

# Leveraging ubiquitous technologies for collaborative online learning

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**Abstract** : In this paper we present the use of a set of ubiquitous technologies to support collaborative learning in a virtual learning environment. The tool set mainly consists of Microsoft Teams and Sutori and could be augmented with other third-party technologies such as Google Drive and Dropbox. We present two case studies—an app development course and an academic writing course—to exemplify how to use this tool set for effective collaborative online learning.

**Keyword**: computer supported collaborative learning, online learning, multimedia

## 1. Introduction

Simply put, collaborative learning refers to pair or group study towards a shared learning goal. There has been increasing evidence that collaborative learning leads to better learning outcomes compared to individual learning [1, 2]. However, it has been a big challenge to achieve collaborative learning in a pure virtual online learning environment where the interaction pattern among teachers and students is altered due to lack of face-to-face contact. The works in literature in computer supported collaborative learning research mostly focus on a blended learning environment where learning occurs across physical and virtual settings, and hence may have limited application to a pure virtual online setting.

In our paper, we describe the use of a set of ubiquitous technologies to support collaborative learning in a pure virtual learning environment. The tool set mainly consists of Microsoft Teams and Sutori and could be augmented with other third-party technologies such as Google Drive and Dropbox. We present two case studies—an app development course and an academic writing course—to exemplify how to use this tool set for effective collaborative online learning.

## 2. Theoretical Framework

This work builds on theories of computer-supported collaborative learning (CSCL). CSCL can be conducted in many forms, ranging from collaborations within small group to massive collaborations for knowledge building and creation [3], and from interpersonal collaboration to human-machine collaboration (e.g. robots and agents) [4]. Jeong and Hmelo-Silver proposed 7 core affordances of technology for collaborative learning, including (1) engage in a joint task, (2) communicate, (3) share resources, (4) engage in productive collaborative learning process, (5) engage in co-construction, (6) monitor and regulate collaborative learning, and (7) find and build groups and communities [5].

In our case studies, we adopted cloud-based ubiquitous technologies to support learning in a pure virtual online learning environment. As has been shown in previous studies, cloud-based services can provide cost-effective solutions to educational needs [6, 7]. In what follows, we first present the learning design in section 3. In section 4, we present demonstrate how our

approach support the seven affordances of collaborative learning.

## 3. Methodology

Our case studies focus on an app development course and an academic writing course. Both courses are for university freshmen and are offered through English medium instruction. The basic information and design of the courses are summarized in Table 1.

Table 1 Basic Information and Design of Courses

	Course I: Android App Development	Course II: Introduction to Academic Writing
Level	Year 1	Year 1
Class size	41	2
Learning goal	Basic knowledge of app development and software project management	Technical communication skills including academic writing and presentation
Technology used	Sutori web app, Microsoft Teams, Flipgrid, Google Drive, GitHub	Sutori web app, Microsoft Teams, Dropbox
Pre-class activities	All learning materials assembled on Sutori and attached to MS Teams before class	All learning materials assembled on Sutori
In-class activities	Whole class activities and one-to-one real-time trouble shooting and debugging using MS Teams video meetings	Co-creating learning materials on Sutori
Post-class activities	Casual Q&A using MS Teams chat feature	/
Homework submission	All code is pushed to GitHub	Directly attached to Sutori
Assessment	Group presentation	Original papers submitted to / presentation in real conferences

## 4. Results

The course design combines multiple technologies to support the seven affordances of computer supported collaborative learning [5]. The mapping of both courses to the seven affordances are presented in Table 2 and

Table 3. Students created tangible learning artifacts using the technologies.

Table 2 Seven-Affordance Mapping of Course I

Affordances	Technology	Learning Activity	Learning Artifact
Establishing a joint task	Sutori	Teacher explain tasks	/
Communication	MS Teams	Real-time debugging; Q&A and discussions using chat	Post threads in MS Teams
Sharing resources	MS Teams	Sharing screenshots and files	Shared resources
Engaging in productive process	GitHub	Project planning	Scrum backlogs
Engaging in co-construction	Sutori Flipgrid GitHub	Co-creating presentation slides; sharing self-intro videos; creating new apps	Group presentation slides; self-intro videos; new apps
Monitoring and regulation	GitHub	Project monitoring	Scrum board
Finding and building group and communities	MS Teams, GitHub	Group project, publishing original code on GitHub, peer evaluation	Public repositories on GitHub; peer feedback

## 5. Discussion

Our approach of combining Sutori, MS Teams and a few third-party technologies supports the seven affordances of CSCL and can be applied to courses of distinct learning goals. The benefit of combining these ubiquitous learning technologies not only lies in the enhanced learning efficiency and learning experience in a virtual learning environment, but also the enriched educational outcomes. Students produced a variety of learning artifacts, ranging from presentation slides to public repositories to publications in real academic conferences. Moreover, being exposed to various ubiquitous technologies enhanced students' digital literacy, which is a critical skill needed in Society 5.0.

## 6. Conclusion and Future Work

We demonstrated how the use of multiple ubiquitous technologies can support collaborative learning in a virtual online environment in courses of different nature. Our future work includes collecting feedback from students and a formal evaluation of the approach.

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Table 3 Seven-Affordance Mapping of Course II

Affordances	Technology	Learning Activity	Learning Artifact
Establishing a joint task	Sutori	Teacher explain tasks	/
Communication	MS Teams	Discussions through video meeting and chat	Post threads in MS Teams; video recording of class
Sharing resources	Sutori, Drop box	Sharing reference papers and paper writing documents	Shared resources
Engaging in productive process	/	/	/
Engaging in co-construction	Sutori, Dropbox	Co-creating learning materials; co-writing papers; co-creating presentation slides	Learning materials, papers, presentation slides,
Monitoring and regulation	Sutori	Make sure to submit paper by deadline	/
Finding and building group and communities	/	Make submissions to and present in real conferences	Published papers; new connection in conference