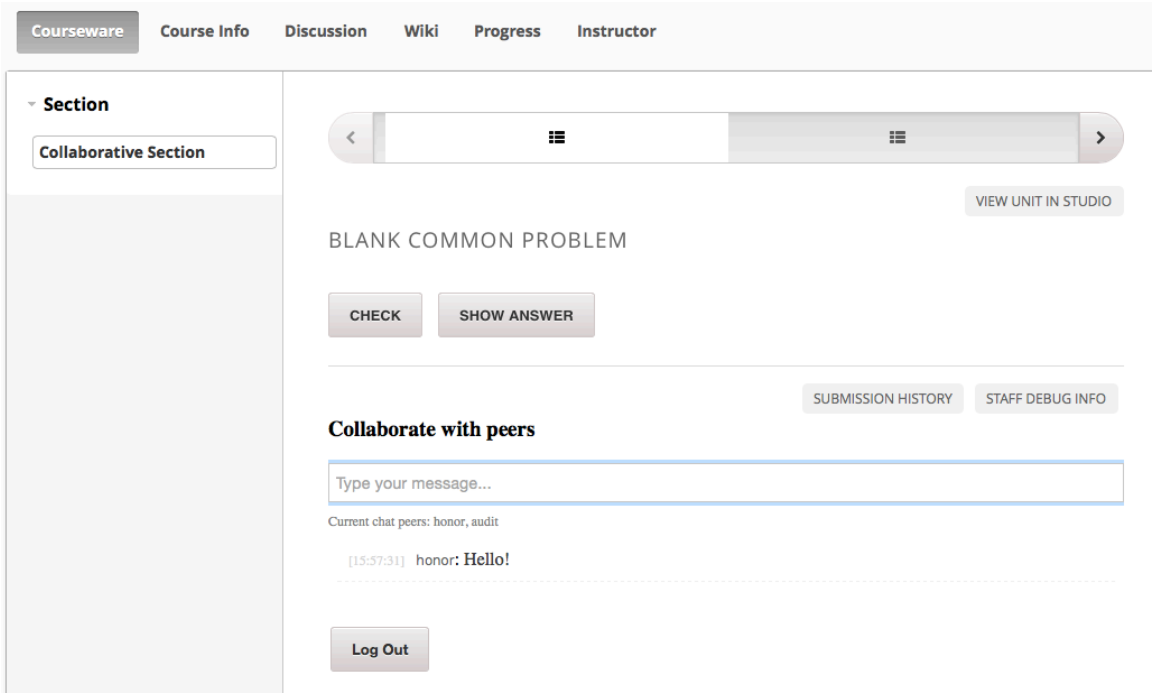

Figure 7. Appearance of the CPSX component once the chat has begun.

Future Enhancements

The CPSX XBlock fills an important void in the functionality of Open edX. Some limitations of CPSX that might be addressed as future enhancements are as follows.

Cohort Criteria

At present, students are assigned to sessions on a first-come basis. Thus discussion group membership is essentially random conditional on availability. However, it would be desirable to allow the instructor or developer to condition grouping on other criteria, such as demographic variables or prior performance measures. This would enable the instructor or experimenter to explore the effects of group composition, for example, hetero/homogeneity.

Synchronization Control

It may be desirable to prevent students from getting ahead of others in their group, perhaps by conditioning subsequent screens on a polling of the group members.

Autocompletion

In the case that group sizes larger than two are preferred, the user might still want to allow an undersized group to proceed. An option could be checked that would permit the system to autocomplete the chat room provided at least two participants are present after the countdown has elapsed.

Graphic Enhancement

Differentiating users by color would be a good enhancement for visibility. Also, the button to log out might be relocated. At present, it disappears into the scroll buffer, requiring users to scroll back through the chat to log out of the chat session.

Intelligent Support

The most sophisticated enhancement of the CPSX would be the inclusion of a computer agent to adaptively facilitate discussions, as is the case for the Bazaar system.

References

Adamson, D., & Rosé, C. P. (2012). Coordinating multi-dimensional support in collaborative conversational agents. In S. A. Cerri, W. J. Clancey, G. Papadourakis, & K. Panourgis (Eds.), *Intelligent tutoring systems*: *Vol. 7315. Lecture Notes in Computer Science* (pp. 346–351). Berlin, Germany: Springer.

Coetzee, D., Fox, A., Hearst, M. A., & Hartmann, B. (2014). Chatrooms in MOOCs: All talk and no action. In M. Sahami, A. Fox, M. A. Hearst, & M. T. H. Chi (Eds.), *Proceedings of the First ACM Conference on Learning @ Scale Conference* (pp. 127–136). New York, NY: Association for Computing Machinery. https://doi.org/10.1145/2556325.2566242

Coetzee, D., Lim, S., Fox, A., Hartmann, B., & Hearst, M. A. (2015). Structuring interactions for large-scale synchronous peer learning. In D. Cosley, A. Forte, L. Ciolfi, & D. McDonald (Eds.), *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (pp. 1139–1152). New York, NY: Association for Computing Machinery. https://doi.org/10.1145/2675133.2675251

Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science, 323*(5910), 122–124.

Topping, K. J. (2005). Trends in peer learning. *Educational Psychology, 25*, 631–645.

von Davier, A., & Halpin, P. F. (2013). *Collaborative problem-solving and the assessment of cognitive skills: Psychometric considerations* (Research Report No. RR-13-41). Princeton, NJ: Educational Testing Service. https://doi.org/10.1002/j.2333-8504.2013.tb02348.x

Webb, N. M. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research, 13*(1), 21–39.

Appendix. Glossary of Terms

Open edX is the open-source platform that powers edX courses. It is freely available code that can be used to run an independent learning system.

XBlock is a component architecture by Open edX for building courseware. XBlocks are written in Python, following certain standards for storing and accessing data, and add functionality to the LMS. This functionality can be as simple as displaying a certain type of image/file or as complex as an interactive simulation.

LTI, or Learning Tools Interoperability, is a specification developed by IMS Global Learning Consortium to integrate remotely hosted learning applications (Tools) with LMSs. LTI components are enabled in Open edX as advanced modules in the CMS.

Heroku is a cloud-based application platform. One may write a Web application, host it on Heroku, and integrate it with an LMS, such as Open edX, as an LTI tool. Platforms like Heroku or EngineYard facilitate scaling applications to large numbers of users as the need arises.

Ajax (asynchronous Javascript and XML) is a collection of Web development techniques for sending and receiving data in the background while displaying Web content. The principal advantage is that whole page reloads are not necessary. In CPSX, the data sent and received are chat messages.

PHP is a server-side scripting language commonly used in Web development. PHP has built-in modules for accessing MySQL databases, and CPSX uses these to queue students, match them into groups, and launch the chat session.

Notes

[1]A more complete list may be found at https://github.com/edx/edx-platform/wiki/List-of-XBlocks

[2]In their experiment, the authors also created an embedded chat version. It is our understanding that this functionality is not generally available to users of Open edX, whereas the chat tab is.

[3]Data, Analytics, and Learning (2014) and Big Data in Education (2015).

[4]The repository for CPSX is located at https://github.com/ybergner/cpsx

[5]Instructions are available at https://github.com/edx/edx-platform/wiki/Installing-a-new-XBlock