Pre-Service Teachers and Interdisciplinary Design in Global Virtual Teams: A U.S. Perspective

Xiaojun Chen
St. John's University

The author presents a qualitative study on engaging teacher candidates in virtual teams towards instructional design projects. Through virtual collaborations via synchronous and asynchronous tools, pre-service teachers engaged in cross-cultural exchanges through project-based learning. This study examines how teacher candidates work in global virtual teams, and discusses the design of the project, strategies to facilitate international virtual teams, and the findings on implementing design projects in teacher education. The results show pre-service teachers' teaching beliefs have been enhanced to integrate technology and live the experience.

Keywords: global virtual teams, pre-service teachers, collaborative learning, cross-cultural learning

INTRODUCTION

Engaging with individuals from different cultural backgrounds has been a focus of higher education institutions. On one hand, providing students opportunities to study in a location outside of their regular education setting and environment has been adopted by many universities. The numbers of students participating in studying abroad programs in US has increased over the years, but at the same time, there are substantial numbers of students not fully taking advantage of such opportunities as a result of financial or time constraints (Amani & Kim, 2019; Bellamy & Weinberg, 2006; Chia, Poe,& Wuensch, 2009). A question that remains is: How can we better support students to engage in global learning without leaving their university? Adopting global virtual teams with design activities might present itself as an opportunity to engage students in international exchanges without leaving their current geographic location. This project aims to address this question through the lens of technology integration in hopes to understand how pre-service teachers work in such collaborations.

Enabling learners to collaborate through online platforms with international partners via the use of a variety of web-based tools and mobile technologies has the potential to engage learners in cross-cultural exchanges. Web-based tools and mobile apps can play an increasingly important role in the development of "communities of practice" (i.e., where

Xiaojun Chen, Ph.D., is Associate Professor and Chair of Department of Curriculum and Instruction, School of Education, St. John's University, USA. Dr. Chen can be reached at chenx@stjohns.edu

individuals with a common set of problems interact with each other to discover solutions), especially when group members are globally distributed and face-to-face time is limited (Wenger, White, Smith & Rowe, 2005). Providing teachers opportunities to interact and co-design instructional materials would be an approach to better address the need for culturally-responsive pedagogy in our globalized world. In this virtual collaborative project, the researcher aims to provide teacher candidates opportunities to work with one another through global virtual teams to design and develop instructional practices through the ASSURE model (Smaldino, Lowther, Mims & Russell, 2019).

GLOBAL VIRTUAL TEAMS AND TEACHER EDUCATION

In this section, the author discusses the literature around the phenomena of global virtual teams, from its definition, benefits, challenges, and the aspects of social structure in such teams. As the workforce becomes more globally diverse, many organizations have adopted using global virtual teams (GVTs), which consist of members located in different geographic locations to work using virtual communication technologies. Jarvenpaa and Leidner (1998) defined "a global virtual team to be a temporary, culturally diverse, geographically dispersed, electronically communicating work group" (p.792). Lee-Kelley and Sankey (2008) conducted a study and concluded "that virtual teams are useful for projects requiring cross-functional or cross-boundary skilled inputs and the key to their value creation is to have a defined strategy to overcome problems associated with at-distance cooperation" (p. 51).

Adopting global virtual teams in different professions would enhance the opportunity for people to learn and work with one another with the support of virtual technology. In order to prepare students for the future workplace, it is important to understand how global virtual teams' function and how such practices can be modeled in teacher education programs. Many works of literature have examined the use of teams in teacher education with its practices to offer authentic learning and teaching environments. Gallimore, Ermeling, Saunders and Goldenberg (2009) used a school-based inquiry team in the elementary school teacher education programs to move "the learning of teaching closer to practice" (p.537). Gregory (2010) used a problem-solving team approach to address students' learning difficulties in schools and in this study a majority of the teachers participating in these teams reported professional gain in terms of new intervention skills to facilitate students' learning.

Nicholas and Ng (2009) conducted a study of pre-service teachers working in virtual teams to co-construct science materials, and the results of the study showed that the product co-constructed by such virtual teams were of high quality and pre-service teachers demonstrated a positive attitude towards collaborative learning. All these studies were examples of the use of teams for teachers and pre-service teachers that have positive outcomes. With the aspect of technology integration, researchers have argued that the best way to support and model these teams is to have teacher candidates to participate in certain practices. Therefore, the benefit of global virtual teams would add value to enhance the teacher candidate's understanding of their future workplace through cross cultural collaboration and cross-functional sectors, and how to use the tools to support such practices.

Global virtual teams in teacher education would be rooted in collaborative learning and experiential learning, which offers great learning opportunities when learners interact with the learning environments, other learners, and other stakeholders in the learning community. Chen & Newby (2012) reported a project that allows pre-service teachers to work with other international pre-service teachers to build a wiki repository for Web 2.0 tools and their applications in K-12 classrooms. Pre-service teachers participated in global

virtual teams in this project, and through such collaboration, pre-service teachers practiced their skills in using Web 2.0 tools in their future classrooms by modeling and researching about Web 2.0 tools. This showcased the best way for teacher candidates to learn the skills is to create opportunities for them to practice those skills in an authentic learning environment.

CHALLENGES AND STRATEGIES TO SUPPORT VIRTUAL TEAMS IN TEACHER EDUCATION

Team members in global or cross-cultural virtual teams often do not share common backgrounds and do not normally make future plans together. Thus, the social aspect of the cross-cultural teams hopes to redesign and facilitate the team's effectiveness (Henttonen & Blomqvist, 2005; Kelley, 2001) as well as recognizing time zone differences (Saunders, Van Slyke, Vogel, 2004; O'Leary & Cummings, 2007) and language difference challenges (Chen, Geluykens & Choi, 2006; Klitmøller & Lauring, 2013; Krawczyk-Bryłka, 2016; Lockwood, 2015; Presbitero, 2020).

Researchers explored the social construct in virtual teams, among which standing four key elements: trust (Alsharo, Gregg, & Ramirez, 2017; Hacker, Johnson, Saunders, & Thayer, 2019; Henttonen & Blomqvist, 2005; Jarvenpaa & Leidner, 1998; Jarvenpaa, Shaw, & Staples, 2004), communication (Daim, Ha, Reutiman, Hughes, Pathak, Bynum, & Bhatla, 2012; Marlow, Lacerenza, & Salas, 2017; McLarnon, O'Neill, Taras, Law, Donia, & Steel, 2019; Morgan, Paucar-Caceres & Wright, 2014; Shachaf, 2008), which presents the challenges through conflict resolutions (Kankanhalli, Tan, & Wei, 2006; Montoya-Weiss, Massey, & Song, 2001; O'Neill, & Mclarnon, 2018; Paul, Samarah, Seetharaman, & Mykytyn, 2004), and the level of virtuality (Chudoba, Wynn, Lu, & Watson‐Manheim, 2005; Dixon, & Panteli, 2010; Kirkman & Mathieu, 2005; Kramer, Shuffler, Feitosa, 2017; Lu, Watson-Manheim, Chudoba & Wynn, 2006; Rutkowski, Vogel, Van Genuchten, Bemelmans, Favier, 2002). Understanding how individuals work and how to support individual in such teams would lead to effective workforce as researchers from different disciplines have reported (Bhat, Pande, & Ahuja, 2017; Cordery & Soo, 2008; Gibson & Cohen, 2003; Maynard, Mathieu, Rapp,& Gilson, 2012).

Building trust early on in such teams is very important throughout the team's working process. Jarvenpaa and Leidner (1998) conducted a study measuring the change of trust levels of virtual teams, and reported that social communication within the team increased enthusiasm and trust levels among team members, while individual actions such as coping with technical uncertainty and taking initiative facilitated trust at the early stage of teamwork. Jarvenppa, Shaw and Staples (2004)'s study demonstrated that an individual member's trust level at the early stage of the team activities would positively influence his or her trust in the team directly throughout the project, emphasizing the importance of activities to facilitate team members' trust-building in virtual teams.

Maynard, Mathieu, Rapp, and Gilson (2012) argued that team preparation activities that are similar to face-to-face teams would enhance the effectiveness of cross-cultural virtual teams. It is important to make sure members in GVTs have adequate time and resources to work on the team plan, which would in turn help members understand the project expectations, limitations and opportunities. The preparedness activities would provide structure and blueprints for cross-cultural virtual teams to achieve their goals, which is mutually beneficial for members to build trust throughout the project duration. In a multidisciplinary review of trust in virtual teams, Hacker, Johnson, Saunders, and Thayer (2019) synthesized that communication, being one of the challenges faced by managers or leaders of virtual teams, is also key to facilitate the virtual teams process, such as setting up team schedule, arrange communication plan, coordinating communication platforms so

that team members can carry out the team tasks accordingly. To be an effective team, it is important to maintain effective communication. When individuals work together, especially in cross-cultural virtual teams, communication plays a vital role to ensure information is shared among members.   Conflict is another layer that presents the challenge among members.

One of the most distinguishing aspects of global virtual teams is that team members who work in a virtual environment stay connected through information communication tools that are connected virtually. Many researchers have examined the relationship between the level of virtuality and the level of interaction among team members. Hacker, Johnson, Saunders & Thayer (2019) defined virtuality as "a multi-faceted higher-order construct encompassing a team's independent identifying dimensions that signify degrees of dispersion or discontinuity" (p.4).

The concept of virtuality refers to the multi-layered structure in teams, including the degree of which tools were used by members but also information richness that was presented by utilizing such virtual tools, the lower the information richness the higher the team virtuality (Kirkman and Mathieu, 2005). The higher the virtuality presents more challenges for teams to perform as compared to face-to-face teams. For pre-service teachers to work in virtual teams, it is important to understand the level of virtuality and how it works to engage pre-service teachers in global virtual teams.

IMPLEMENTING CROSS-CULTURAL VIRTUAL TEAMS IN TEACHER EDUCATION

One particular focus of the current study is to investigate teacher candidates' engagement in cross-cultural virtual teams through the lens of utilizing technology to collaborate and design cross-cultural lessons for K-12 students. This paper presents findings as well as approaches to enhance teacher education programs with an emphasis on technology-enhanced instructional design in cross-cultural settings. Current practices in many teacher education programs teach pre-service teachers to design curriculum and lessons in their pedagogical and methods classes; however, this current study aims to provide further exploration in engaging pre-service teachers in an authentic learning environment to solve an ill-structured design problem so that teachers can practice collaborative learning in finding the design solution.

Based on the literature review, it is recommended to adopt virtual communication tools that allow multimodality of communication styles, such as text, audio, and video to engage GVTs to lower the virtuality of the team to present a higher level of information richness. The first phase of the collaboration was designed to introduce those tools and allow pre-service teachers to find the appropriate combination of tools to communicate with team members virtually.

Furthermore, the author would argue that it is important to build in structures in the team process to allow team members from both international sites to ask questions, clarify project expectations, such as synchronous sessions for team members to meet with leaders and instructors from both sites to establish a common understanding about the project progress. Lastly, it is important to provide virtual teams a sense of ownership of their design products, thus organizing their products for video presentation is vital.

METHODS

The purpose of this study is to examine how pre-service teachers engage and work in virtual teams. More specifically, this study focuses on student teachers working in global virtual teams to design interdisciplinary lessons for K-12 students. This study addresses the following research questions: How do pre-service teachers work in global virtual

teams? In what ways can such experience help pre-service teachers develop technology integration skills for their future students?

CONTEXT AND PARTICIPANTS

    Graduate students from a US Northeastern metropolitan university enrolled in an educational technology graduate course and graduate students from an international partner institution worked collaboratively in a 10 weeklong instructional design project. Each team consisted of approximately two US university graduate students and four or five graduate students from the international partner university. The main task for the teams was to design and develop an interdisciplinary unit for middle school students in two metropolitan cities in both countries, while conducting research and creating lesson plans that would employ the application in classroom teaching.

    The project guidelines required team members to work as communities of practice to design an interdisciplinary unit for middle school students in both countries while simultaneously learning to use various online web- based and mobile-supported technologies to collaborate effectively. IRB approval was obtained from IRB review boards. Eleven graduate students voluntarily participated in this study and completed the projects through the course of the semester. This study reports the participation and results from the US pre-service teachers. Table 1 below shows the demographic information of the U.S. participants, and Figure 1 outlines the project overview.

Table 1
Pre-Service Teachers' Demographic Information

Pre-service Teachers (pseudonyms)	Gender	Graduate Major
Bella	F	Childhood Education
Katie	F	Childhood & Childhood Special Education
Hailey	F	Special Education
Nancy	F	Teaching Students of Other Languages
Emma	F	Teaching Students of Other Languages
Yvonne	F	Adolescent Education English
Annie	F	Adolescent Education English
Steve	M	Adolescent Education Social Studies
Oscar	M	Adolescent Education Math
Carson	M	Adolescent Education Math
Nick	M	Adolescent Education Math

Figure 1
Project Overview
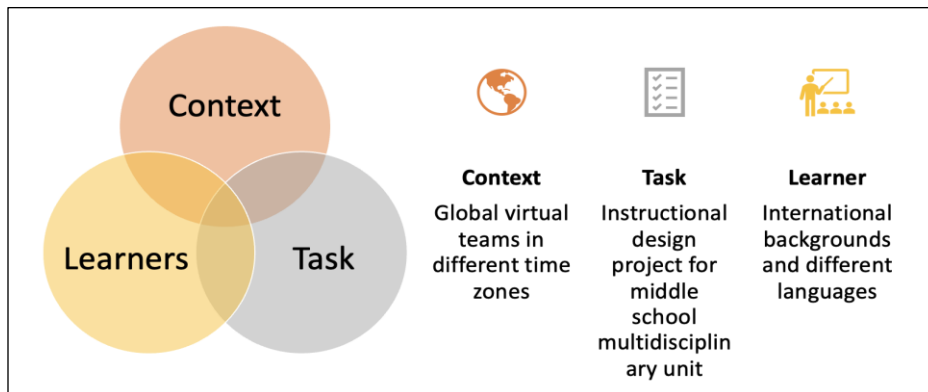
PROJECT PROCESS AND DATA COLLECTION AND ANALYSIS

To facilitate the virtual collaboration, the project was broken down into four phases: 1) project planning: establish virtual teams, design training, and facilitate initial communications between two sites; 2) developing and discussing the units: each virtual team brainstorming the topic and participating in online discussion, co-constructing a collaborative concept map. Each team works collectively to design the draft of the plan. Peers were given a week to review and provide feedback to each other's instructional activities design for each unit; 3) prototyping, when teams design the unit lesson plans and make sure to integrate at least two digital learning tools into the lesson. Each team incorporates feedback from peers and completes a full technology-integration lesson or learning solutions; and 4) presentation, evaluation, and project reflection, when each team co-design and presents a video for their unit and completes individual project reflection. There are designs in between each stage to support the transition and the pre-service teacher GVTs. Three mini conferences between two sites were arranged to establish common ground for the teams, and to clarify goals and roadblock, as well as to provide evaluation and feedback. Each mini conference was hosted by instructors from both collaboration sites.

The researcher investigated individual participants' experiences through examining students' artifacts, such as individual reflections and communication documents and design notes. Data analysis was conducted as guided by grounded theory (Charmaz, 2006) and ethnographic approaches (Denzin & Lincoln, 2005) to provide a more holistic view of the pre-and in-service teachers' perceived understanding of cross-cultural virtual collaboration in cross-cultural virtual teams.

RESULTS

Qualitative data was collected and analyzed to address research questions, including individual posts, team artifacts, collaborative concept maps, team mini conferences notes, teamwork log, and individual reflections. The following three assertions were summarized from the data and presented as results to research questions. Research Question 1: How do pre-service teachers work in cross-cultural virtual teams? Research Question 2: In what ways can such experiences help pre-service teachers develop technology integrated skills for their future students? The results from the study were organized in three assertions, with assertion 1 & 2 answering Research Question 1, and assertion 3 answering Research Question 2.

- Assertion 1: Facing language barrier and time-zone differences, written communication and asynchronous activities enables pre-service teachers to collaborate in global virtual teams.
- Assertion 2: Collaborative workspace and strategies such as concept map, mini conference and peer-review enhances global virtual teams' effectiveness.
- Assertion 3: Pre-service teachers' beliefs in technology integration was strengthened understanding about teaching as a collaborative method and enhanced teaching beliefs to be open, adaptive, and flexible.

In the following sections, the author shares the findings around each assertion.

ASSERTION 1: FACING LANGUAGE BARRIERS, WRITTEN COMMUNICATION AND ASYNCHRONOUS ACTIVITIES ENHANCE PRE-SERVICE TEACHERS' COLLABORATION IN GLOBAL VIRTUAL TEAMS.

Pre-service teachers collaborating with their international partners recognized the challenges of designing and collaborating in lesson activities. Instant messaging apps, such as Skype and iMessage turned out to be the most frequently used means of communication. Pre-service teachers found that asynchronous discussion facilitates the team building and communication given the language barrier in oral communications or time zone difference. Steve said, "*We … kept contact consistently on Skype where questions, comments, and concerns could be addressed without a formal meeting. This was essential, in my opinion, for overcoming the time difference that existed with our (international) partners and kept everybody aware of what was taking place for our project*". Yvonne also shared these similar experiences, stating that adopting an instant messaging app enhanced the team's communication: "*Without the use of Skype, my group would have had a challenging time communicating at all in real-time. My group leader was able to communicate asynchronously through email with our (international) partners, but Skype ultimately became the singular reliable medium for real-time communication across countries.*".

Pre-service teachers also found instant messaging tools beneficial to build team understanding as well as clarifying team expectations, as each team can share their expectations and follow-up with questions in message chains. Nancy reflected that: *"We found that through constant communication on … chats we could be very clear as to the expectations from both sides."*

The need for text-to-text communication has also been found beneficial for participants to establish common ground to work with their team members. It allowed translation assistance and was used to support team design. Annie said '*When my group worked on our project outside of class, we found that communication did not go as well as it did in class because of our ability to rely on our professors to prompt us with questions or explain American sayings or differences in the two languages, so we found ourselves relying then on other forms of technology that would aid in discussion….We found that text to text communication was effective because (our international partners) students could use other translation devices to understand what we were trying to convey through text that they struggled with catching when we spoke on video.*'

ASSERTION 2: COLLABORATIVE WORKSPACE AND STRATEGIES SUCH AS CONCEPT MAP, VIDEO CHAT, MINI CONFERENCES AND PEER-REVIEW ENHANCE PRE-SERVICE TEACHERS GLOBAL VIRTUAL TEAMS' EFFECTIVENESS.

Collaborative workspace. In addition to seeking team communication via instant messaging, another important aspect of written communication was through establishing collaborative workspace that allows asynchronous editing and collaborations. Preservice teachers' reflections show that they appreciate the synchronous collaboration to build connections within the group which in turn facilitates team effectiveness. Using collaborative editing platforms, each team was able to build team artifacts synchronously. The editing history feature eases pre-service teachers' stress to gain feedback and build on activities, as it allows group members to collaborate in real-time and to synchronize the information on multiple devices. These features were instrumental in making new connections within the group by enabling management with social tools, storage, and unifying digital content creation for sharing valuable information. Annie shared that "*My group organized our concept map, (our) research topics, lesson plans, and lesson summary on (the collaborative tool), and it really helped this project be truly collaborative because we were able to edit and contribute elements at the same time.*" Yvonne also reflected that "*When we used tools (on shared drive) we were able to collaborate during real time to effectively add to each other's ideas. I personally liked using both of these tools because we were able to work on the same file and nothing had to be merged or changed. We were able to ask questions in real time and work together to fix any discrepancies we had*

throughout the process." Bella pointed out in her reflection that, " (the collaborative online space) *allowed for the sharing of charts through PNGs or even JPEGs. For that reason, this was a great tool that enabled the group members to work in conjunction and also simplified work to a great extent.*"

   Visual concept map*.* Collaborative concept maps facilitates team effectiveness in global virtual teams. Concept maps turn out to be a good tool for students to organize their thoughts. They provide a clear vision for students to plan their design. Concept maps provide structure to the drafting process, and it helps each team to stay focused on the main topics of the project and create a shared vision of the project.

Figure 2
Example of Collaborative Concept Map Around The Theme Biology Constructed by A Global Virtual Team
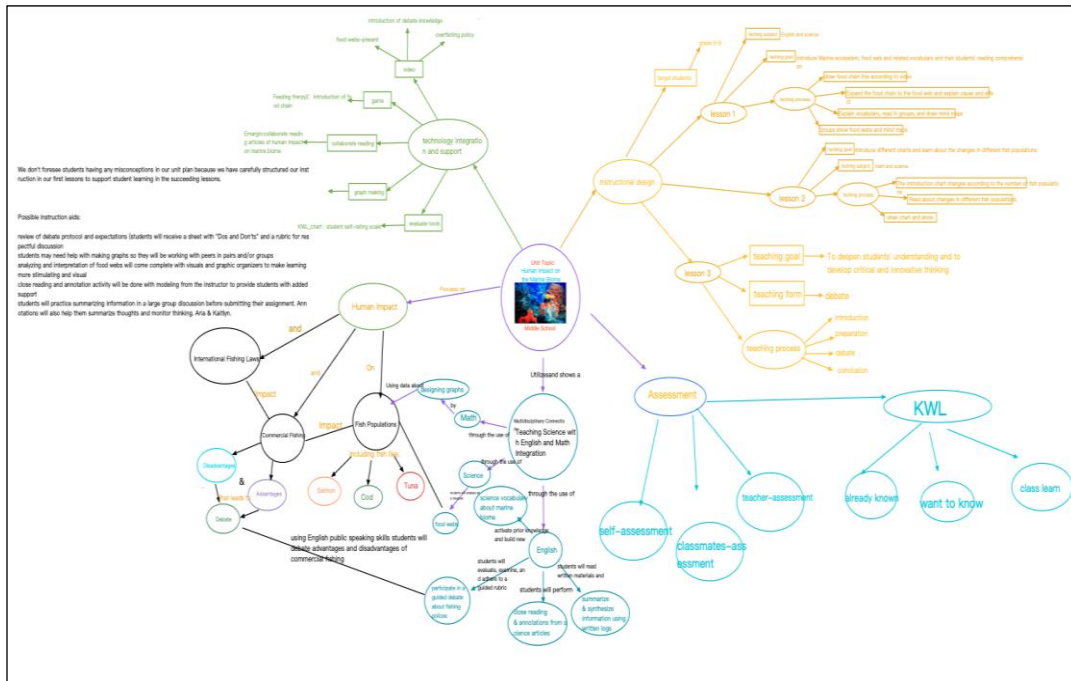
   Working on the theme of biology, shown in Figure 2., Annie and Nancy shared that "*During the concept map stage, we were able to outline the different elements of our interdisciplinary elements, draw connections between themes, and assess integration of differentiated assessment and technology integration. The map served as a reference point that we consulted during the different stages of our project and helped to make sure that we stayed on topic with our goals*"; and Nancy added that : "*Once our thoughts were presented, we were able to link the concepts using linking words. The concept map helped my group because it provided structure and organization to the drafting process of the unit summary. We were able to informally collect our thoughts and view the thoughts of our peers*". The visualization of team knowledge building process allows members in global virtual teams to navigate through the complex process of building a cohesive design plan.

   Bella shared that after the initial stage of learning of using the tool, a concept map became an effective way to facilitate team collaboration, "*I must admit, after being taught how to use concept mapping, it turned out to be easy since it required minimum effort to create well-organized ideas. By using the tool, the group members were able to design simple flowcharts to be integrated with assignments and collaborate on the same platform.*"

Katie reflected that "*We were given clear instructions and expectations, and both the (U.S. and international) groups were able to contribute our thoughts. Once our thoughts were presented, we were able to link the concepts using linking words. The concept map helped my group because it provided structure and organization to the drafting process of the unit summary. We were able to informally collect our thoughts and view the thoughts of our peers.*"

Figure 3

Example of Collaborative Concept Map around the Theme Algebra Constructed by a Global Virtual Team
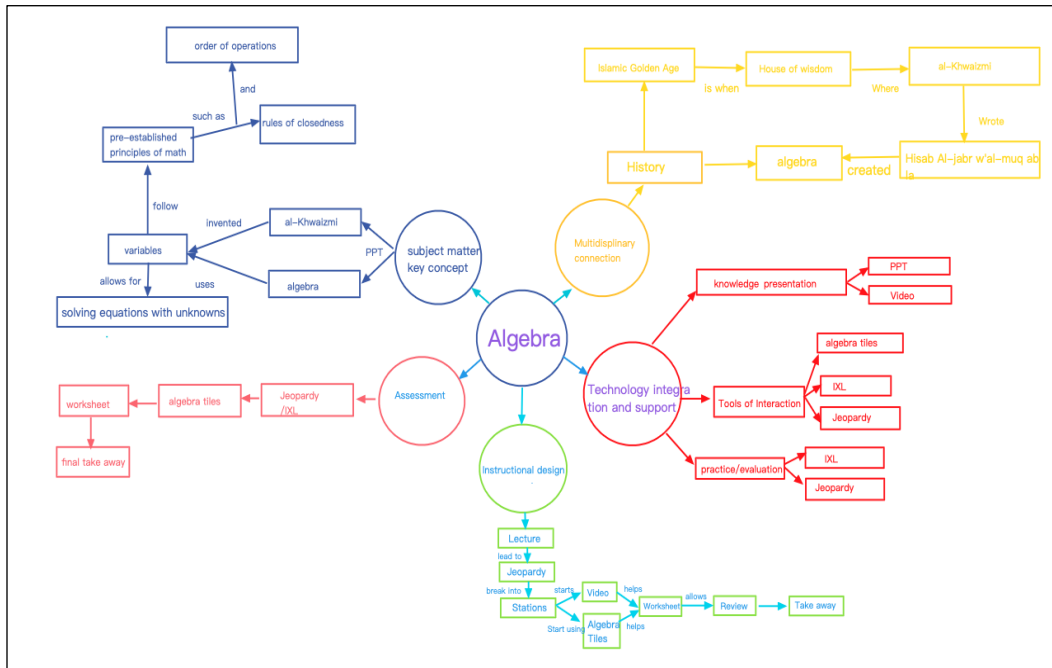
Working on the theme of algebra, as shown in Figure 3, this global virtual team identified key areas to be included in this interdisciplinary unit for middle school students. In this team, Hailey reflected that: "*I enjoyed planning out our lesson together and it was really cool to experience that type of collaboration. I created the map by hand and then sent a picture of it to our (international) group members…They then helped us create the digital map on(line). Our (international) group members … had so many good ideas for the concept map and I loved seeing them all come alive.*"

Visualizing the learning and collaborative process is an effective way to engage team members in global virtual teams. Another pre-service teacher also shared that "*the concept map I felt was a great idea because it let us put all of our ideas together in one document making it easier for us to see*", while Emma also shared that "*working on the concept map really helped our group get a clear vision and idea from the beginning. We were able to clearly lay out everything we were interested in including in our unit and work together to figure out how to make our unit cohesive and clear. The concept map was the best way for us to start our unit with a clear, concise vision for every group member to be aware of.*"

Video Chat. Synchronous activities such as team member video meetings and team mini conferences with instructors also proven to enhance team effectiveness. Video chats were used in one team to plan team work, asking questions to each other, and hoping to get things ready. Video chats also promoted trust-building amongst team members. Hailey shared that "*we used Video calls to make sure we were all on the same page. When we*

received a new assignment in the unit we would have a video call to plan and get on the same page, then we would use …(instant messaging) to further communicate throughout the process. We were always aware of the time difference and did our very best to communicate when we knew it was possible for all teammates."

In addition to sharing content related to the project during video chat times, pre-service teachers found it useful to share each other's lives. Annie reflected that: "*We shared other parts of our lives like out pets in video chats, holidays like thanksgiving and talked about our families. I think this is essential when working in a team. A team is more than just people that work together; a team with a deeper connection is more cohesive and willing to work harder for their teammates. I have learned this through many years of sports. The cooperation, kindness and understanding we always used was a huge part of our success as well.*"

Mini Conferences. Pre-service teachers acknowledged the challenges and to establish a common ground for understanding and asking for questions, a mini conference was designed to engage members from both US and international partner institutions in each team. Instructors would provide guided feedback to each team regarding their artifacts and team progress, while team members asking questions for clarification. Mini-conferences were used as a checkpoint for the progress of the group. Also mini conferences helped clarify confusions and misunderstandings regarding the team expectations and team assignments. Nancy reflected that:" *The mini conferences were abundantly helpful because our instructors helped facilitate conversation. The target questions allowed the group members to think about the … (project) process and determine areas of success and some challenges so that we can plan for further execution of the project. I appreciated being able to have structured conversation where both groups can benefit from each others contributions.*" Her team member Annie shared that: "*Anything that we were struggling with or confused about we were able to go over in our mini conference sessions. These sessions were helpful because we had the support of our professors to aid in communication, and their questions and prompts helped us stay on track of the work we were responsible for in the project. This allowed every member of our group to not only be accountable to our own workload, but also to one another…I think they were a great way to show the work we were all doing in the project. I also think this was a great platform to have our professor's assistance when we couldn't communicate effectively.*"

While Carson and Hailey worked in their unit, they appreciated the mini conference sessions as their team discussed the directions, mitigated team conflicts as well as team expectations. Carson shared that: "*The mini-conferences served as a middle-ground that really helped us clear up misunderstandings with a few clarifications about points that might have gotten lost in translation".* Hailey also agrees when she said that: "*The mini conferences helped us be in the place we had to be and where we had to go from there. The conferences helped my partner and I discuss what we were doing and how far we had come.*"

Pre-service teachers appreciate the instructor-facilitated nature of mini conferences that allow U.S. pre-service teachers to engage in cross-cultural conversations with their peers from the international institution. Emma shared that "*Our mini conference sessions were helpful because sometimes I felt we had a language barrier or that the expectation was unclear between both groups (U.S. and international). I think discussing with our professors in our mini conferences helped clear up any confusion between the group. Through these mini conferences we were able to have a clear discussion with both professors to translate and clear up any misconceptions*".

Peer-review. While mini conferences provided a platform for all members from the same team to communicate with the instructor's guide, another important aspect of the collaboration is cross-teams feedback. Hence, in this project, students' were provided with

an opportunity to review each team's work via constructive feedback and revise the work as the project continues.

Peer-review process allows reviews to spot out problems by peers. It provides good feedback to students on their projects. Annie reflected on the benefit of peer-review process as she said: "*The peer-review process allowed our group to examine and discuss the projects of our classmates. This helped us troubleshoot the potential strengths and weaknesses of our project and let us ponder ways we could address these strengths and weaknesses to make the project the best it could be*. In another team, Nick shares that: "*The peer-review process … gave us another perspective from someone who was not in our group. This feedback helped us change certain parts of our process that others were not sure about and it helped us look at things that we maybe did not see*." While Carson and Emma shared a similar thought when Carson mentioned that: "*The peer-reviews were also helpful to work out some of the flaws in our lesson that we hadn't seen ourselves* ", and Emma said "*the peer review process was definitely helpful because it helped us bring in a clear perspective from our peers. I think it was nice for us to have our peers review and comment on our work thus far and work together to fix any confusion that came up. I think it was also helpful to see how our peers were able to collaborate and their thoughts on the unit and process. I liked getting feedback from other groups because I was able to see their thoughts on what was expected and how they understood the assignment.* " This strategy has provided pre-service teachers ways to incorporate in their future teaching as shared by Hailey: "*the peer reviews gave us good ideas to add to our lesson plan and we did use most of the suggestions. Our fellow classmates helped our lesson grow and I will be using their ideas throughout my teaching career and beyond.*"

ASSERTION 3: PRE-SERVICE TEACHERS' BELIEFS TO INTEGRATE TECHNOLOGY INTO TEACHING ARE STRENGTHENED WITH THE UNDERSTANDING OF THE IMPORTANCE OF EMERGING TECHNOLOGIES; AND TEACHER CANDIDATES VIEW TEACHING WITH TECHNOLOGY A COLLABORATIVE, CREATIVE, OPEN, ADAPTIVE, AND FLEXIBLE PRACTICE.

Working in global virtual teams to construct interdisciplinary teaching unit, pre-service teachers in the U.S. found that technology integration was necessary to work and teach effectively in a global classroom. Ranging from course management systems, to emerging technologies in classrooms, U.S. pre-service teachers' reflections and presentations have shown that their views on teaching and integrating technology has been shaped by this experience. Participating in a global virtual team in a project-based learning approach allowed pre-service teachers to discover creativity to design instructional materials and lessons. One pre-service teacher reflected that "*as a 21st century teacher, this … (project) has taught me the importance of working on a team and working with different means of technology...One of the biggest takeaways I had for this project is how important it is to not only encourage students to be creative in class but also how important it is for teachers to be creative in their lesson planning and interactions with students… Working with my partners (from another country) really showed me how different we all were in not only cultural background but also interests, and our project wouldn't have been as successful as it was without us all bringing our own individual creativity to the table when working on our unit*."

In working with teacher candidates from other countries, U.S. preservice teachers also acquired open perspectives on emerging tools. By using the tools, pre-service teachers in the U.S. learned to incorporate the tools into their teaching practices. Steve reflected that: "*looking back on the project now that is has been completed; I can see just how important technology was in actually getting this project completed...Thankfully, great online*

applications were provided to help with the collaborative work with our (international) partners."

Another point teacher candidates made is that they gained a global perspective in the trends and applications that are adopted in other countries in K-12 classrooms. Carson says that "Our *international partners were much more open to including technologies into the classroom that were way beyond anything that I would consider using in the classroom. One of the best examples of this comes from another group, who used VR/AR in their lesson plan, allowing students to explore the solar system in a VR world, which is something that sounds so obvious that it would be engaging and educational, but would also be something that I would never even consider. VR is something that I have only ever seen used for playing games or watching cool videos, but I would have never imagined trying to design a lesson with it.*"

Katie said that "*The strength of this project is the technology integration. The lesson plan created by my (international) partners includes rich use of technology, including AR/VR technologies. Because such significant technologies are not typically available in schools in (U.S.), the literacy lesson that (my team member in U.S.) and myself developed made use of relevant technology typically used in local classrooms, such as a SmartBoard and computers/iPads. I believe that each team was able to achieve the goal of integrating appropriate technology in the lessons, though those technologies are different.*"

Pre-service teachers shared that their view was shaped by the cross-cultural communications, and teacher candidates view teaching with technology a collaborative, creative, open, adaptive, and flexible practice as they learn ready to be open, adaptive, and flexible. Learning from people that are from different cultures enabled pre-service teachers to reflect and broaden their understanding of the teaching practices in general.

"*Through this journey I have learned about their culture. I personally think my teammates were exceptional people and I don't know if that is true of the entire culture, but I have seen real understanding and kindness from my group*", Nancy reflected, "*Teaching our students to work together with people who are different from them is the recipe for a better future for our world. Many teachers get into teaching to make a difference in this world and we have now been through a project that has demonstrated this. When we show our students that differences are what makes us all great, then we can make better humans. Differences are the reason we have new ideas and create things together that are better than individual works. I have truly been thankful for this opportunity and thankful for the beautiful differences and similarities we all share.*" Annie also said , "*In working in such a close setting with so many people on this project, I learned that communication, flexibility, and adaptability are key to being a teacher….. In working with the students from (another country), I learned to communicate through media and in person with people who had a very different culture from my own. In turn, this required that I become comfortable with being adaptable because while it is difficult enough to collaborate on a unit plan in the United States, it was doubly difficult when we had to consider the different educational expectations in lesson planning in different cultures and different technology availability. Not everything went as I necessarily expected, but I was able to adapt to the changing nature of my project and the final result was both impressive and rewarding. Take away: **Not only have I learned about important 21st century learning topics, but I have also had the chance to truly live them as well**. 21st century teaching is not so much changing what we teach, but rather supplementing the same content we've always taught with additional resources that will help us reach every child.*"

The project-based learning approach enabled pre-service teachers to design in an authentic learning environment that they can experience, reflect, design, and develop technology-infused media-rich lessons. Hailey shared in her reflection that "*As a 21st century teacher it is so important to use technology because our students use technology.*

Through the use of all the tools we have at our fingertips we can keep our students engaged and motivated to learn something new. Through this (global virtual team) project I have learned how to use certain technologies, but more importantly I have gained a new perspective...This project is an excellent example of the technologies we have being applied to connect people in different parts of the world. I hope this becomes a more practiced strategy when it comes to learning in the classroom. Today it is so important to be understanding and knowledgeable about different cultures and by working together on projects like this we can all be better citizens of this world."

DISCUSSIONS

By participating in global virtual teams, teacher candidates, through their reflections and presentations, showed that they were more equipped with skills to integrate technology into teaching practices. Pre-service teachers gained skills identifying and using technologies to support team communication and team collaboration in global virtual teams. Facing language barrier and time-zone differences, written communication and asynchronous activities enables pre-service teachers to collaborate in global virtual teams. Collaborative workspace and strategies such as concept map, mini conference and peer-review enhances global virtual teams' effectiveness.

During the process of collaboration, pre-service teachers used collaborative tools to establish team structures to plan and debrief on team plans, echoing Maynard and et al (2012)'s study that teams used activities such as instant chat and sharing their lives to establish trust early on led to team effectiveness in terms of communication. The established workspace, such as collaborative editing platforms and concept maps allowed virtual pre-service teams to check each other's ideas and expectations of the project. This confirmed the findings from Hacker and et al (2019)'s study that setting up team schedules such as mini conferences facilitated by instructors to be check-points for team milestones allowed teams to conquer the communication challenges due to the time zone differences and language differences. It would be a valuable take-away to implement global virtual teams in teacher education programs to include synchronous activities with all members involved through pre-planned mediated support. The collaborative nature of design teams allowed pre-service teachers to utilize both synchronous and asynchronous activities to build workflow that are like in-person collaboration to support each team's work. The text-based communication tools such as instant chats served the purpose to provide a lower level of virtuality as the team members could view clearly with the time flexibility due to the time zone differences.

The interdisciplinary nature of the design task became the driving force of pre-service teachers collaboration. It allowed pre-service teachers to think beyond the subject that they tend to focus in their concentration areas, which in return allowed creativity and knowledge construction for their K-12 students. This echoed the previous studies by Gregory (2010) and Nicholas and Ng (2009). Team collaboration in this project benefited from receiving feedback from their instructors and peers. In this project, different channels and types of support were designed and provided to GVTs, including mini conferences with instructors and peer-reviews among different teams allowed. U.S. preservice teachers in their reflections demonstrated appreciation of both support mechanism that facilitated each team's progress towards their project goal.

Finally, through this project, pre-service teachers in U.S. have acquired a sense of appreciation of how education has been taken place in other countries, especially towards the adaptation and application of emerging technologies in K-12 classrooms. When pre-service teachers in the U.S. realized how immersive tools and apps have been adopted in K-12 classrooms in Asia, they reflected on the importance and the necessity to evaluate the

affordance and constraints of the immersive tools, which in return shaped their teaching beliefs of how technology could be incorporated into their future teaching practices. This echoed the findings of Chen and Newby (2012) study that the best way for pre-service teachers to learn the skills and shape their beliefs of incorporating technology into teaching is to create opportunities for them to practice those skills and beliefs in an authentic learning environment, that is this virtual collaborative project.

CONCLUSION: IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

This study showcased an interdisciplinary design project that allows pre-service teachers to engage in authentic design environment while collaborating virtually with international counterparts. As the finding suggested that pre-service teachers have the capacity of working with teacher candidates from another country through the adoption of collaborative virtual tools to complete the ill-structured design problem. Findings of the U.S. preservice teachers' perspectives of designing in global virtual teams shows that GVTs have value in promoting pre-service teachers' skills and competencies in incorporating collaborative tools into established team structure to facilitate team learning.

This project also enhanced pre-service teachers' cross-cultural communication skills and increased their awareness of cultural-response pedagogy in a global society. One limitation is that the study analyzed U.S. pre-service teachers' perspectives only, and for future research it would be valuable to include international pre-service teachers' data in the analysis. Another limitation is that this study focused on individual level reflection and only included one team artifact, i.e. the co-constructed concept map. For future research, it would be helpful to understand the team dynamics from analyzing multiple sources of team level communications including team chat files and team activity logs.

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