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Research article

# CoLabS: A collaborative space for transdisciplinary work in sustainable community development

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ABSTRACT

Currently, the need for transdisciplinary approaches and collaboration, to reduce the gap between science and practice, is continuously rising along with the need for sustainable development. An increase in knowledge transfer, meetings and overall communication among researchers and practitioners is a logical consequence of the previous. However, the resulting higher transaction costs, mainly related to transportation-related greenhouse gas emissions (and additional financial costs) involved in face-to-face meetings, are in direct conflict with the urgent need to reduce our carbon footprint. This research explored the development of an online platform, "CoLabS", specifically designed as a virtual meeting and learning space to support collaboration within and between communities to accelerate sustainable community development efforts. While the move towards online collaboration in virtual environments has steadily increased in the past decade, it has now become essential due to the COVID-19 pandemic. Based on the feedback provided by focus groups, the *collaboratory* platform's design and usability as well as the technical aspects and its functionality are discussed in this paper.

## 1. Introduction

Effective solutions to messy wicked problems, such as climate pollution and biodiversity loss, and the implementation of sustainable community development require collaboration (Gollagher and Hartz-Karp, 2013). These issues are beyond any one sector, any one discipline, or any one level of government to implement without unprecedented levels of collaboration (Dale et al., 2012a,b). Fundamental to identifying innovative solutions is the capacity for interdisciplinary discourse and research. Decreasing transportation costs of face to face (F2F) meetings have allowed for diverse actors in countries as large as Canada and the United States (as across the globe) to connect about critical sustainable issues, thereby contributing to the unprecedented collaboration and dialogue necessary to identify novel solutions to the challenges now facing modern society and their implementation. However, the increased frequency of F2F meetings has also resulted in negative externalities that have ironically contributed to sustainability issues, such as transportation-related greenhouse gas emissions, as well as the increasing transaction costs of airline travel. Moreover, most of the municipalities' staff are currently working remotely and council meetings are held virtually (Syed et al., 2020). This has taken place to comply with travel restrictions and the physical distancing measures outlined by, for example, the Provincial Health Officer (Provincial state of emergency of British Columbia, Canada; www.emergencyinfobc.gov.bc.ca/covid19-provincial-state-of-emergency) due to the current coronavirus pandemic. As a consequence, some municipalities have experimented with - or expanded - the use of online consultation formats, including webinar sessions and websites for receiving feedback, both for COVID-19 related decisions and for ongoing planning matters. In several municipalities, online public consultations during COVID-19 have been received positively which, arguably, may give rise to long-term improvements (Syed et al., 2020). It is imperative, therefore, to explore new innovative methods and platforms that facilitate critical collaboration, while minimizing unintended consequences and impacts.

Modern communications technology has provided a suite of tools to share ideas among large, diverse populations of people (Newell and Dale, 2015). These technologies have opened new opportunities for virtual knowledge sharing and collaboration (Dale et al., 2019), while reducing transactional costs and environmental impact associated with F2F meetings (Dale et al., 2010). As humans delve deeper into the rapidly increasing social connectivity associated with this current era of the information age, communication channels between people of different

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cultures, beliefs, ages, and lifestyles are becoming increasingly more accessible as meeting software improves. A heavy reliance on virtual communications is changing the nature and scope of community because ideas and relationships are no longer geographically dependent, changing in the longer term the way and nature of collaboration and social innovation. Over the last two decades, the third author has explored the potential the Internet has for engaging diverse groups of people and multiple perspectives in substantive dialogue on sustainability and increasing literacy on key sustainable development issues while informing the public policy community. Her on-line research has demonstrated the efficacy of connecting people from a variety of different community types, i.e., urban or rural, and technological capabilities on-line, regardless of scale, ensuring that inclusive perspectives are captured while simultaneously minimizing meeting transaction costs (Dale and Newman 2006).

Many tools for online communication, such as video conferencing, social media, and project management systems now exist; however, these tools have not been specifically developed with the expressed purpose of serving as a platform for collaborating around sustainable community development. Sustainable community development is a challenge without one-size-fits all approaches (Dale et al., 2008), requiring continual improvement (Newman and Jennings, 2008) and novel social innovation (Westley et al., 2011). Similarly, collaborative tools should be flexible and allow for diverse forms of engagement. Perhaps even more important, these tools could be used to accelerate the uptake of social innovations by sharing lessons and providing researchers and civil society leaders the means to learn from one another's mistakes and successes in local community development efforts and campaigns. Often, because civil society leaders experience advocacy fatigue and consultative overload, they reinvent local initiatives with little capacity to learn what worked and did not work from one another; thus, this situation presents a need for a tool/platform that could enhance learning from one another.

This research effort explores the development of an online platform, specifically designed to support collaboration within and between communities to accelerate sustainable community development efforts. This platform was created as a virtual meeting and learning space for researchers and civil society leaders to engage in such collaboration. The intention of creating this tool was not as a substitute for F2F meetings, as the researchers recognized the value of engaging in such a manner (e.g., Dale et al., 2019). Rather, it was designed as complement to F2F that can reduce transactional and environmental costs from frequent meetings, while also continuing momentum, social learning and action between place-based meetings.

The objectives of this research are to experiment with developing a platform that can be used to connect researchers and communities of practice, as well as place-based communities to engage in substantive dialogue around critical social issues such as sustainable community development, climate change, and biodiversity loss. In this way, the research aims to facilitate the creation of a virtual highway for connecting the knowledge and research outcomes of academics, municipal staff, decision-makers and innovators by providing a dynamic, interactive space that allows the research teams and communities to bridge beyond their geographical borders, asymmetries of place, and augment their access to intellectual capital outside their respective communities. The research also aimed evaluate the effectiveness of the infrastructure in enhancing research team connectivity and transdisciplinary collaboration.

The current study examines the development and evaluation of CoLabS, an online platform created for supporting collaboration in sustainable community development (www.changingtheconversation.ca/colabs). For clarification sake, the terms 'sustainable community development' refers to efforts conducted on local-scale issues; whereas, the term 'community' in online collaboration sense refers to government, practitioners, and stakeholders working on and/or affected by these in a particular locality, as well as those involved with similar issues in different localities that would benefit from knowledge sharing. This paper begins with a discussion of the concept that guided the development of CoLabS, that is, the 'collaboratory'. The following sections detail its development and evaluation through focus group testing. The paper concludes with insights and recommendations for developing an online platform for supporting collaboration in sustainable community development.

## 2. Background: what is a collaboratory space?

The concept that guided the development CoLabS is the 'collaboratory', an organizational entity that spans distances, supports rich and recurring human interaction oriented to a common research area, fosters contact between researchers who are known and unknown to each other, and provides access to data sources, artifacts, and tools required to accomplish research tasks (Bos et al., 2007). A collaboratory, as defined by Wulf (1989), is a "center without walls, in which the nation's researchers can perform their research without regard to physical location, interacting with colleagues, accessing instrumentation, sharing data and computational resources, [and] accessing information in digital libraries" (p. 19). Bly (1998) defines it "a system which combines the interests of the scientific community at large with those of the computer science and engineering community to create integrated, tool-oriented computing and communication systems to support scientific collaboration" (p. 31). Rosenberg (1991) considers a collaboratory an experimental and empirical research environment in which scientists work and communicate with each other to design systems, participate in collaborative science, and conduct experiments to evaluate and improve systems.

The portmanteau, CoLabS, was formed by bringing together the words: community, collaboration, and sustainability. CoLabS was developed with the assumption that local civil society leaders require the capacity to share expertise and best practices on sustainable community development, climate innovations and so forth. In addition, it was developed to be a user-friendly tool to encourage access by diverse audiences and facilitate the transdisciplinary learning and research that occurs through bringing together research findings with the knowledge needs of practitioners. In terms of the latter, transdisciplinarity is more than a new discipline or super-discipline; instead it is a different manner of seeing the world, more systemic and more holistic (Max-Neef, 2005). The inclusion of many perspectives can serve to 'uncover' sustainable development paths and promote adoption of further innovations; for example, uncovering co-benefits to climate action can allow communities to implement strategies that address this imperative while also achieving broader sustainability objectives (Newell et al., 2018).

CoLabS differs from other collaboratories in that it uses interactive learning technologies and peer learning exchange approaches (e.g., www.changingtheconversation.ca/policy-documents) to convene municipal decision-makers, community practitioners, and civil society leaders with researchers in a reflexive, dynamic learning environment. The purpose was to create a user-friendly infrastructure and engaging interface that provides space for transdisciplinary interaction and the capacity to share research findings with the knowledge needs of practitioners. If effectively designed, such a platform can result in the acceleration of the uptake of community innovations.

CoLabS optimizes research and collaboration around online knowledge sharing and exchange by bringing together a combination of online tools and integrating their functionality into the infrastructure. As aforementioned, many tools for online communication have been developed, and rather than entirely 'reinventing the wheel', CoLabS aims to harness the potential of current technology by combining online tools and offering them in a single, easy-to-navigate platform. In addition, CoLabS was designed to be flexible and responsive to community needs, meaning it has an open source architecture that can be refined according to user feedback and/or customized to community needs. Through such a design, CoLabS provides opportunities for research on how to most effectively use these tools in tandem for conducting transdisciplinary work, facilitating discussion, sharing ideas and innovations,

disseminating outcomes from discussions and knowledge sharing to the broader publics. Research has shown that the implementation of innovations in communities is still heavily related to place and geography (Dale et al., 2010). This work aims to demonstrate the importance of developing a virtual infrastructure with the potential to span spatial considerations and enhance future innovative capacity by accelerating faster local uptake regardless of place.

## 3. Methods

### 3.1. Online collaborative platforms

Decisions around what to include in the CoLabS platform were based on previous experiences working with online technologies in sustainability research, as well as inspired by other platforms for facilitating web-based collaboration. In terms of the former, CoLabS incorporates a variety of interactive elements into its architecture, drawing from what the researchers have learned in their experiments with online research and online research dissemination (Clifton et al., 2019; Dale and Newman, 2006; Newell and Dale, 2015). A precedent for collaboratory design was developed through the MC$^3$ project (mc-3.ca/collaboratory), consisting of applications for storing, archiving, and sharing data and results from analyses. Because dialogue is an integral feature of transdisciplinary research, collaboration, and emergence of innovation (Dale et al., 2010), the MC$^3$ collaboratory was equipped with an interface that allowed for real-time conversations. Other features include facilitating and managing research projects such as interactive calendars and task organizer widgets. It is worth noting that MC$^3$ was a 7-year project, and the collaboratory had gone through several iterations based on feedback from the research team and collaborators, with two particularly significant restructuring and redesigns (i.e., the platform has three major versions). Therefore, although the focus of this paper is not the MC$^3$ collaboratory, since it served as a precedent for CoLabS, the feedback that informed the iterative development MC$^3$ space also indirectly informed the development of CoLabS.

In addition to the MC$^3$ collaboratory, the researchers have used web forum applications to facilitate online discussions around sustainability issues, particularly the e-Dialogues platform (www.changingtheconversation.ca/eDialogues). The e-Dialogues platform was developed in the early-2000s as an entirely text-based system for facilitating online conversations among those with differing (and unequal) Internet bandwidths (Dale and Newman, 2006), thereby providing capacity to connect people from a variety of urban and rural communities and technological capabilities (Newell and Dale, 2014). As Internet connectivity improved, enabling accessibility for groups and individuals with low-bandwidth Internet became a less relevant (but not completely irrelevant) concern; however, the researchers continued to use the text-based platform, as it proved to be a useful method for facilitating dynamic discussions with multiple simultaneous threads (Newell and Dale, 2014). Similar to the MC$^3$ collaboratory, the e-Dialogue platform has been redeveloped based on user feedback, and a revised version was launched in 2014 which contained new features such as instant chat functions and a more aesthetic and legible design.

As advancements in communication technologies provided more opportunities for video conferencing, the researchers also incorporated these tools into their research activities. Such activities included a series of workshops and peer-to-peer learning exchanges that employed a combination of virtual and place-based interaction by remotely connecting discussion roundtables using BlueJeans software (Dale et al., 2012, 2019). These activities demonstrated the value and utility of having video-conferencing tools; however, it is worth noting that such tools are mostly useful in the context of discrete events. Sustained collaboration in contrast requires a suite of tools that allow for regular resource and idea sharing over longer periods. Accordingly, this work draws from multiple projects and experiences (as listed above) to develop a platform that engages users in different (and complementary) ways.

In addition to the previous tools developed and used by the researchers, CoLabS incorporates a number of features that are present in other platforms for online collaboration. Numerous platforms exist for facilitating web-based project management and collaboration, including Trello, Microsoft Teams, Adobe Connect, Slack, Asana, Zoho Projects, monday.com, Breezio, HyLighter, and Google's G-Suite. Such platforms have a number of useful features for facilitating online collaboration and research; for example, Majchrzak et al. (2018) describe the use of Trello in their case study of an organization that works to develop novel transportation technologies. Although CoLabS does not specifically derive from any of the particular software listed above, it shares similarities in terms of the features and tools present within the platform, such as capacities for video conferencing, instant messaging, forum discussions, posting on ideas boards, sharing and archiving resources, etc.

The researchers in this study initially considered experimenting with an existing platform such as Adobe Connect; however, it quickly became apparent that several issues existed with this approach. Firstly, although number of applications are free to use (e.g., G-Suite), many are proprietary, with license fees for upgraded (e.g., monday.com, Zoho Projects, Trello, Slack, Asana, Microsoft Teams) or all (e.g., Adobe Connect, HyLighter, Breezio) versions of the software. Sustainability is a challenge experienced by communities across the global, and similar to the researchers' thinking on e-Dialogues and bandwidth, it was deemed important that CoLabS should also be accessible in that it is an open-source application with the ability to use and add features without financial barriers. Secondly, Newell et al. (2020a) and Newell and Picketts (2020) posit that tools for sustainable community planning and engagement should be designed in collaboration with community users and based on their needs. This calls for tools with a high degree of flexibility that can be easily changed according to stakeholder/user needs, something that can not be accommodated by platforms which are not open-source in their code, structure, and design. Finally, as a number of different platforms are currently available in the modern Internet age, it is important to recognize that preferences for online tools vary among different user groups and individuals; thus, engaging diverse people is best done using a platform that has the ability to embed/integrate a variety of tools, based on said preferences. It was therefore deemed appropriate to develop a new platform that aligns with these sustainable community development considerations, that is, considerations associated with accessibility, flexibility, and diversity.

Another critical difference between the CoLabS platform and other platforms for online collaboration and project management is that the motivations for developing and promoting the tool differ. CoLabS was developed through a research effort; it was not done as a private company for commercial pursuit. As a result, the goal of this work is not to compete with other software companies on the commercial market per se; rather, the motivation for the research is to experiment and gain insight into a developing platform geared toward collaborating on community sustainability issues, and promoting the platform serves to provide flexible, open-source options to communities seeking such a tool. Although out of the scope of the current paper, it is worth noting that the researchers have already built upon this work by adapting the platform to specific sustainability issues and research projects, such as challenges and solutions in landscape connectivity in Canada (Newell et al., 2020b). As this work is not commercial in nature, the platform was adapted without concern around effective branding or promotion of product, meaning the focus remains on knowledge generation and application of ideas and approaches rather than 'marketing the CoLabS product', so to speak.

### 3.2. CoLabS and face-to-face collaboration

Findings on the comparative performance and the production outcomes of face-to-face (F2F) versus virtual collaboration are mixed. Among the advantages, F2F communication has the highest level of social presence due to the limited nonverbal cues and reduced feedback found in virtual settings (Shah, 2017). Traditionally, F2F has a greater

capacity to carry information, although this does not automatically translate into a more effective use of it. Additionally, a general level of training might be required for some users to be at ease with the virtual interface. According to Lipnack and Stamps (2000), there is also a potential generation gap with some senior managers being more likely to lack the expertise in technological applications related to virtual teaming.

Nonetheless, in addition to the above mentioned reductions in travel time, costs and GHG emissions, virtual collaboration has other advantages. By reducing the level of disruption to every day office life, municipalities can meet virtually with a higher frequency, increasing their efficiency when tackling specific tasks. Regardless of their budget and geographic locations, a larger number of municipalities might be able to virtually collaborate with each other, especially small municipalities that could not afford it otherwise, thus increasing the outcome and benefit potential through a higher diversity of participants and increased collaboration between municipalities (Bergiel et al., 2008). In a virtual platform such as CoLabS, participants are able to use different channels simultaneously, e.g., by typing messages or sharing documents during a video meeting. They can contribute ideas without delay and without disrupting a speaker or needing to take control of the floor (Straus and McGrath, 1994). Furthermore, asynchronous channels provide decision-makers with the option to self-pace and access materials at flexible hours.

Some researchers argue that because F2F contact better enables communication and trust, the need for individuals and organizations to collaborate in the physical presence of one another will persist (Learner and Storper, 2001; Olson and Olson, 2000). Hence, the authors consider that the use of the virtual CoLabS platform should not be exclusive among participants and that F2F meetings should also be considered when appropriate to develop new relationships and reinforce trust among participants, as it is important for successful online interactions (Coppola et al., 2004). Then, the use of CoLabS is intended to reap the benefits of (virtual) collaboration, not only as an alternative whenever F2F interactions present higher transaction costs and/or are beyond question, but reinforcing and complementing each other when possible. As stated by Lipnack and Stamps (2000), the "organizing challenge of our time is to learn to work in virtual teams and networks while retaining the benefits of earlier forms''.

### 3.3. CoLabS approach

CoLabS is a webspace that was developed as an online site using Drupal (v. 7.68), which integrated, embedded, and customized a number of widgets for interaction and resource sharing. The aim was to create a space with integrated tools that serves as a research, learning, and social space. As noted, the $MC^3$ collaboratory provided a useful precendent for CoLabS, particularly in terms of design and structure; however, it was created specifically for use by a limited number of research team members and research partners, due to a need for storing sensitive data (i.e., interview transcripts with interviewee identifiers). CoLabS infrastructure comprises a much larger, more sophisticated platform that connects a much broader range of actors, enables transdisciplinary research sharing, involves local community civil society campaigns, and provides options for public dissemination of data and research outcomes.

CoLabS was designed to be both useful and attractive to researchers, practitioners, civil society leaders, and community members, containing features to facilitate exchange of ideas about local community issues initially in a private space, which could be made public at their discretion. In this way, CoLabS was built with a balance of 'fashion' and 'function', the former capturing the importance of aesthetics in the development of an engaging web tool (Lavie and Tractinsky, 2004). The research team aimed to give CoLabS an aesthetic that was inviting and retained attention to foster a virtual 'sense of place' (Harrison and Dourish, 1996), given the diversity of users it was hoping to attract. Importantly, adults learn firstly from their peers; thus, increasing engagement in professional conversations that bridge 'silos' is considered effective to speeding local innovations (Jost et al., 2019; Cowell and Martin, 2003), which has yet to be evaluated.

### 3.4. CoLabS evaluation

A virtual space must first be user-friendly, suited to user needs, functional, and attractive. These features were evaluated through user testing and feedback. Doing such testing first required thinking about who would be potential users of a tool for transdisciplinary research and collaboration around sustainable community development, as well as who would be able to effectively assess the needs for such a tool. To this end, participants who were affiliated with a research institution were recruited, but were also diverse and associated with a variety of professions and/or community projects.

User testing was done in two stages, firstly involving online participants and then placed-based focus groups. In both cases, an ethical review was requested and later approved by the Royal Roads University Research Ethics Board. The first stage was comprised of 12 students from a certificate course in sustainable community development delivered through Royal Roads University in Victoria (British Columbia), who as a part of their coursework prepared proposals to municipal decision-makers on local community issues in the Greater Victoria area. The tool was integrated into their work, and was used to facilitate student teamwork as the groups developed their proposals (due to research ethics considerations, the instructor for the course was not part of the research team). Following the course deliveries, the researchers asked students to provide feedback on what features were useful for their work and what features were missing and/or could be improved. Feedback data were qualitatively analysed by the researchers to identify recommendations and critical areas for improving the platform. Refinements were subsequently made based on these ideas and recommendations.

Following the student tests, the place-based focus groups were held at Royal Roads University. As aforementioned, the research sought feedback from diverse users, and thus recruited participants included community researchers, IT specialists, and administrators, among others. In total, 9 people participated in the focus groups. Albeit a small sample, this methodology follows research that employs small-sized groups primarily for qualitative data and analysis (Munday, 2006), and it aligns with other research involving small focus groups of people with knowledge, skills, or positions relevant to the topic under study (Onwuegbuzie et al., 2009). In addition, it is worth noting that larger focus groups or surveys could be regarded as inappropriate for this study, as the research explores a platform designed to be a tool that can be developed and customized based on different user needs. Therefore, a larger sample size would pursue recommendations and refinements based on the assumption that homogeneity and broad commonalities in needs exist for a collaborative platform; whereas, the research aims to explore a tool that can be evolved and adapted to specific contexts and projects. Therefore, in many ways, the process employed which refined the platform using smaller focus groups more accurately emulates its potential real-world applications, and thusly better examines how it can be evolved in response to user needs of a transdisciplinary team collaborating on a sustainable development issue.

Focus group participants were given a 15-minute presentation on the purpose and functionality of the platform. Then, a case study focused on developing sustainable transportation networks was presented, and participants were asked to test the tools by engaging in discussion and sharing materials/ideas on the topic. User testing lasted for approximately 45 min, during which participants were invited to provide comments and feedback as they tried out different features of the platform. Following user testing, a 15-minute plenary discussion was held to gain additional feedback. As done after the online participant phase, feedback data were qualitatively analysis to identify areas where the platform could be improved, and the platform was refined accordingly. Feedback from the first focus group was used to refine the platform for the second focus group, and then it was further refined after the second session.

This is a research project that focuses on an online collaboration platform which can be evolved based on user interests and needs, and accordingly, the methods employ an iterative process for developing the platform. However, this paper reports on early stages of research on the platform; thus, instead of applying it to a specific case study or problem, the research explores its capacity for flexible development and responsiveness to user needs. As such, it engages focus groups consisting of different participants to see how it can be evolved based on feedback, rather than developing it iteratively with the same group of people who are applying it to a specific sustainability issue. Future work explores the latter and applies CoLabS to the specific issue of landscape connectivity in Canada (Newell et al., 2020b), but this work was considered out of the scope of the current study.

## 4. Results

The following sections describe the platform produced through the research and the outcomes of the user testing. Section 4.1 describes the CoLabS platform, and its structure and features. Section 4.2 gives impressions of the CoLabS platform from the user testing, and discusses refinements made to the platform based on the feedback. Since CoLabS was developed iteratively through user feedback, descriptions of the platform and user comments are not entirely separated by the two subsections, and in some places (where appropriate), they appear next to each other within the same paragraphs.

### 4.1. The CoLabS platform

The CoLabS interface is an online site with a series of tools for collaboration, and these can be reached by clicking the 'meeting rooms' link in the main navigation menu. The menu also contains an 'about' page with an overview of the purpose of this collaboratory space and a short description of how to use this space, as well as an 'open resources' link that allows website visitors to see research shared by users (see below). Any visitor can access the 'about' page; however, accessing the collaboration tools requires a one-time registration by providing a user name and a valid e-mail address.

There are five collaboration tools that can be accessed through the meeting rooms link, as well as a real-time messaging tool that can be used throughout the CoLabS site. One of the tools is a video conferencing tool that allows groups of up to 12 users to meet. The application used for this tool is appear.in (now known as Whereby), and this was selected as it allows for direct user access, meaning it has no downloading or login requirements. The tool can be embedded directly into a webpage, offering a seamless experience, but a link directing users to a widget on the appear.in site was also provided to allow users the option to open the video conference in a different window. The tool has a free version; however, it is also the only tool in the CoLabS platform which has a paid/professional plan. The decision to upgrade the software version from the free plan was made in this research to increase video conferencing capacity from four to 12 users. The previous limited capacity was identified as a drawback by focus groups. Moreover, the professional plan also provides users with an optional recording feature, and this was also identified as an essential feature by the student participants.

Two of the other tools in CoLabS are the 'working table' and 'design studio'. These are embedded online boards designed for intuitive and quick collaborations. The free version of Padlet was the application used for these tools, and the software allows elements such as text and link to be added to a board, as well as the uploading of documents, images, video, and audio. In the working table the content is laid out in a brick-like display, where elements can be moved around the canvas, and other users can provide comments and/or reactions (e.g., 'likes') to these materials. In the design studio, elements can be connected together to visualize their relationships, allowing for work that focuses more on the project design and research connections. Both tools can be accessed without the need of a login; however, authentication with a Padlet user account was proven useful by focus group participants because it allowed for more features, such as the option to copy and transfer posts from one Padlet board to another.

Other tools in the CoLabS suite are the 'discussion forum' and 'working library'. The discussion forum allows users to post discussion topics or respond to topics or questions, enabling asynchronous dialogues where members can review and participate in discussions with other users at times convenient to them. The *working library* is a private library or community folder where users can upload, download, and share files. Options exist to give these files tags and descriptions, as well as organizing them in different parent folders. Users are able to edit folders and reorganize files according to their needs. Access to these resources is password-free for all authenticated community members.

A messaging feature, the open source AJAX DrupalChat module, was integrated into the CoLabS platform and is available on all pages. The purpose of this module is to allow users to have one-on-one or group chats in real time, thereby increasing user interaction and overall engagement in collaborating on their initiatives. It also supports chats for anonymous users. Additionally, this module logs the user conversations so that they can be later viewed. The DrupalChat module was selected because it is a Drupal-based application, that is, it integrates into CoLabS without requiring installation of any additional software or embedding from another site. The tool then exists on the same server where the CoLabS site is hosted, and thus the information remains in the same server, keeping the data private unless a user-group chooses to make their information public following the end of a project or community initiative.

CoLabS also includes 'open resources', which consists of materials and resources that are open to the general public and can be accessed directly without the need to be an authenticated user. CoLabS users can use this space to showcase different initiatives and work that takes place in the involved communities. The section also holds two other libraries: one of articles and resources, and another of videos related to community collaboration and sustainable development.

### 4.2. User feedback and platform refinements

Focus group comments identified considerations around the need for a more detailed description of the purpose and applicability of the CoLabS platform to transdisciplinary interaction and community innovation when it is presented to the communities/final users. A short introductory video was subsequently produced and added to the 'home' and 'about' pages to be used as a tutorial with general instructions explaining how to navigate the platform and how to use the different modules and features available.

An initial need for closer guidance, addressing doubts, inquiries and concerns that the intended community developers might have at the beginning was also identified. Additionally, during the focus groups, glitches such as security settings preventing the use of certain tools (i.e., Padlet widgets and the chat box of the video conferencing tool) were identified, illustrating the importance of beta testing. These technical issues, which are dependent on the institution or work place, exposed the need to familiarize the municipalities and/or final users with trouble-shooting solutions when opening up the platform to its intended user communities.

Several participants positively commented on the incorporation of the Padlet application given their familiarity and comfort using it. Their comments support the approach taken in developing CoLabS to integrate existing tools rather than reinventing the wheel. Others suggested using other applications with less customizable but better structured interfaces (such as network mapping tools) for formalizing projects in the design studio. These findings confirm not only the value of user testing but mainly the importance of keeping a flexible approach when developing these platforms, so that communities have the potential to customize some features according to their preferences. In response to the feedback,

instructions in both pages as well as in the tutorial video were added to clarify the tools' specific functions.

Users found the discussion forum tool to be a useful feature; however, issues were noted with the design. The initial color palette prevented users from noticing some functions available in the module, and this issue created difficulties for users in terms of editing or adding further discussion forums. Both issues were addressed in the final version of the platform. Other comments concerned the lack of an option to upload documents in forum responses. While changes in this regard were not implemented in the discussion forum, participants were informed that, in addition to the upload options available in both Padlet-based tools, the working library module was created for that specific purpose.

User feedback on the working library tool indicated that there were difficulties in searching and downloading documents. To address these issues, detailed instructions were provided in the tutorial video. In addition, the process of adding hyperlinks is not straightforward, as they cannot be directly added to the library and need to be uploaded in a document. Participants considered this to be a limitation, indicating it could disrupt workflow. Participants also commented on potential options for incorporating and syncing external cloud storage and file-sharing services (e.g., Dropbox, iCloud, OneDrive, Google Drive). They noted this could be useful; however, this type of integration of account-based tools was deliberately avoided for CoLabS so that users could access all the database from only one storage location and spare them the need of creating additional accounts or downloading external software. Aside from these issues, focus group participants mentioned they were very pleased with the tool, clearly stating its usefulness and easy to learn graphical user interface which utilizes self-explanatory tabs for major functions.

Although the DrupalChat tool is available as a small, expandable bar at the bottom right of the screen, it was initially deemed by participants as inconspicuous due to its size. It was consequently enlarged to be more apparent and operative on every page of the platform (Figure 1). With respect to the open resources function, participants noted the utility of sharing resources and knowledge with other communities, organizations, and projects, highlighting the importance of such a feature.

Participants also commented on minor nuisances such as the need to excessively scroll in both the working table and design studio meeting rooms, due to the instructions written over top of the tool. In response to this feedback, the embedded tool frames were enlarged and the instructions reduced, and hyperlinks were added to provide users with detailed information in a pop-up box upon clicking on them (Figure 2). For the most part, impressions of these tools were positive, with participants commenting on their usefulness; however, a few participants refrained from commenting, noting that they needed more experience with these tools before being able to adequately assess them.

No features were described as not useful or without value by the participants; however, some tools were considered more valuable than others, in particular, the video meetings, design studio and discussion forum. Overall participants were pleased with the clean, uncluttered design of the CoLabS site (including the refinements with reduced wording and tutorial video), simplicity of use and straightforwardness. This being said, the platform was not universally favoured as one participant commented on not finding the platform particularly useful considering that other platforms they used were as good or better. It is important, however, to stress the distinct intention of the CoLabS platform as it categorically differs from learning management systems (LMS) designed for the exclusive delivery of online educational courses and training programs that tend to come with additional proprietary expenses and with less attention to aesthetics and design. CoLabS was designed to convene very diverse groups of people together rather than more homogenous learners with a common purpose.

Suggestions for implementing additional features, software and for expanding its functionality were provided by the focus groups, for example, the addition of a synchronizing calendar, an address book for the provision and display of contact information of users, on a voluntary basis, or Asana work management applications and data visualization tools. Regarding the expansion of its functionality, focus group participants also suggested including an option for synchronized working in text document and tables (e.g. for planning and budget) as featured in Google applications, as well as the inclusion of a searching and reorganizing option for the open resources library. A number of applications or computer software could be catalogued in a CoLabS tools library, and the current functionality of the platform could be expanded with additional features users choose to install or embed. However, such integration might also greatly add complexity to the platform and dependence on third-party products (and their potential failures), as well as increase the expertise requirements of future community groups' administrators, among others. This is critical, as the ease of use, robustness, simplicity and open access characteristics of this platform were regarded favourably by participants, who also positively noted the use that CoLabS can have beyond community development, including for educational and teaching purposes. Ultimately, the CoLabS platform was developed as a flexible and customizable platform, so users can assess the benefits and trade-offs of adding more tools themselves since the integration of additional

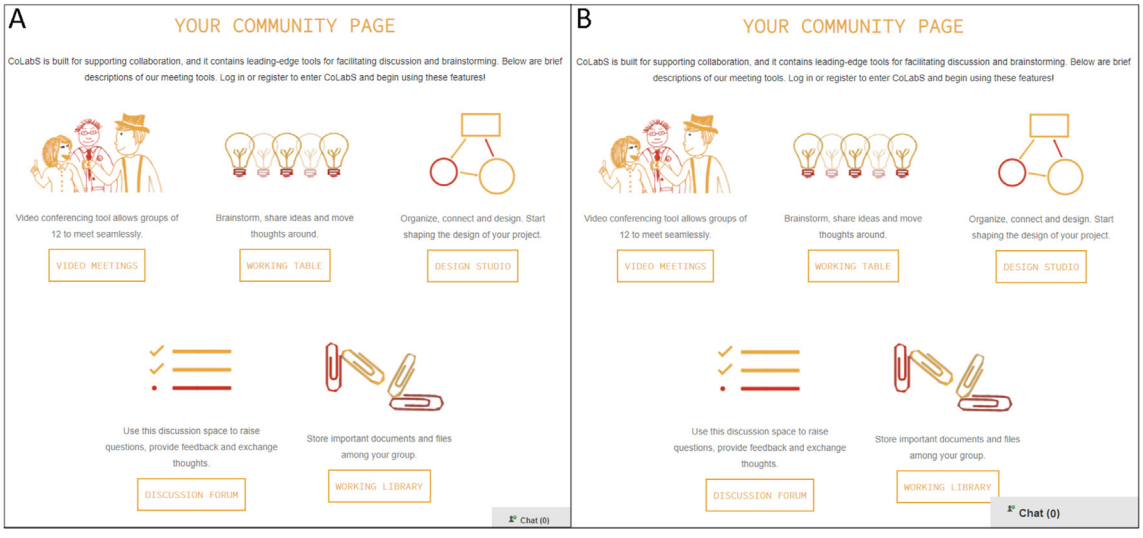


**Figure 1.** Refinements to CoLabS instant messaging tool. The figure features (A) the initial version of CoLabS with smaller instant chat bar, and (B) the refined CoLabS platform with a larger instant chat bar.


**Figure 2.** Refinements to CoLabS instruction text. The figure features (A) the initial version of CoLabS design studio page without instruction text hidden, and (B) the refined CoLabS platform where design studio instructions are accessed through pop-up window that is opened by clicking a button on the page.

features and programs into the platform was purposefully left to the discretion of the user communities.

The research employed focus group methodology with relatively small group sizes, and although participants were diverse in terms of the professions, knowledge, and interests, they all worked orstudied within a university setting. This perhaps could have affected the variety (or lack thereof) of tools and features recommended for the CoLabS platform, as a number of suggestions focused on administrative or project management tools, and other groups and stakeholders that work in different professions and environments may express needs for different types of tools. For example, the subsequent study that applied CoLabS to a research effort on landscape connectivity issues included a map interface in the project site (Newell et al., 2020), and this type of interface could be a particular useful tool when collaborating with professions and working on issues associated with environmental planning. Ultimately, sustainable community development and stakeholders span broad ranges; thus, collaboratory tools for addressing these issues are likely to be equally as varied. Therefore, when developing a CoLabS tools library, it would be useful to continually collect suggestions for other useful tools, and also catalogue these based on applications of the platform to different case studies and types of sustainability problems.

In plenary discussion, focus group participants commented on the platform's usefulness, clear image, seamless built-in and straightforward design, easy set-up without need of fussing with various settings, and the options provided by the software. Negative impressions were associated with both the limited number of participants in the video meetings and the recording feature that was not available in the previous free plan, both of which were later resolved with the subscription to the professional plan. The presence of a library of open resources was also regarded as valuable as many organizations struggle to find resources on where to start. In addition, while some tools might require a certain familiarity to learn how to use all their features, the straightforward and user-friendly approach used in the elaboration of the CoLabS platform in addition to the video tutorial and instructions added later reduced the learning curve. For the most part, impressions regarding the CoLabS platform were highly favourable. Participants described the platform as being "robust, aesthetically pleasing, easy to navigate, and useful"; as "easy to use, very intuitive"; and as having "the features I would be looking for in

a collaborative platform". This being said (and as noted above), some participants had a more critical view of CoLabS, and comments negatively described the platform as "not useful, easy to use" and "useful but difficult to use with community members as they have to sign up for account".

## 5. Discussion and conclusions

There are more and more calls for community engagement to close some of the large implementation gaps in realizing sustainable community development (Jentoft and Chuenpagee, 2009; Ling et al., 2009; Raymond et al., 2017; Robinson, 2004; Sheppard et al., 2011). Third generation responses to sustainability acknowledge that there has been a failure of the discourse to systematically address structural impediments and organizational rigidities and that meaningful, diverse stakeholder inclusion and widespread community engagement is key to delivering an integrated sustainability effort (Dale et al., 2012a,b). Most critically, a study by Bradford (2003) identified the need to create learning communities to overcome inadequate local problem-solving capacities and collaborative planning processes among diverse actors that enhance local innovations.

Moreover, the recent alarming reports from IPCC (2018) that humans have essentially a decade left to avoid catastrophic change and from IPBES (2019) on the scale of biodiversity loss, means that collaborating between multiple sectors, levels of government, and civil society leaders has never been more urgent. Yet, communities and societies can no longer afford to collaborate purely through conventional F2F meetings due to associated transactions costs and environmental impacts. The increasing movement towards reducing air travel due to the GHG emissions (even when mitigated by carbon offsets) demonstrates a need for new tools and ways for continuing to convene large interdisciplinary research teams and community groups. In addition, many community groups have consultation fatigue as the costs of meeting consultations, and often not being heard, reduces their desire to continue to participate.

An assumption underlying this research was that combining learning technologies with the capacity to participate in real-time, on-line dialogue connected to leading-edge research outcomes would enhance the ability for the critical kinds of collaboration that are necessary for responses to urgent sustainability imperatives. The task of designing virtual collaboratory spaces is not easy, particularly given the multiplicity and diversity of existing platforms, and people's previous experiences and current preferences for communication and content management software. Ultimately, the feedback received in this research reflects the challenges of attracting users to a new file storage system, while being unable to satisfy all potential user needs for integrating their pre-existing accounts and preferred individual software.

In many ways, the user feedback on CoLabS could apply to a variety of tools used for online interaction in a number of contexts, such as project management for businesses and sites for communities that form around a hobby or interest (e.g., games, sports, etc.). For example, design issues related to visibility (or lack thereof) of the chat tool and the colour palette of the discussion forums would affect the performance of any site. However, user comments also elucidated specific challenges experienced for collaborative platforms used for sustainable community development, even when the connection between the issue and sustainability was not immediately obvious. For example, technical issues related to work place security settings preventing functionality of CoLabS tools could be regard as an issue for any type of online communication platform; however, this is a particularly significant issue for sustainable development as it requires broad collaboration that includes groups that typically take such security measures, such as universities (i.e., the focus group location in this study) and government agencies. As another example, research participants noted that it would be useful to integrate CoLabS with their preferred cloud storage services, which is useful for applications in many areas and is particularly relevant to sustainable community development efforts that require inclusivity of diverse users/people and integration of diverse knowledge. As a final example, one of the critiques of CoLabS was that it would be difficult to use with community members due to the sign-up requirement. Such a comment illuminates a tension in sustainability development efforts between the need for open, inclusive processes and concerns for privacy around data, nascent thinking, and brainstorming sessions. Ultimately, although user comments could apply to tools and fields outside of sustainable community development, examining the feedback through this lens allowed for better understanding of the needs of a tool designed for collaborating around efforts to addressing sustainable community development.

A number of project management and online collaboration applications have been used in other research efforts related to sustainable development, such as the use of Trello in a study on transportation innovation (Majchrzak et al., 2018), Adobe Connect in work on climate change and agricultural systems (Eigenbrode et al., 2014), and Microsoft Teams as a knowledge building platform for sustainable assessment projects (Buchal and Songsore, 2019). The aim of this research effort is not to challenge the merit of using these platforms for sustainability work; rather, it explores a collaboratory approach that aligns with sustainable principles both in its development and use. Participatory processes are essentially elements of sustainable community development (Ling et al., 2009), and accordingly, the tools and techniques used to support efforts toward sustainability should also be participatory in their design and application (Newell et al., 2020a). Unlike other applications, CoLabS aligns with this thinking in how it is specifically designed as a flexible platform with capacity for further development and integration of a number of tools in response to stakeholder needs, place-based contexts, and/or the sustainability issues at hand. In this way, CoLabS could be viewed more as an approach rather than a product, which can be adapted accordingly.

There are, however, some challenges to be addressed. The fact that design, functionality, and technical issues arose before, during, and after the focus groups demonstrated the strategic importance of having a website manager for collaboratory spaces. As well, although resolved by further refinements, concerns still remain with using a subscription-based tool, as it involves uncertainty in terms of who will continue to support the tool and potentially reduces transferability in terms of interested groups creating a similar site. While this task may be conferred and later performed by a CoLabS 'community administrator', it is important to emphasize that such spaces cannot be fully automated nor become ubiquitous without some supervision and management (i.e., communities will ultimately need to designate an administrator). A community administrator role is also important for other functions, such as providing oversight to the platform, keeping the software and user accounts updated, and addressing questions and issues that are not covered in the tutorial video. Local group administrators will lastly have the resources to add specific content, accept and manage (new) users' permissions and customize the platform's further utilities and functions.

Additionally, to promote collaboration in a virtual environment, the development of social presence is key, as participants should be able to relate to one another, share a sense of community and a common goal (Gunawardena, 1995). This social presence can be cultured by a virtual moderator/community administrator and leader by training participants to enhance their skills (i.e., through group facilitation, soliciting input, meeting management, process documentation, among others; Pasquina, 2018). Thus, leadership in the CoLabS community administrator role is deemed critical to promote virtual interaction and collaboration and to overcome conflicting interests and perceptions among participants. In order to be effective and accelerate the uptake of community innovations, virtual team leaders need to take advantage of any technology means available to make sure the virtual team can interact (Malhotra and Majchrzak, 2004).

In this sense, ColabS presents a clear advantage over other similar platforms by being more dynamic with modules and tools adaptable to suit each communities' specific needs. CoLabS can be further personalized as an interactive and collaborative platform by embedding social

network platforms to engage with citizens (Johnston and Stewart-Weeks 2007). Creating two-way channels will not only serve to inform community practitioners, but also, by allowing them to participate in the process, it will make them contributors, assisting municipality decision-makers in development of more sustainable communities. In recent research, Recalde et al. (2020) identified the need to strengthen citizen participation in urban planning processes. They concluded that "involving people in the co-creation of their cities (by collaborative computer-mediated means) may improve their living conditions" and eventually overcome the challenge of urban resilience.

The positive feedback received about the CoLabS design and usefulness indicates that the research was successful in form but still needs further refinement in platform functionality. The proof will be in the pudding when community groups begin to use the platform for their activities and projects whether or not virtual collaborative spaces can contribute to enhanced community learning. Challenges exist around applying this research to practice because as noted above, many online project management and collaboration applications already exist, thus creating problems around its widespread adoption. However, it is important to regard this work as a research effort rather than commercial pursuit, meaning the focus is on developing knowledge of how collaboration platforms could be made as flexible tools that can be evolved depending on contextual factors and stakeholder needs. As noted above, CoLabS could be viewed more as an approach rather than a product, and it can be adapted to different project and issues, as was done in a subsequent research effort (Newell et al., 2020b).

Just as meeting software is now virtually seamless, it is anticipated that CoLabS with need to go through several iterations before we can begin to see the same efficacy of this virtual space complementing place meetings. Alternatively, CoLabS could be regarded as a constantly developing tool that will continue to evolve as more communities use it and provide input and or customize the platform. Such a perspective aligns with principles of sustainable community development, particularly that it is a process with no 'end state' and requires striving toward continuous improvement (Newman and Jennings, 2008).

## Declarations

### *Author contribution statement*

F. Jost, R. Newell, A. Dale: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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### *Data availability statement*

Data will be made available on request.

### *Declaration of interests statement*

The authors declare no conflict of interest.

### *Additional information*

No additional information is available for this paper.

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