The Unexpected Problem of Classroom Video Conferencing: An Analysis and Solution for Google Hangouts and Jitsi Meet

Jason Byrne (byrne@iniad.org)
Toyo University, Japan
http://orcid.org/0000-0003-3258-0567

Mariko Furuyabu (furuyabu@iniad.org)
Toyo University, Japan
http://orcid.org/0000-0002-3957-2642

Jeff Moore (moore@iniad.org)
Toyo University, Japan
http://orcid.org/0000-0003-1810-7503

Takehiko Ito (ito9041@iniad.org)
Toyo University, Japan
http://orcid.org/0000-0001-5174-1843

Abstract: The paper looks at a multi-classroom video conferencing activity case study from the perspective of EFL classroom practitioner action research. The practitioners had identified an unknown usage limitation problem when simultaneously using large numbers of video conferencing tools. The research took place at a tech focused university campus in Tokyo, Japan, during June and November 2019. The problem had actually manifested because the practitioners had a high degree of confidence in their WI-FI and broader network environment. The research identified and subsequently isolated the specific problem through A/B testing, and the findings were supported by linear regression analysis. On the basis of the findings, the research successfully trialled a solution. However, it became apparent that this was not a localised problem and that the identified issue was relatively generalisable to other school environments. The issue will eventually be faced by other schools as 5G and improved WI-FI are rolled out worldwide. The reaction to the COVID-19 lockdown is likely to speed up the process and mean the identified solution will be required sooner rather than later.
Keywords: CALL, Video Conferencing, Action Research

Introduction

Communicative English teaching can evidently make use of familiar communication technologies to aid learning. However, while familiarity with tech is a very useful intuitive guideline for selecting technologies to be used by both students and

teachers, the classroom context can provide unexpected challenges that test the limitations of technology not specifically designed for groups of students. Working in a tech driven school, the practitioners in this case study came up against a technical issue. The practitioners sought advice from both local media center support and the specific technologies help center support. In both instances they were told that their problem was not caused by breaching the limitations of the environment and/or the technology. This was puzzling. What was causing their difficulty? That was the beginning of this action research project. It led the practitioners on a path to understanding limitations of consumer technology in the classroom and also becoming aware of the future implications for schools worldwide. The issue, as will be shown, had manifested almost because of the confidence the practitioners had in their network environment, rather than in spite of it. In this sense, the outlined research issue may herald a new form of challenge that teachers and schools will face in the years ahead, that stems from having good WI-FI and Internet infrastructure, but largely relying on free software solutions.

Rainey (2000) asserted the need for EFL classroom practitioner action research to bridge the gaps between theory and practice. The knowledge gap described in this paper could destroy a school-wide video conferencing activity program in its infancy. However, by providing practitioner awareness of, and simple solutions to, the problems herein outlined, it is possible that this paper might breathe life back into an otherwise stuttering CALL activity program.

Literature Review

Over the past decade, the literature (e.g. Hilao & Wichadee, 2017; Joyce-Gibbons, 2018) suggests, education has seen the gradual implementation of mobile devices in the classroom. There would also appear to have been an increase in synchronous computer mediated communication usage, such as videoconferencing, for language learning (Alshahrani, 2016; Vurdien, 2019). However, implementation and usage has not been problem free and it has met resistance from some educators. Kern (2014) points out that technology such as videoconferencing presents both positives and

challenges, and some issues are related to the lack of familiarity with using the technology. Indeed, Stanley (2013) echoes this concern suggesting technology used in the classroom should be familiar to both the teacher and students. Even using "Familiarity" as a guiding principle of implementation, to date, there has been a very broad eclectic approach to mobile device usage in the classroom. It has ranged from cases where classroom technology implementation has been student driven (e.g.Trinder, 2016), while in other cases, it has been teacher driven. For example, Leis, Tohei, and Cooke (2015) advocate the active encouragement of students using smartphones in the classroom.

However, for every teacher that has been willing to use in-class consumer mobile technology, there are many who have not. Godwin-Jones (2018) points out that the resistance that some educators have had towards mobile phones is likely related to the fact teachers tend to teach as they were taught. This is supported by Gloria & Oluwadara (2016) who suggest more mobile education training is required. Furthermore, this resonates with the findings of Silviyanti & Yusuf's (2015) study of teacher ICT uptake in Indonesia. In essence, past collective experience validates future mainstream teaching practice. While one potential catalyst for pedagogical change is teacher training, Larsen-Freeman (2018) highlights the importance of sociopolitical context in framing approaches to second language acquisition. Given the 2020 teacher experience of COVID-19 lockdown and the sudden urgent need for remote teaching capability, it seems probable that there will have been a significant movement in both teacher IT experience and awareness of IT based teaching approaches. Indeed, such approaches will most likely now, in the new global sociopolitical context, be greeted with greater mainstream approval and/or acceptance than they may have been before. In addition, in response to the COVID-19 lockdown, there will very likely be major improvements in local network connectivity at the school, city and national level, with tele-working and tele-schooling potentially having a greater societal role than previously envisioned (Hishan, Ramakrishnan, Qureshi, Khan, & Al-Kumaim, 2020).

Against the backdrop of social change and adjustment, as WI-FI and mobile bandwidth becomes less restrictive, more schools and teachers will most likely explore using CALL technologies in their classrooms. However, having access to mobile devices and the capability to connect to the Internet, does not always translate into seamless usage of cloud based applications. It is quite probable that many schools will make use of free software (e.g. Byrne & Furuyabu 2019; Mali, 2016; Mehring, 2016; Nguyen, 2008) and will be unknowingly reliant on free backend servers that support the usage of the free applications. It will most likely be at these free servers, as opposed to today's often substandard in-class WI-FI, that the network bottleneck in future CALL classroom usage will occur. In this paper we spotlight a video chat example of this CALL classroom network bottleneck and a simple approach to largely overcome the problems faced.

Methods

Given that this was classroom practitioner action research, the methods section explains the process by which the practitioners were able to reach a solution to an identified problem. The context was very important, as it gave the practitioners the opportunity to realise there was a solvable problem. The solution essentially involved A/B testing two video conferencing tools. This process evolved through three clear research stages.

Participants and context

The lessons using the video conferencing software took place at the Department of Networking for Innovation and Design (INIAD), Toyo University, Tokyo, Japan. The department was recently established in 2017, aiming to foster students who can start innovations compatible with the network era after their graduation. Apart from the IT related compulsory courses such as programming and data management, the department requires all students to study foreign language (English or Japanese) communication in their first year. There are three English communication lessons per week: two Listening and Speaking (LS) lessons and one Reading and Writing (RW) lesson. All lessons are 90 minutes in length. There are 12 classes for LS, with 25-35

students per class, grouped according to the results of an online placement test administered at the beginning of the semester. Most of the students lie in the range of CEFR level B1 to A1.

At INIAD, all students are required to bring a charged laptop personal computer (Bring Your Own Device) to every English class. Most of the class activities, including vocabulary quizzes and lesson worksheets, used during the lessons are based on online materials, indeed paper based materials are rarely used. Furthermore, the LS classes do not have a textbook. Instead, the lessons are based on digital materials distributed by the teacher before and during the lessons. Therefore, the students become familiar with handling their PC troubles relatively quickly. When troubles arise which they are unable to solve, there is a Media Center on campus site to provide professional support.

In terms of WI-FI and Internet access, the school is designed for high levels of device connectivity. There are at present over 1200 students making use of the WI-FI network on both their personal laptops and mobile phones. Some students also use tablet computers as a third device. In addition to the school's internal network, Tokyo is known to have some of the best Internet infrastructure in the world. Problems faced in this teaching environment today, are very likely to be problems faced by teachers elsewhere, in the near future, as 5G mobile and improved WI-FI connectivity are rolled out worldwide.

Video conferencing tools

In the case study the practitioner researchers A/B tested two video conferencing tools, Google Hangouts and Jitsi Meet. This allowed the practitioners to compare the usage of the two applications and eventually to understand the underlying issues associated with using these tools in the classroom.

Google Hangouts

Initially Google Hangouts was used as all INIAD students must use the Google Chrome browser. Google Hangouts is available from the side panel on the Chrome Browser.

The flow of the lesson was as follows. First, the teacher explained the task to the class using a 10 minute PowerPoint presentation. This included how to use the Google Hangout system, as it was anticipated that most of the students would have no prior experience in using the application. After this, one of the pairs would move out of the classroom, in order to minimise sound issues and network load, to other classrooms or empty spaces on the campus. Once the connection between the pairs was secure, they started the video conference playing the roles of designers, programmers, or clients.

Connecting and starting a group video call with Google Hangouts is a relatively simple process. First of all, Google Hangouts requires all users to log into their Gmail or G-Suite account. Then to start a new video group, one person needs to access the Google Hangout website (https://hangouts.google.com/) using the Chrome browser, and choose "Video Call". By entering the other participants' email addresses, a new video group can be formed. Users can also join existing video groups by entering meeting codes.

The Problem

Using Google Hangouts as a classroom activity is a simple procedure, however, it was soon noted that the classes were experiencing problems. In most of the lessons, teachers observed a few groups (normally 1 or 2 groups out of 7-8 conferencing groups) having problems with the use of the Google Hangouts application. None of the teachers reported that students had difficulty understanding the procedure to connect to Hangouts, but some pairs met device related or network related challenges during their attempts to start the video conference. For example, the sound being poor or nonexistent, and fuzzy or unmoving video images. In some

cases students were unable to connect to their partners. It was not clear why they were unable to access the same video meeting place. Starting a video chat took 5-10 minutes for the groups that did not have technical problems, but took much longer for the groups who experienced errors.

To be clear, at INIAD, students and teachers use their own computers in every class. IT problems are rare, and do not typically impede the flow of the class. Consequently, a sudden wave of problems that were impeding the class was highly unusual. The Hangouts problem instigated the need for a solution. This in turn led to the start of this classroom action research. The objective of this research was driven by a real need to improve the student and teacher classroom experience.

Jitsi Meet

The first step to a solution, was to see if using a different application would lead to better results. All Japanese students have LINE, it is by far the most popular messenger app in Japan. However, as teachers, we preferred not to request students to hand over their personal LINE ID to people that they may not wish to do so. Google Hangouts had only required them to share a school provided email address which is far less invasive. Consequently, Jitsi Meet was selected as the second application, as it provided greater privacy to the students.

Jitsi Meet (https://jitsi.org/jitsi-meet) is an open source communicator that provides audio/video conferencing capability, video streaming, text-based chat, and file transfer. Jitsi Meet is a good choice for anyone with privacy concerns. Jitsi Meet does not require the students to share personal email addresses or other personal information with other students. In fact, no account is needed. Conference members can easily create customized codes with letters and numbers, and people can then join video conferences by simply typing the provided code. Viewing from simplicity and privacy perspectives, it is an excellent choice.

Research procedure

The research followed three key stages over a six month period in 2019. In stage one, Google Hangouts and Jitsi Meet were used sequentially for simple comparison and the findings were later supported by linear regression analysis. In stage two, a connection test was undertaken to clarify the results from stage one. Finally, in stage three, the video conferencing tools were used in tandem, to test the selected solution.

Stage one: Google Hangouts and Jitsi Meet

The four teachers who taught the first year listening and speaking classes were asked to record their experiences of using Google Hangouts and Jitsi Meet during the first semester of 2019. From June 3-7 teachers collected data on Google Hangouts and from June 20-21 Jitsi Meet data was collected. The data was collected using a simple questionnaire with additional spaces for individual thoughts and reflections.

Stage two: Connection test

As a result of the teacher experience in stage one, a connection test was conducted by one researcher to see how many devices could be connected to Jitsi Meet and Google Hangouts video chat applications. The test was undertaken by progressively asking groups of four students to connect to the video chat services. This was continued until users could no longer connect.

Stage three: Either Jitsi Meet or Google Hangouts

Stage three is based on the findings of stages one and two. The decision was made to ask the four teachers to exclusively use either Jitsi Meet or Google Hangouts. This occurred in the second semester, between November 1-8, 2019. Two teachers volunteered for each application, thereby guaranteeing that usage would be more equally spread and potentially less overloaded. Given the real world context, it was impossible to balance perfectly, and only one class period included a large number of devices. The teachers then answered a follow up questionnaire.

Results

The results of the research were not a simple singular end finding, but data that drove a process. The findings from stages one and two were analysed and then applied, leading to stage three. Stage three provided the practitioners with a solution to the classroom problem and insight into what is very likely to occur, or probably is occurring, in schools worldwide.

Stage one

According to Figure 1, the Google Hangouts problems appear to be a reflection of the number of devices in use. The number of problems are expressed as an increasing percentage rate of devices. The higher the number of devices in use the greater the percentage of problems. The lower the number of devices in use the less likely to be problems. But there was always a problem. On Google Hangouts both Monday 2nd period and Tuesday 1st period 25 devices successfully connected. Yet, with only 12 devices to connect there were still problems for two groups on Thursday 2nd period and Friday 1st period.
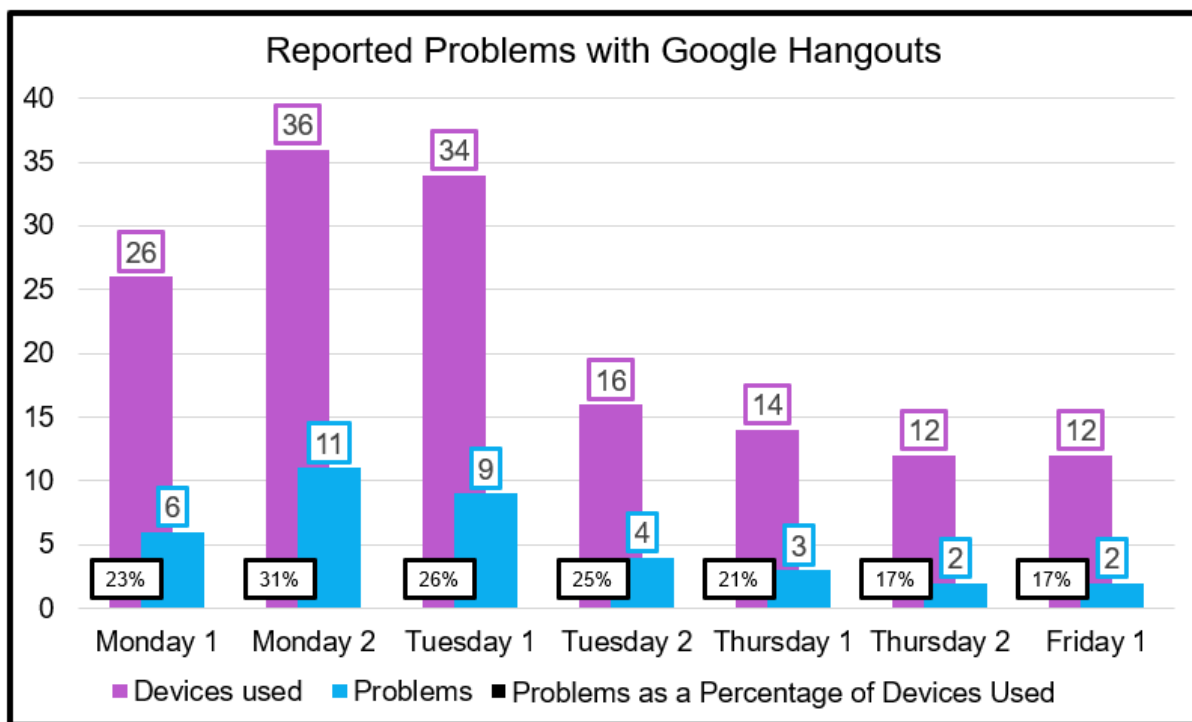

Figure 1. Google Hangouts June 3-7, 2019

Modelling likely problems

The Google Hangouts data clearly suggested that the greater the number of devices the greater the percentage of problems. There is not enough data and the class usage size is too small to accurately predict, however we can suggest broad usage buckets and the likely outcomes.

Table 1. Model Usage Buckets

| Bucket	1	2	3	4
Number of Devices	<13	13-29	30-39	40+
Problems as a Percentage of Devices Used	<20%	20-25%	26-35%	36%+

In Table 1, buckets one to three are based on Google Hangouts actual data, while bucket four is a broad over-spill bucket based on the data entered from the first three buckets. Consequently, to fairly compare Google Hangouts and Jitsi Meet, we can only compare relatively bluntly in terms of the four broad buckets.

According to Figure 2, Jitsi Meet across June 20-21 experienced many more problems than Google Hangouts. For example, Thursday period 1 saw 66 devices with 32 problems. This led to a number of disappointed teachers stating that they really liked the privacy and ease of use associated with Jitsi Meet, but it simply was not functioning. However, upon examination, many more devices were being used than had been the case for Google Hangouts. Three of the four Jitsi Meet class periods fell into the large bucket four.
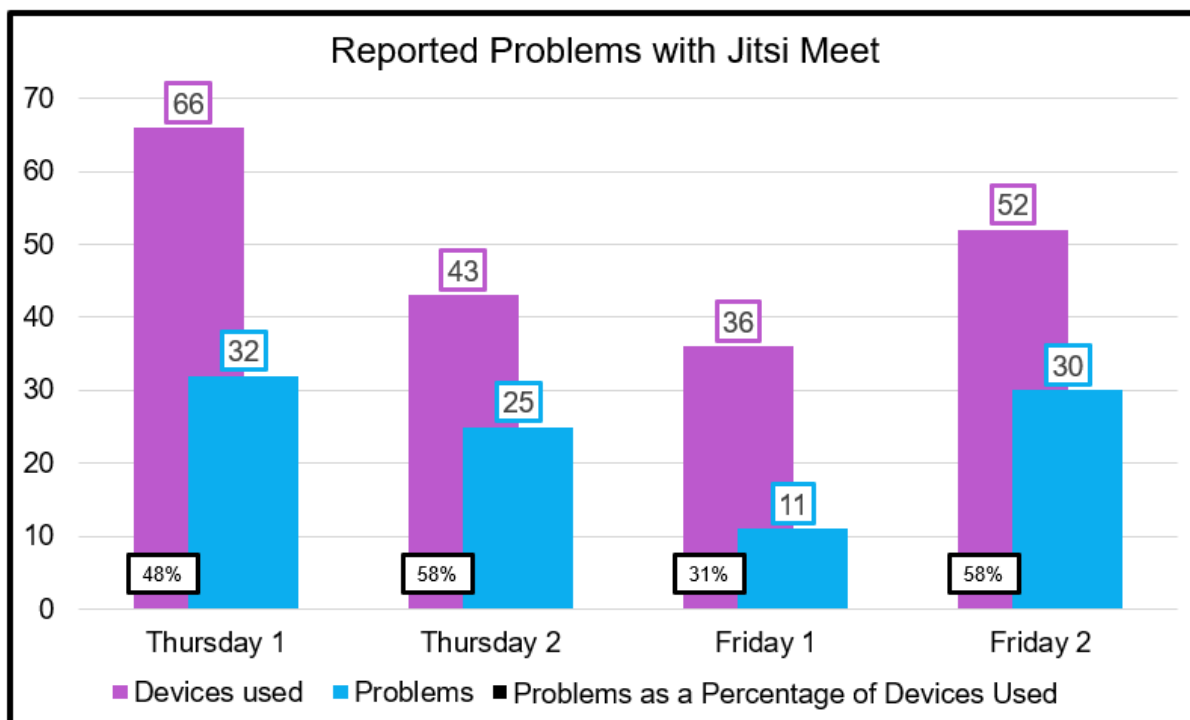
Figure 2. Jitsi Meet June 20-21, 2019

In addition, the notion that more devices has led to a higher percentage of devices with problems, as expressed in the bucket model, has been further supported by a linear regression analysis. The analysis, as shown in the Figure 3 scatter plot, was undertaken on admittedly limited data. R2 (0.718) suggests a strong positive linear correlation between the number of devices, irrespective of being Google Hangouts or Jitsi Meet, with the number of problems experienced. In simple terms, more devices meant a higher percentage of devices with problems.
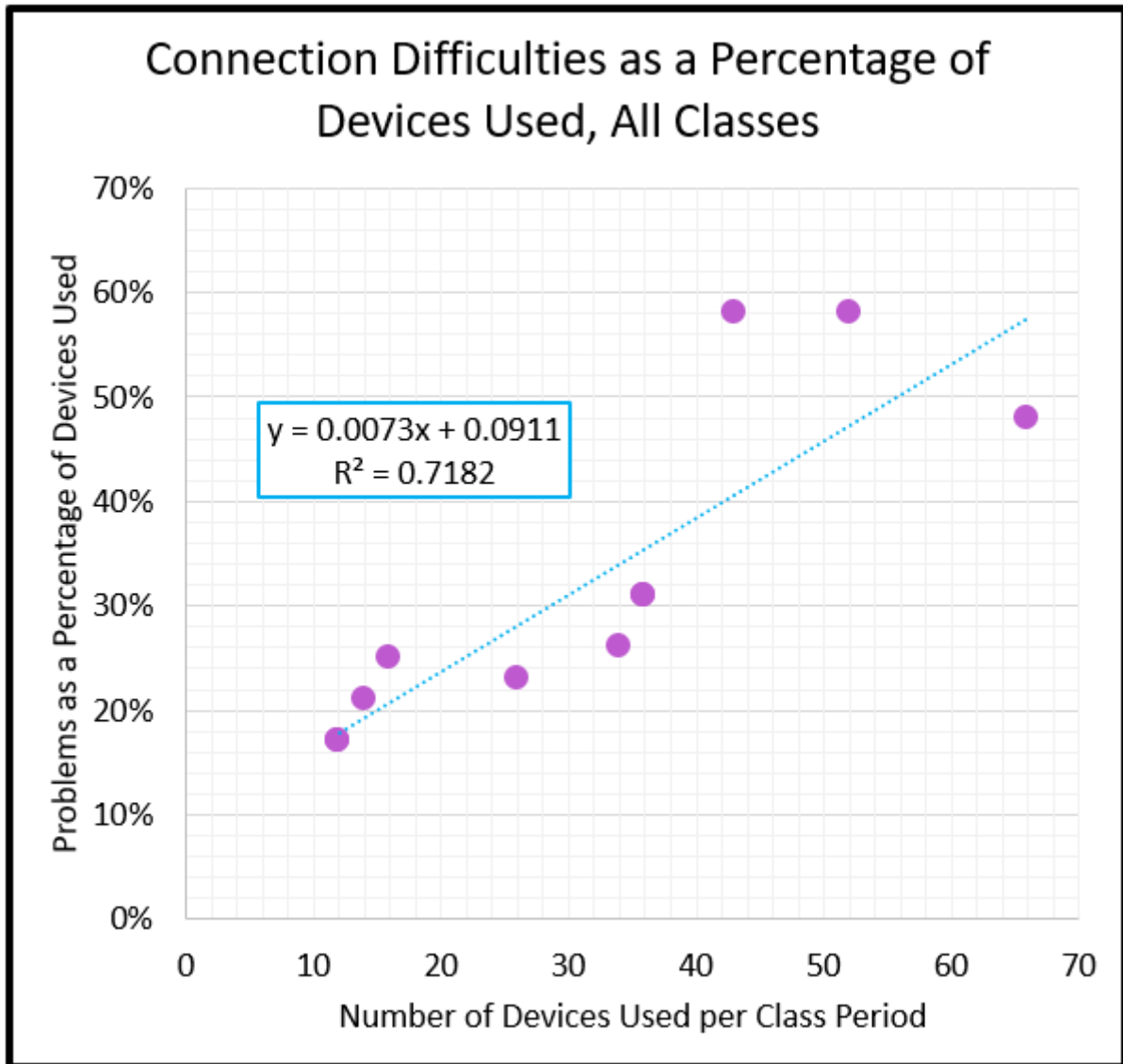
Figure 3. In Class Device Connection Difficulty

The comparison

Gathering qualitative data directly after the classes, the initial feeling of the teachers based on their experience was that Jitsi Meet had more problems than Google Hangouts. However, upon analysis, the Jitsi Meet data (see Figure 2) seems to agree far more closely with the Google Hangouts data than the teacher experience may have suggested. Essentially, there were far more devices in usage during the Jitsi Meet study periods and this almost certainly led to more technical difficulties as opposed to a deficiency in Jitsi Meet itself. There are three points that support this conclusion. Firstly, the model bucket data. Jitsi Meet had four periods of data. Three periods fall into the large over-spill bucket four. There were many problems because

there were many devices being used (43-66 devices). The fourth period of 36 devices, which corresponds to bucket three, had 30.56% of problematic devices and was identical to the Google Hangouts data for 36 devices. Secondly, while 66 devices led to 32 problem groupings, it is also true that 34 groups connected successfully to Jitsi Meet as opposed to a high of 25 for Google Hangouts. This would suggest that Jitsi Meet was not any more problematic than Google Hangouts, but rather Jitsi Meet was used under greater stress creating a negative response from the teachers. Finally, the linear regression analysis, as shown in the Figure 3 scatter plot, strongly supports this argument.

Initial conclusions

It would appear the issues faced were not caused by a specific video chat application. It seemed clear that Google Hangouts and Jitsi Meet had performed quite similarly. This led to a working assumption that the problems were occurring either a) within the local WI-FI, b) at the video chat backend server, or c) on route between A and B. Since the school technical support had suggested the WI-FI connection was strong enough to handle the classroom video chat traffic, a server connection test seemed a reasonable next step.

Stage two: Connection test

As stated in the materials and methods section, the aim of the connection test was to discover how many devices could be connected to the video chat applications without issue. For Jitsi Meet, 20 devices connected and then as more devices were added, others would experience connectivity issues or lose connection completely. Google Hangouts appeared to allow 25 devices to connect before some devices were dropped. These usage experiences are what you would expect if the servers were throttling (limiting) usage.

Throttling makes perfect sense, since a sudden burst of multiple users from one IP location, all calling users at the same location, would be somewhat unusual. This activity would be automatically flagged and could be seen as a pattern resembling

the early stages of a denial of service attack. Therefore, the servers would throttle usage to the flagged location in order to preserve the integrity of their entire network.

Proposed improvement

The results of the comparative data, linear regression analysis and the connection tests suggest that by using more than one app during the same class period, the number of problems are very likely to decrease. Looking at the data, it seemed our local WI-FI environment could handle at least 34 device connections, while Jitsi Meet would allow 20 connections and Google Hangouts 25 connections.

The comparative data suggested that Jitsi Meet was able to successfully connect as many as 34 devices (while 32 failed) during one class period, yet the connection test suggested problems would begin to occur at around 20 devices connected. The comparative data for Google Hangouts suggested 25 devices were successfully connected (while approximately 10 failed) during one class period, and the connection test suggested problems would begin at around 26 devices. The conclusion drawn from this was that by limiting Jitsi Meet to 20 devices and supplementing with Google Hangouts, at least 34 devices would successfully connect with minimal problems and quite possibly more devices might work. The 34 device limit most likely represents the limitations of the school WI-FI in 2019, this was more clearly understood in stage three. Whereas in a future 5G and improved WI-FI environment the limit is more likely to be 45 devices (20 Jitsi Meet and 25 Google Hangouts). It is also possible that Jitsi Meet and Google Hangouts will increase their user limits. For example, during the COVID-19 period, Google temporarily increased their Google Meet limit from 25 to 200 users on an educational conference call. In a new social context, it is very possible that communication app backend servers will provide improved access parameters, especially for educational purposes.

Stage three: Either Jitsi Meet or Google Hangouts

The proposed solution was for teachers to use either Jitsi Meet or Google Hangouts, thereby diversifying usage. Furthermore, the diversified use of the two video conferencing tools by the teachers in the same class periods appears to have had the intended effect of decreasing user difficulty.

Table 2. November 7, 2019 period one

App	Devices	Problems	Problems as a Percentage of Devices Used	Percentage of Devices Connected
Jitsi Meet	28	8	28.6%	71.5%
Google Hangouts	16	4	25.0%	100.0%
Total	44	12	27.3%	81.8%

The problems during period one on November 7th decreased significantly in both number and difficulty. Looking at Table 2, the total number of devices with problems stood at 27.2% when 44 devices were in play, this compares very favourably to the second period on the 20th of June when 58% of 43 devices reported issues (see figure 2). Essentially, the problems had halved by using two applications in tandem. In addition, Jitsi Meet was used by 28 devices and eight reported connectivity problems. The findings once again support the view that 20 devices appears to be the problem-free limit for Jitsi Meet at one IP location. The Google Hangouts class made use of 16 devices and four reported sound problems. Since all of the Google Hangouts devices were connected to their partner device, it is likely that the sound issues were caused by a degradation of network latency somewhere between the users' devices and the backend servers, as opposed to application server-side throttling.

To be clear, the connection rate for the 16 Google Hangouts devices was 100%, while the number of Jitsi Meet connections matched the expected limitation of 20 devices.

In total 36 devices from 44 connected via the applications, this is an 81.8% success rate. In addition, 36 connections is the maximum number that could have been expected to connect from this specific classroom configuration (20 from 28 Jitsi Meet and 16 from 16 Google Hangouts). If in this case, Jitsi Meet usage had been kept to 20 devices and Google Hangouts usage expanded to 24 devices, then it is likely there would have been an even better connectivity success rate.

Discussion

The action research has raised two key points. Firstly, teachers must be mindful that when they re-purpose freely available consumer tech for classroom usage, they may encounter issues outside of the scope of tech support. The teachers appear to have become more knowledgeable on this specific issue than tech support. In fairness, Google Hangouts was not designed for classroom speaking activity and a typical consumer user would not need to know how many devices can hold multiple conversations at a single location. The application tech support told the practitioners correctly that they would be limited to 25 devices per conversation, but they also appeared to tell the practitioners that there were no limits on the number of conversations at one location. Actually, it was found that they were effectively limited to 25 problem-free devices on Google Hangouts at the school location. The practitioners also found that this is normal, with Jitsi Meet also limiting the school location to 20 devices. There are very few scenarios where video conferencing users would hit such a limit, but small group classroom activity is one of them. This would suggest teachers using free software will need to problem solve and be creative in finding solutions. Or, use solutions designed specifically for education.

The second raised point is that solutions are often quite simple fixes. By using two or more video chat apps, in stage three, the practitioners were able to minimize problems and maximise the number of devices they could use. In the case-study, the WI-FI was able to handle more devices (34) problem free than the singular app servers (20 & 25 respectively) would appear to allow at one IP location. The problems that did occur are most likely caused at least in part by server throttling by both Jitsi

Meet and Google Hangouts. In the November 7th period, as shown in Table 2, the Jitsi Meet connectivity issues were almost certainly an example of throttling. However, the Google Hangouts issues were probably caused by reaching the limits of the network, somewhere on route between the users' devices and the application servers, and with increased bandwidth and better network latency these issues would most likely disappear. This means that for classroom usage, as 5G networks and stronger WI-FI decrease the points of friction, backend server throttling will be the greatest point of future network bottleneck in free video chat CALL. In this case, the simplest and cheapest solution will be for schools to implement several video chat applications, diversifying usage among teachers for each class period.

Conclusion

As was stated in the introduction, the practitioner researchers found themselves on a path to understanding limitations of consumer technology in the classroom, while also becoming aware of the future implications for schools worldwide. An individual teacher working alone would almost certainly not have met the challenges described in this paper, however, once you have a co-ordinated, multiple teacher, multiple classroom in tandem pattern of usage, then eventually limits applied to free software (especially the cloud components) will be triggered and problems will start to follow.

In this case, the stage one linear regression analysis supported a strong correlation between the number of devices used and the number of problems faced irrespective of application. This led to stage two which allowed for an unmasking of the local user limits set by Jitsi Meet and Google Hangouts. In stage three, the successfully applied solution of using the two applications in tandem led to a significant decrease in problems. This strongly suggested the problems did not originate at INIAD, or indeed in Tokyo, but were related to server throttling. The application backend servers were placing limits on the numbers of users at one location. Once this was understood, it provided greater confidence and control over what the practitioners were doing, and indeed could do, given the working environment.

In summary, it is quite likely that as access to mobile devices, 5G and improved WI-FI is combined with a student/teacher interest and need to use communication apps in the EFL classroom, then schools will inadvertently stumble upon similar masked problems that will appear invisible and unfathomable. However, with a little problem solving, A/B testing and analysis, simple fixes can be found and the CALL classroom can survive and thrive.

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