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A Spectrum of Online Rehearsal Applications: A Potential Means for Cultural Connection

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A Spectrum of Online Rehearsal Applications: A Potential Means for Cultural Connection

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Abstract

The current array of telematic music applications offers exceptional opportunities to transcend distance and enable networking between various cultures and communities. As a means to achieve this, network music applications require assessment through their previous implementations, installation requirements, cost, hardware requirements, and usability in order to assess their potential and to decipher improvements needed as a means of cultural connectivity. An early precursor of telematic music was an innovative concert by Paul Robeson in 1957, which circumvented political restrictions and enabled activism as it occurred, despite the U.S. State Department's revocation of Robeson's passport due to his left-wing tendencies and activism in support of poor, black, and working-class populations in the United States. More recent cultural connections are evident through modern telematic events such as Michael Dessen's project "Telematic Bridges," which commenced in 2017. While some musicians that have taken part in such performances were subject to the challenges of telematic connections, their access to telematic means was not inherently limited by accessibility or technical ability. Network music applications have the potential to provide a valuable service that can promote growth and understanding between cultures. However, the use of telematic applications as a cultural tool has not previously been studied. In order to evaluate this potential, a review of their usability is recommended and an overview of requirements for JackTrip, Jamulus, JamKazam, SonoBus, and Deck 10 Studio are highlighted. While each offers a much-needed benefit to specific users, all are not without issues, which can range from the complications of setting up of a private server to the installation of the application itself. Network music applications must evolve in simplicity of installation, a reduction of cost and required

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hardware, and ease in usability in order to lessen users' cognitive load and be financially and intellectually accessible. In doing so, there is the potential to act as a device to bypass cultural and socio-economic barricades and connect humans through music.

Introduction

A renowned diversity-training veteran with over 35 years of experience, Lewis Brown Griggs has long considered how people are influenced by group and cultural differences, individual uniqueness, and relationship dynamics. His work helped spawn Diversity, Equity, and Inclusion (DEI), which is paramount to today's cultural footprint.[3] DEI encompasses communication, thus including communication via the internet, and therefore, communication through network music. Considering that the current array of network music applications offers exceptional opportunities to transcend distance, we can now consider that by connecting through musical exchange in real-time, those of different cultures, socioeconomics, and race can potentially bypass prejudices. As a means to achieve diversity, equity, and inclusion, it is an opportune time for network music applications to assess their previous implementations, hardware requirements, installation requirements, cost, and usability in order to gauge their potential and to decipher improvements needed as a means of cultural connectivity.

Telematic Events

A remarkable precursor to networked music in which the physical restrictions of geographic locations were bypassed was held on Sunday, May 26, 1957. On this date, Paul Robeson (1898-1976), world renowned bass baritone, and son of an ex-slave and Methodist minister, appeared in concert at St. Pancras Town Hall in London by way of the first transatlantic telephone cable, Transatlantic No. 1 (TAT-1), while he remained in New York.[7] The TAT-1 is a submarine repeater; a string of repeaters was made as amplifiers for telephone cables and laid across the Atlantic. The broadcast was so incredibly clear that the audience thought that the transmission of Robeson's voice was coming from a recording. This innovative concert circumvented political restrictions and enabled activism as it occurred despite the U.S. State Department's revocation of Robeson's passport due

[3] "Lewis Brown Griggs Legend of Diversity Award," ISDIPinc., accessed May 20, 2022, video, 1:41. https://www.youtube.com/watch?v=GYso5yyNeqQ.

[7] "Specimen of the First Transatlantic Telephone Cable, 1956," Science Museum Group Collection Online, Science Museum Group, accessed July 10, 2021, https://collection.sciencemuseumgroup.org.uk/objects/co33334/specimen-of-the-first-transatlantic-telephone-cable-1956-cable; Jonathan Karp, "Performing Black-Jewish Symbiosis: The 'Hassidic Chant' of Paul Robeson," *American Jewish History* 91, no. 1 (2003): 54, http://doi.org/10.1353/ajh.2004.0032.

to his left-wing tendencies and activism in support of poor, black, and working-class populations in the United States. In addition to his political activism, Paul Robeson was known as a cultural barrier-breaker for his performance of folk songs from throughout the world, as well as for his unprecedented performance as the first Othello of color on Broadway in 1943, which only aided in the cultural outreach of his transatlantic performance in 1957.[8]

More recently, in 2017, composer, improviser, and educator Michael Dessen used online network music applications to cross cultural barriers and create connections through his project "Telematic Bridges," in which he held a weeklong course with Santa Ana High School in California and a school in Manizales, Colombia. This course was based on collaboration and telematics and offered the added benefit of cultural exchange. It has continued as an ongoing project.

A telematic event created by Scott Deal and Matthew Burtner, this time employing five remote sites and their populations over the Internet, was the opera *Auksalaq*.[9] As a student of Scott Deal, this project was part of the inspiration in my study of network music applications as a means of bypassing socio-cultural barriers. *Auksalaq* premiered in October of 2010 at the *Ear to Earth Festival* in New York and explored the northern geographic perspective of global climate change. The opera utilized scientific commentary with dialogues between citizens of the region; these statements were then developed into a narrative regarding global warming in the far north, and were musically represented via research-grade, high-speed networks through supporting institutions in the Internet2 organization. The audience became part of the performance as they commented from their computers or devices during the opera and the performers responded musically. Ultimately, *Auksalaq* evoked the philosophy that a subtle and intellectual relationship develops during the real-time collaboration between performing and computer artists.[10] Deal and Burtner have stated that "telematic art is an expressive action involving human-computer and human-computer interaction, where verbal and graphic narratives, musical concepts, data, and feedback combine with gestures to create a vivid information environment."[11] Fundamentally, *Auksalaq* explores human interconnectivity via a networked context and music that reflects environmental content.

Much more recently, musicians have experimented with the use of telematic network applications in their own practice. During 2020 and 2021, pianist and composer Dan Tepfer built a community of musicians that practiced and worked on new music together and even performed income-producing live-streamed concerts while live venues around the world were closed due to

[8] "Robeson Sings: The First Transatlantic Telephone Cable," Science Museum, accessed July 10, 2021, https://www.sciencemuseum.org.uk/objects-and-stories/robeson-sings-first-transatlantic-telephone-cable.

[9] Matthew Burtner, "Matthew Burtner: 'Auksalaq' Music," accessed July 10, 2021, http://matthewburtner.com/auksalaqexcerpt/.

[10] Scott Deal and Matthew Burtner, "Auksalaq, a Telematic Opera," in *Proceedings of the International Computer Conference 2011* (Huddersfield, UK: University of Huddersfield, 2011), 511–514, http://auksalaq.org/main/wp-content/uploads/2011/08/Auksalaq-a-Telematic-Opera.pdf.

[11] Matthew Burtner, "Matthew Burtner: 'Auksalaq' Music," http://matthewburtner.com/auksalaqexcerpt/.

the pandemic.[12] Riley Mulherkar and Andy Clausen, members of the Westerlies, experimented with using Zoom for production of their album during the pandemic, but the latency delay was too great to allow them to play in time together. They ultimately used the Audiomovers application to allow them to send high-quality audio of their album work to each other in real time. The synchronization of their live audio feeds then enabled the leader to hear the other three group members, although they could only hear the leader.[13] Mark Dresser, a Grammy-nominated bassist, improviser, composer, and telematic performer and educator, has remarked that telematic interaction fosters a distinctive type of collaboration, serving as an alternative venue to live performance, not as a replacement. He says that the emerging technology and resulting resourceful means offer an "atmosphere of creating communications."[14] Consider if the "atmosphere of creating communications" extended to differing cultural populations and socioeconomic levels. Connecting as musical artists within our global society would then be magnified by the dissolution of distance.

Overview of Five Online Network Music Applications

The evolution of telematics supports that telematic applications can be used as a tool for crossing social and cultural barriers. Examining five telematic network applications (JackTrip, Jamulus, JamKazam, SonoBus, and Deck 10 Studio) illustrates the requirements for their use. The table shows comparisons of cost, bandwidth requirements, and audio and visual offerings of the applications, as well as port-forwarding requirements (see table 1). All applications require a computer, power supply, sound card, and microphone. Most systems require headphones for optimal music networking. Systems work with internal mics but work best with an external mic and audio interface. In addition, Ethernet is strongly recommended by all applications except JackTrip, which requires Ethernet, and Deck 10 Studio, which does not require Ethernet. The user cost varies: it can be free, contain subscription fees, or have a one-time fee, such as the $149 cost of JackTrip's Raspberry Pi4 device.

Bandwidth requirements have a similarly wide range. At one end, there may be no specific requirements, but data rates can range from to 300 kilobits per second up to 2 megabits per second. All services offer audio, while JamKazam offers a paid upgrade version with video and Deck 10 Studio includes both audio and video (see table 1). The number of people or points that can be

[12] "Is it Possible to Play Music Together Over the Internet?" July 15, 2020, Jazz Night in America, video, 6:12, https://www.youtube.com/watch?v=Sj6Ij1Oxe1s.

[13] Marcie Sillman, "Musicians Turn to New Software to Play Online [transcript]," All Things Considered, November 21, 2020, https://www.npr.org/transcripts/937043051.

[14] Pauline Oliveros et al., "Telematic Music: Six Perspectives," *Leonardo Music Journal* 19 (December 2009): 95–96, https://doi.org/10.1162/lmj.2009.19.95.

connected is another consideration. However, in a network music environment with music being played in real-time, two to three connection points would be sufficient for most purposes.

Each of the applications evaluated offer a much-needed benefit to specific users. All are not without issues, which can include the complication of the setup of a private server and of the installation of the application itself. All the applications offer low latency, while the more complicated setups offer the lowest latency.

Application	Origination Date	Cost	Bandwidth Requirements	Audio or Audio/Video	Port-forwarding: Required or Recommended
JackTrip	Early 2000s	Free-$149 for Raspberry Pi4	2.0 Mbps both download and upload bandwidth for two channels (stereo) of 48 Khz lossless audio (CD quality)	Audio[22]	Not required for cloud servers Required for physical servers.[23]
Jamulus	2013	Free open-source download	Approximately 300 Kbps for both download and upload bandwidth for two channels (stereo) of lossy audio	Audio	Yes[25]

[22] "Virtual Studio: Frequently Asked Questions (FAQs)," JackTrip Virtual Studio, JackTrip, accessed July 11, 2021, https://help.jacktrip.org/hc/en-us/articles/360055332753-Virtual-Studio-Frequently-Asked-Questions.

[23] Sarah Weaver, in discussion with the author, January 2022.

[25] "Setup: Getting Started with Jamulus," Jamulus, accessed July 11, 2021, https://jamulus.io/wiki/Getting-Started.

			(high mp3 quality)[24]		
JamKazam	March 2014	Free (basic) Upgraded versions with video - $4.99-$19.99 monthly	1Mbps uplink bandwidth for real-time online sessions Download not indicated	Audio Paid upgrade version offers video	Yes[26]
SonoBus	August 2020	Free download	Not specified	Audio	Advised[27]
Deck 10 Studio	April 2020	Subscription- based pricing in development	No bandwidth requirements	Audio and video	No[28]

Table 1. Online Network Applications

The HCI Perspective

Ultimately, from a human-computer interaction (HCI) perspective, it is beneficial to review the usability of the applications as they relate to their intended users. For example, consider the capabilities and requirements of a computer-researcher musician versus those of a financially disadvantaged amateur musician. The relevance of one application over another becomes apparent. A full analysis of competitive research would be necessary for complete evaluation of the improvements needed for an application based on the needs of a particular person.

As the evaluations of each of these applications are undertaken, it should be considered whether they are a usable service in the context of creating social connections and/or breaking social barriers. Is the application useful, efficient, effective, satisfying, learnable, and accessible?

[24] "Virtual Studio: Frequently Asked Questions," JackTrip, https://help.jacktrip.org/hc/en-us/articles/360055332753-Virtual-Studio-Frequently-Asked-Questions.

[26] Jamkazam, "Minimum System Requirements," JamKazam Forums, accessed July 11, 2021, https://forum.jamkazam.com/showthread.php?tid=114.

[27] "If You Cannot Connect," SonoBus User Guide, SonoBus, accessed July 11, 2021, https://www.sonobus.net/sonobus_userguide.html.

[28] Chuiyuan Meng, e-mail message to author, July 9, 2021.

To elaborate, consider the following questions: Is the user able to achieve their goals? Are they willing to use the product? Is the application of the program accomplished correctly and completely within a certain degree of time? Does the application behave in the manner expected of it? Can the users operate the application effectively and recall the operation after a period of inactivity? Are users satisfied with the application? Finally, is the product usable by people with disabilities, including physical, financial, social, and educational ones?[29]

Since the spring of 2021, I have been engaged in research on Deck 10 Media. My work involved assisting for the Summer Institute for Contemporary Performance Practice (SICPP) Conference at the New England Conservatory in Boston in June of 2021. The symposium utilized Deck 10 Media as their platform. SICPP's rehearsals and live-music performances were presented through Deck 10 Studio, the online rehearsal application portion of Deck 10 Media, and portions of the final concerts were then broadcast live via Deck 10 Studio through the Deck 10 Media application. SICPP participants had the option of presenting their concert portions of the conference in a recorded format through Zoom or live through Deck 10 Studio, regardless of whether the music was transmitted from one location or several. Faculty administrators were recommended to use Deck 10 Studio for rehearsals but were also permitted to use Zoom for performances telecast from a single location.

One participant commented via the SICPP administration survey that, based on their experience, they "think the rehearsals should also have been held over Deck 10 instead of Zoom." Due to the sound quality and ease of use, they said that they would assume that "more people would present their piece live instead of (as) a pre-recorded video/audio."[30] This comment suggests hesitation by some users to try new computer applications. Experience has shown that people that do not use the computer frequently are resistant to trying new technology and have more difficulty adjusting to its procedures. Familiarity is key to a high ease of use or reduced experience of user friction. Ease of use is crucial in order for targeted users to be able to utilize a telematic application and its full range of features and benefits.[31] This sentiment holds true for any network-music application. Hesitation is likely superseded by rejection of a telematic-music application associated with increased user friction. Ease of use is essential for any of these applications to be successful as a cultural networking tool.

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[29] Jeffrey Rubin and Dana Chisnell, *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*, 2nd edition (Indianapolis: Wiley Publishing, 2008), 4, http://ebookcentral.proquest.com/lib/iupui-ebooks/detail.action?docID=343716.

[30] Survey comment supplied by Rebecca Hallowell, e-mail message to author, July 11, 2021.

[31] Christian Rohrer, "Quantifying and Comparing Ease of Use Without Breaking the Bank," Nielsen Norman Group, April 16, 2017, https://www.nngroup.com/articles/pure-method/.

Beyond HCI and User Friction

Looking beyond the user experience of working with telematic music or online network music applications and before many populations can experience or even consider the use of network music applications as a means of crossing cultural barriers, consideration must be given to the socio-economic conditions of these populaces. This includes lack of internet access, race, the ability to pay for internet, access to a computer in the home, lack of exposure to technology, and the requirements necessary for each participant in telematic music use.

In one sense, disadvantaged populations can be indicated by reference to poverty. As identified by the U.S. Census Bureau, geographical "poverty areas" are those which experience a lack of economic security and which have poverty rates greater than or equal to 20 percent of the population.[36] However, this is an oversimplification, both in the United States and worldwide.

In another sense, measures to indicate poverty also include income, health, and political rights—all of which are often closely correlated—and can be expanded today to include "risk, vulnerability, powerlessness, and lack of voice."[37] A reduction in these interrelated perils, particularly lack of voice, can decrease the sense of isolation, providing an immediate benefit.[38] Network music applications and their associated musical and societal connections can serve as an implementation device for the voice of the poverty-stricken and disadvantaged. Their feasibility as a means of creative expression and intercultural connection is dependent on their accessibility and usability. Consider that, as technology advances and there is an ascension in the overall standard of living, items and services once considered to be luxuries might now be considered necessities.[39]

Recognizably, internet access is essential to all applications because without it there is no means of connecting one location to another. Yet the probability of having internet access is notable, whereas in 2019, more than one in six people living in poverty had no Internet access in the home. [40] The lack of access has been made widely apparent during the Covid-19 pandemic, in which a Pew Research poll evaluating access of homebound school-aged children in the United States found that one out of five parents said that their children would not be able to complete their

[36] Alemayehu Bishaw et al., *Changes in Poverty Rates and Poverty Areas Over Time: 2005 to 2019*, ACSBR/20-08 (United States Census Bureau, Washington, D.C.: United States Census Bureau, 2020), https://www.census.gov/library/publications/2020/acs/acsbr20-08.html.

[37] Ravi Kanbur and Lyn Squire, "The Evolution of Thinking About Poverty: Exploring the Interactions," in *Frontiers of Development Economics: The Future in Perspective*, ed. Gerald M. Meier and Joseph E. Stiglitz (New York: Oxford University Press, 2001), 185.

[38] Ravi Kanbur and Lyn Squire, "The Evolution of Thinking About Poverty."

[39] Ravi Kanbur and Lyn Squire, "The Evolution of Thinking About Poverty," 186.

[40] Kendall Swenson and Robin Ghertner, "People in Low-Income Households Have Less Access to Internet Services – 2019 Update," Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services, March 2021, https://aspe.hhs.gov/system/files/pdf/263601/internet-access-among-low-income-2019.pdf.

schoolwork due to lack of internet access.[41] Twenty-two percent of the parents also reported unreliable home internet connections.[42] The numbers increase among poverty-stricken homes with 40 percent indicating unreliable home Internet.[43]

Race and ethnicity also play a role in the likelihood of having internet access in the home. According to a report by the U.S. Department of Health and Human Services, Caucasian- and Asian-identified respondents were much more likely to have internet access with rates of 70 to 80 percent of their populations (fig. 1). Approximately 65 percent of Hispanic and Black Americans have home internet access, making them the populations with the least accessibility (fig. 1).[44]

[41] Emily A. Vogels et al., "53% of Americans Say the Internet Has Been Essential During the COVID-19 Outbreak," Pew Research Center, April 20, 2020, https://www.pewresearch.org/internet/2020/04/30/53-of-americans-say-the-internet-has-been-essential-during-the-covid-19-outbreak/.

[42] Vogels et al., "53% of Americans Say the Internet Has Been Essential During the COVID-19 Outbreak," https://www.pewresearch.org/internet/2020/04/30/53-of-americans-say-the-internet-has-been-essential-during-the-covid-19-outbreak/.

[43] Ibid.

[44] Kendall Swenson and Robin Ghertner, "People in Low-Income Households Have Less Access to Internet Services – 2019 Update," https://aspe.hhs.gov/system/files/pdf/263601/internet-access-among-low-income-2019.pdf.

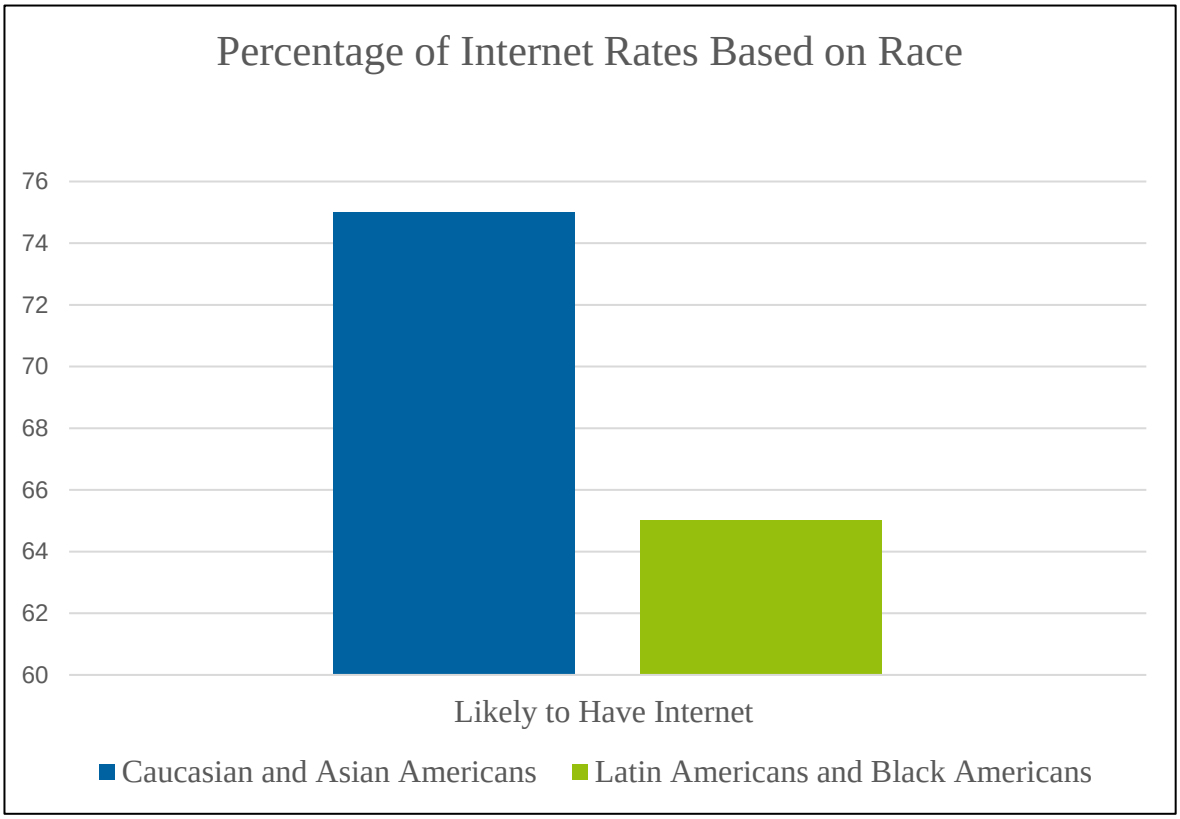

Figure 1. Based on data from "People in Low-Income Households Have Less Access to Internet Services – 2019 Update." Chart by Dana Kemack Goot.

While most people who live in the United States feel that the internet is a necessary and critical tool, many that have high-speed internet connections in the home are also worried about their ability to pay for this service in the coming months (fig. 2). Concern is likewise expressed for paying for cell phone service, which some parents resort to for internet access. Hispanic and Black Americans express more concern about paying these bills than other users, and those with lower incomes express the most concern about bill payment (fig. 2).[45] The Pew Research Center found that approximately half of lower income Americans are worried about paying for broadband and cellphone bills in the coming months.[46]

Internet access and the ability to pay are prefaced by the access to a computer within the home. Only 21 percent of those with children have a computer. Twenty-nine percent of parents state that it is likely that their children will have to use a cellphone to complete their schoolwork due to lack of computer access.[47] Moreover, among parents of lower incomes the prevalence rises.

[45] Vogels et al., "53% of Americans Say the Internet Has Been Essential During the COVID-19 Outbreak."

[46] Ibid.

[47] Ibid.

Thirty-six percent of these parents say that they do not have a computer at home and forty-three percent of those whose children's schools closed due to the Covid-19 pandemic say it is likely that it will be necessary for their children to do their schoolwork on their cellphones.[48] To further complicate matters, lack of exposure foments the development of negative attitudes toward technology, which presumably deters populations from adopting the internet.[49] In addition, telematic music-making requires an equitable distribution of technical skill, access to a computer and other hardware, and access to the internet by each the participants in each of the locations that are attempting to connect with each other.

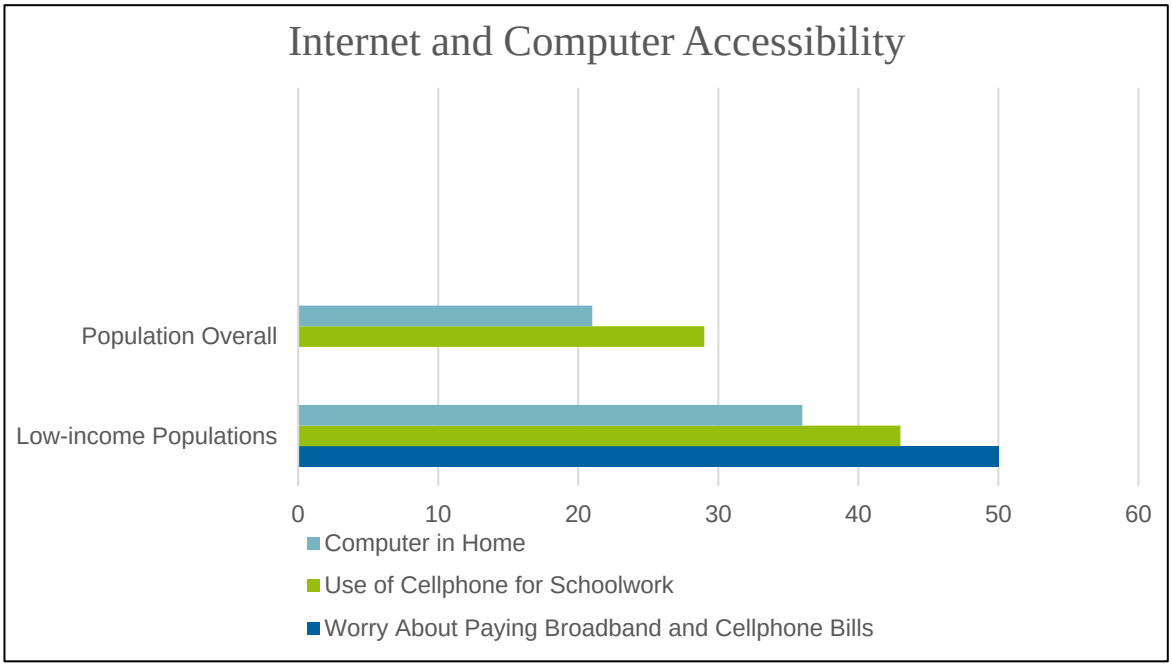

Figure 2. Based on data from Emily A. Vogels et al., "53% of Americans Say the Internet Has Been Essential During the COVID-19 Outbreak." Chart by Dana Kemack Goot.

Conclusion

Provided that its obstacles can be overcome, the utilization of telematic and network music applications as a method of creating understanding among different cultures and people is plausible given that music has the power to transcend cultural and linguistic obstacles and produce

[48] Ibid.

[49] Gustavo S. Mesch and Ilan Talmud, "Ethnic Differences in Internet Access," *Information, Communication & Society* 14, no. 4 (2011): 445-471, https://doi.org/10.1080/1369118X.2011.562218.

equivalent emotions in individuals, irrespective of their background.[50] If hipsters in Montreal and tribespeople in the Congo can share the same psychophysical reaction when listening to the same musical excerpt, then musicians of differing cultural and socio-economic backgrounds are likely to connect when creating or listening to music on a shared networked platform.[51] In an online panel discussion held by Mannes College, composer and technologist Sarah Weaver said that she has been able to expand her artistic work through telematics and that her exploration of community and social work has been a motivating factor.[52] In that same panel, Ross Karre from the Mannes School of Music referred to a communication that said the community that telematics has built deepens the capacity for intercultural collaboration, dialogue, and understanding.

These questions remain: How can effective accomplishment of intercultural collaboration, dialogue, and understanding through online network music applications be achieved? Should the sophisticated and complicated low-latency applications remain accessible in the hands of the few that have the ability and means to install and utilize them? Or can this innovative technology with vast capabilities be designed to serve more varied populations?

Some network applications offer a more concise means of access with relatively low latency. Yet access to the internet and associated costs of equipment and service remain a barrier to many. To accommodate various cultures and socio-economic backgrounds, the procedural requirements of telematic rehearsal and performance applications must be more clearly understood by these populations and more easily accessible and obtainable. Users must not be faced with a system that induces a high level of friction in terms of difficulty in installation and low-rated heuristics. It must offer clear visibility of system status, contain designs that match the user's language and concepts familiar to them, give freedom to leave an unwanted action, maintain consistency with other applications, allow for error prevention, minimize the user's memory load, and, finally, it must be flexible and efficient. Network music applications must also be affordable, accessible by commonly available and inexpensive internet services, and they must run on various operating systems with a minimum of hardware needs. Crossing cultural barriers must not be impeded by a wall of technical aptitude and financial means.

Composer Michael Dessen has recognized that telematics is not about the technology: "It's about the music, which is about the people."[53] He says that the tools we have are new, but telemat-

[50] Hauke Egermann et al., "Music Induces Universal Emotion-related Psychophysical Responses: Comparing Canadian Listeners to Congolese Pygmies," *Frontiers in Psychology* 5, article 1341 (2015), https://doi.org/10.3389/fpsyg.2014.01341.

[51] Hauke Egermann et al., "Music Induces Universal Emotion-related Psychophysical Responses," *Frontiers in Psychology*, 5, https://doi.org/10.3389/fpsyg.2014.01341.

[52] Mannes School of Music, "The History of Telematic Performance in Creative and Experimental Music," Facebook, August 4, 2020, video, 10:18, https://www.facebook.com/MannesCollege/videos/2797068310526884.

[53] Ibid.

ics is not entirely new. These newer tools must continue to evolve in terms of simplicity of installation, a reduction of cost and required hardware, and ease in usability. Without disregarding the need for technology, these tools must reduce the user's cognitive load and be financially and intellectually accessible by those it aims to serve. In doing so, network music applications have the potential to act as a device to bypass cultural and socio-economic barricades and connect humans through music.

It is foreseeable that within a few years, inexpensive high-speed internet access could be available to underserved rural areas and tribal lands within the United States as supported by the United States Department of Agriculture's (USDA) ReConnect Program, which has invested over $1 billion dollars toward this goal since 2018.[54] In 2017, the Federal Communications Commission (FCC) developed a set of "strategies and recommendations for promoting digital inclusion" that recognizes the access to art and entertainment that the internet provides.[55] The FCC espoused amendments to its programs to create more affordable broadband for low-income residents, but it also recognized the non-financial barriers to internet inclusion, such as a lack of digital literacy and perception of relevance.[56] With the development of affordable and accessible internet supported by such government programs, network music developers can lead the way in the development and advancement of web-based applications that follow real-world conventions, offer natural-mapping, and ease of connection. [57] The actualization of these factors would open up pathways for school systems to incorporate music-making among students in neighboring and distant regions, and subsequently other community groups, instituting the creation of a means of cultural connection among them as well.

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[56] FCC, *Strategies and Recommendations for Promoting Digital Inclusion*, 1.

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