

Empowering Educators: HubICL's Contribution to Intercultural Competence Development

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Abstract—Developing an interculturally competent STEM workforce has become increasingly crucial in today's globalized environment. Intercultural competence is an important skill as it enables individuals to interact and behave effectively across different cultures. Higher Education Institutions (HEIs) are thus encouraging educators to integrate intercultural competence into their curricula. However, research has revealed that STEM educators and program leaders often feel ill-prepared to weave intercultural learning outcomes into their curriculum. Although training and workshops work to bridge this knowledge gap, they demand significant resources, financial cost, expertise, and time commitment. In light of these challenges, our study investigates the role of an open-access intercultural learning science gateway, The Intercultural Learning Hub (HubICL), designed to equip STEM educators and program leaders with the necessary resources and activities to foster intercultural competence in learners. It is important to note that intercultural competence is a rapidly growing field; the HubICL serves and supports 1000 unique users monthly ranging from various disciplines across the globe. Therefore, to understand the impact of the HubICL, we conducted in-depth interviews with prominent HubICL users. The interview data was qualitatively analyzed using narrative inquiry. In the interviews, participants reflected on various aspects of the HubICL such as: i) an educational platform for imparting intercultural competence. ii) a developmental tool for enhancing the intercultural competence of instructors and program leaders. iii) a source of experiential learning opportunities within classrooms to refine pedagogical approaches. iv) a repository of activities for instructors to actively engage students, allowing them to explore and develop intercultural competencies firsthand. Participants also provided feedback to improve the usability and maximize the potential of the platform. The findings of the study demonstrate that the HubICL is a great asset for STEM educators and program leaders seeking to integrate intercultural competence into their curricula or programs. The HubICL serves as a bridge between educators and students by providing educators with the resources and knowledge to integrate intercultural competence into their learning outcomes. Implications of these findings extend beyond resource provision; they emphasize the necessity of integrating accessible, comprehensive resources like the HubICL in educational settings to promote intercultural competence. As STEM educators continue to seek efficient means to develop and impart intercultural competence to align with HEI goals for learning outcomes, platforms like the HubICL offer promising solutions to overcome existing barriers to seamlessly integrate intercultural learning into STEM curricula and programs. This study suggests a shift towards leveraging digital platforms for educator development and calls for continued investment in such technologies to enhance the intercultural competence of future STEM students.

Index Terms—HubICL, STEM, intercultural competence, digital platform

I. BACKGROUND

Intercultural competence is highly valued by employers, especially with the globalized nature of today's workforce. Fresh STEM graduates are increasingly expected to effectively communicate and collaborate within multicultural teams [1]. However, integrating soft skills such as intercultural competence into the STEM curriculum presents challenges, including rigid program structures that leave little room for skill development outside the standard curriculum, a lack of tailored approaches to meet diverse student needs, and instructors' uncertainties about how to embed these learning opportunities [2]. Recent research has identified effective strategies for incorporating intercultural competence into STEM education. For instance, Jaiswal et al. [3] demonstrated how online self-paced modules on teamwork and communication can enhance students' understanding of cross-cultural interactions. These modules proved effective in helping students recognize and adapt to different communication styles, thereby fostering more effective teamwork across cultures. In this context, educational technology emerges as a powerful tool to further these efforts. Luppigini [4] describes educational technology as a "goal oriented problem-solving systems approach utilizing tools, techniques, theories, and methods from multiple knowledge domains, to: (1) design, develop, and evaluate, human and mechanical resources efficiently and effectively in order to facilitate and leverage all aspects of learning, and (2) guide change agency and transformation of educational systems and practices in order to contribute to influencing change in society" (p.107).

A. Science gateways

Science gateways exemplify this approach by providing tailored technological solutions that adapt educational content to the personal contexts, interests, and learning levels of individual learners. Such technologies not only support the personalization of education but are also shown to be more effective than traditional methods that focus solely on aligning with learners' interests, being driven by assessments, or incorporating feedback mechanisms [5]. Therefore, science

gateways can play a crucial role in enhancing student learning and developing intercultural competence within STEM disciplines. Science gateways foster open science by facilitating connections among individuals across institutions and organizations within specific disciplines, and empowering users to tackle problems in a holistic and collaborative manner. In this context, open science refers to a collective way of researching and accessing research and other resources via digital technology. When utilized to their full potential, science gateways are powerful vehicles for reproducing research and bringing together communities to share resources and bridge solutions to real-life issues. An important factor determining the effectiveness of science gateways is that they are only effective to the extent that users maintain them by contributing resources and research and connecting with one another. In other words, they are sustained by the communities that both contribute to and benefit from them. A key value and mission of science gateways is to provide user-friendly sites in which a user can efficaciously find information in a timely manner, with ease, and in a way that aligns with their personal preferences [6]. A defining feature of science gateways is their ability to be adjusted to meet the needs of the community. The collaborative nature of science gateways can give way to communities of practice, a term describing individuals with a common goal and/or knowledge, coming together to form communities where resources are shared, and everyone can learn from one another. Science gateways offer communities an online platform within which to connect virtually, equipped with tools to support the communities' goals. A defining feature of science gateways is their ability to be adjusted to meet the needs of the community. Science gateways are also meant to be secure space where users can expect both shared ownership and that their contributions will be accurately credited. A key value of science gateways is the space and tools they provide for communities to connect, crowdsource, communicate, and collaborate, as well as their appeal to a wide array of individuals including higher education students and professionals, independent and governmental researchers, and more [7]. Intercultural learning is a field that is rapidly growing and the need for diverse perspectives is inherent to the work. Science gateways provide a way for individuals across the world to connect, encouraging inclusion, diversity of perspectives within the field, and multidisciplinary. Science gateways also promote sustainability and scalability by removing the need for each individual institution to build and maintain their own hub of resources, a costly venture in terms of both time and resources, and one that can easily lead to missing or dated information. Due to their inherent adaptability, science gateways are also platforms within which communities can be responsive to the ever-changing nature of virtual environments and equip current and future leaders in the field with a specific and necessary set of skills to succeed and propel the community of practice forward in their respective field [7]. Given the impactful benefits and promising potentials of science gateways and the novel nature of the HubICL as the first and only intercultural learning science

gateway ever created, we wanted to explore the current impact of the HubICL on prominent users to describe the platform and perceptions as related to impact on STEM students, bring visibility to the resource as a whole, and provide suggestions for improved user experience. Our research question was as follows:

RQ: What are the perceptions of the HubICL among educators in teaching intercultural competence to STEM students?

II. INTERCULTURAL LEARNING HUB (HUBICL)

The goal of HEIs is to prepare students for their future career, therefore helping them to develop intercultural competence is one of the key objectives. As globalization efforts increase, intercultural learning has become an important skill that students need to acquire to behave appropriately and effectively with people from diverse backgrounds. Historically, practitioners in intercultural learning relied on a disparate array of resources, including journal articles, books, consultancy websites, conference workshops, and internet searches of mixed quality to source material for their educational and training initiatives. To centralize and enhance the accessibility of these resources, Purdue University's Center for Intercultural Learning, Mentorship, Assessment and Research (CILMAR) envisioned a solution that would consolidate these varied materials into a cohesive, easily accessible repository. Partnering with HUBzero®, a platform primarily for STEM-focused science gateways through the Science Gateway Community Institute (SGCI), CILMAR ventured into new territory by developing a sociological science gateway. This collaboration led to the creation of the HubICL, the first and only science gateway serving as a central hub for cross-disciplinary intercultural learning activities, assessments, research, and other resources. Launched after initial planning in March 2018, the HubICL adapted several features from the HUBzero® template, such as *Publications*, *Courses*, *Collections*, *Groups*, *Forums*, and *Projects*. Additionally, unique developments were made to craft the HubICL's distinctive *Digital Toolbox*.

The HubICL *Toolbox* is curated by CILMAR staff with expertise in intercultural learning, who create new, adapt, and add existing intercultural activities and assessments, prioritizing resources that are not only free but also of high quality, featuring well articulated learning objectives, comprehensive lesson plans, and supplementary materials like slide decks and recordings. The HubICL, like other science gateways, is built in such a way that users can add their own created, adapted, or already existing intercultural learning activities, assessments, research, and other resources to build upon this open access, community-driven, centralized site. This renders the HubICL a dynamic repository, with new resources added and updated regularly. While any user can add a resource, CILMAR staff curate each addition thoroughly to ensure alignment with intercultural learning goals. While there are many online sites that include intercultural learning activities and resources, the HubICL is the only collaborative and community-oriented space which pulls resources from a vast array of media and text in order to centralize all things intercultural learning, not

only relying on users to contribute, but also providing expertise in the form of a staff specialists dedicated to managing and maintaining the gateway.

A notable and unique resource available in the HubICL is a *Collection* of 127 *Tools* created and adapted by the CILMAR Curation Team of Intercultural Learning Specialists.

Another unique feature of the HubICL is that it is built on a library model which indirectly reflects the history of the field of intercultural learning. In light of this, it is important to keep in mind that the resources included are meant to serve a diverse range of educators, practitioners, and leaders in a variety of fields and disciplines with a wide range of priorities and needs. Therefore, the search filter feature, detailed later in this paragraph, is essential to filter through the vast repository of *Tools* and find relevant and applicable resources based on time limitations, audience, and more. The *Toolbox* contains over 800 *Tools*, which are searchable by *Tool* type—including activities, assessments, reflection and debriefing *Tools*, curricula, and media resources. It also allows for filtering based on logistics like group size, activity modality (e.g., kinesthetic or not), duration, cost where applicable, the intercultural development stage of the audience, purpose of the learning activity (focusing on attitudes, skills, or knowledge), and any additional skills the activity works to build (such as building friendships, teamwork, mentorship, leadership, or emotional resilience). Another feature of the HubICL that addresses the need for technology-supported personalized learning experiences is a space to leave a review on a *Tool*, which allows practitioners to share and communicate about best practices and experiences facilitating intercultural learning activities. These customizability features are an asset that can address the need for learner-centered teaching methods, with curriculum adapted to student learning level and needs, an essential feature, described previously in this paper, of impactful student learning. In its continued evolution, the HubICL saw significant enhancements in 2021-2022 with the addition of the *Professional Development Zone (PDZ)*. This new feature aggregates ICL offerings from field professionals in one location, searchable by theme, instructional level, learning environment type, and cost where applicable, and offers recommendations for further exploration either broader in scope or deeper in content. The *PDZ* notably includes self-learning modules developed by CILMAR staff, utilizing the HubICL *Courses* feature. Moreover, the entire Intercultural Learning Hub supports keyword searches, making it a comprehensive, user-friendly portal designed to support and enhance intercultural competence globally. Lastly, signing up for a HubICL account is free, yet all HubICL *Tools*, *Collections*, and *Research Publications* are accessible for free even without a HubICL account. The *PDZ* is freely accessible for HubICL users with an account.

III. METHODS

A. Context and Participants

This study was conducted to understand the perception of educators and program leaders toward an intercultural learning



Fig. 1. User Interface Intercultural Learning Hub (HubICL)

TABLE I
SAMPLE INTERVIEW QUESTIONS

	Interview Questions
Q1	Could you please describe your initial impressions of the HubICL and how you first started using it in your role as an educator or program leader?
Q2	In what ways has the HubICL influenced or changed your approach to teaching intercultural competence to undergraduate students?
Q3	Could you provide specific examples of resources or <i>Tools</i> from the HubICL that you found particularly useful for your course or your educational programs?
Q4	In what ways do you think the HubICL will be beneficial to a new STEM educator? What resources would you recommend?
Q5	Looking forward, what enhancements or additions to the HubICL would you suggest to better support STEM educators in fostering an intercultural learning environment?

science gateway known as the HubICL, and to understand the benefits of the HubICL in the context of STEM education. For the purpose of this study, we interviewed 4 educators, out of which 3 were STEM educators and 1 educator was from liberal arts but had experience working with STEM educators in facilitating intercultural learning workshops for STEM educators, students, and staff. Each educator has more than 10 years of experience in teaching and integrating intercultural competence in STEM education.

B. Data Collection

The data was collected in the form of semi-structured interviews. Two researchers conducted 45-minute long semi-structured interviews with all 4 participants. The goal of the interview was to identify educators' perceptions regarding the HubICL platform created by CILMAR Purdue University. Table 1 below contains the sample interview questions. We also plan to use quantitative surveys in the future with our educators to seek real-time feedback.

C. Data Analysis

The study used narrative inquiry to analyze the interview data. Narrative inquiry is an excellent method to narrate the

experiences of participants in a storytelling format. The steps delineated by Jaiswal [8], Emden [9] and Petty [10] were followed to conduct the narrative inquiry. We started with reading the interview transcripts multiple times to gain a deeper understanding of the experiences. In the next step, we deleted all the interview questions and comments of the interviewer and all the words that undermined the key idea of the experiences. We then re-read the clean transcripts again and focused on the series of events and themes that emerged from the transcript. Lastly, we combined the event and themes to generate a coherent story. To ensure the trustworthiness of the data, first, the two researchers coded one interview independently by following the narrative inquiry steps. Upon completion of the first round of narrative analysis, they met and discussed their story and a peer debriefing was conducted. Based on the feedback from the peer debriefing, both researchers re-analyzed the data utilizing narrative inquiry for Participant 1 and also wrote the narrative for Participant 2. Again the peer debriefing was conducted and this time the story from both the raters showed a decent overlap. Therefore, the remaining two interviews for Participants 3 and 4 were coded independently by researcher 1 and 2.

IV. RESULTS

The paragraph below discusses the results of the narrative inquiry.

a) **Participant 1:** Participant 1 is an experienced language educator and trainer who shared their experience of using the HubICL. They mentioned that they have used the HubICL for every educational endeavor, sharing, *“Oh you know I have used Hub for almost everything, you know from teaching, to curriculum design to assessments, I mean for everything that I do.”* The dialogue highlighted HubICL as a critical resource as it contains intercultural learning materials that are freely accessible and thoughtfully structured to enhance educational effectiveness. Participant 1 expressed their reliance on the platform, stating, *“I don’t know where else I would go to find these resources, you know, everything in one place. And it’s not only about finding their source, it’s also how they didacticized it, which is really helpful for us instructors.”* The interview also highlighted the platform’s significant role in Participant 1’s own professional development. Participant 1 credited the HubICL for enhancing their teaching style, sharing *“You know something like ‘debrief’ is a concept that I learned from intercultural learning, but also debriefing is a critical component of HubICL activities. And that has become my way of teaching, or I would rather say, I love to debrief my students and ask those questions to allow them to critically reflect on their learning and I credit this new teaching style of mine to the Hub activities.”* Participant 1 went on to highlight the experiential learning opportunities that they create for their students when they use HubICL activities in their classroom. They also mentioned that The HubICL activities are designed to deepen student engagement and promote critical reflection. They gave an example of intercultural labs that they conduct in their classroom, *“I see*

that students are learning, they are always engaged in the classroom, um, I would say they look forward to the classes that we call ‘intercultural labs,’ they are ready to participate and learn from them.” They further mentioned that students have found the activities so engaging that they have reached out to them inquiring about the source, saying, *“Students have reached out to me a couple of times to ask about the resources, as they want to conduct these activities in their sororities and fraternities.”* Participant 1 also shared a couple of activities that they find very useful and that could benefit students in helping them understand different communication styles, help them develop openness and empathy, mentioning, *“I like the D-I-E (Describe, Interpret and Evaluate) activity. It is really important and has been very well received as it teaches you perspective-taking. I like the one on direct and indirect communication as it teaches us a lot about how to communicate and respond. I also like the activities on empathy, as these are crucial skills for any student to master.”* In summary, the collective insights from Participant 1 showcased the HubICL as a useful resource for intercultural competence and also fosters professional growth, supports experiential learning, and actively engages students in their educational journey. This comprehensive utility makes HubICL a resource for educational technology and intercultural learning.

b) **Participant 2:** Participant 2 is a STEM educator with more than 30 years of experience in teaching STEM students. In an in-depth discussion about the HubICL platform, Participant 2 shared their experiences and insights, focusing on both the strengths and areas for improvement of this resource-rich platform. The interview shed light on how the HubICL serves as a centralized repository for intercultural educational materials. Participant 2 shared that they find the HubICL impressive for its extensive range of activities that cater to diverse educational needs. The activities range from brief exercises to comprehensive group tasks, and Participant 2 highlighted the HubICL’s adaptability and utility: *“HubICL is a great platform to start with. You can go there and get these full-fledged modules, all the teaching things and instead of looking through my files because it’s there somewhere or we used to use books, it is much easier to go to the HubICL and get them.”* Furthermore, Participant 2 viewed the HubICL as a pivotal tool for STEM education as it can help instructors to foster soft skills in students alongside technical knowledge. They remarked, *“Building the soft skills, professional skills that go along with the technical skills that they know how to teach. I think, you know, it’s a fantastic resource to look for activities that can engage STEM students and help them learn those life skills.”* Participant 2 also provided examples of HubICL activities that they use with their students. The first activity that they mentioned is the *Clock on the Ceiling* Activity. Participant 2 describes this as a great icebreaker that helps students understand different perspectives. They mentioned, *“The Clock on the Ceiling activity is great to get people to get the idea of different perspectives and so that one I do fairly frequently.”* The second activity that they

like to use is *A Flower's Point of View*. Participant 2 is fond of this activity as it helps students to learn empathy. In this activity, students write from the perspective of a flower. Participant 2 states, *"I love telling something from the flower's point of view... I love that activity and I love to see what people write, how they respond to it."* Overall Participant 2 found the HubICL to be a great resource and repository of activities to impact intercultural learning, but they also mentioned some user interface challenges that they experience as a HubICL user. Participant 2 expressed: *"Despite the fact that the HubICL is sometimes difficult to use...it's still wonderful to have."* This narrative highlights the essential role of educational technology platforms like the HubICL in supporting and enhancing intercultural learning for STEM students. This participant felt the need for these platforms to be user-friendly to maximize their potential impact.

c) **Participant 3:** Participant 3 is a STEM educator and Program Director for study abroad initiatives with more than 15 years of experience in designing curriculum and mentoring STEM students while abroad. During the interview about the HubICL, Participant 3 focused on the *Toolbox* feature of the HubICL. In the exploration of the effectiveness of intercultural learning *Tools*, Participant 3 shared their experiences with the HubICL *Toolbox*. The *Toolbox* is a repository that contains intercultural learning activities and assessments. Participant 3 acknowledged the potential of the activities in the *Toolbox* for enhancing intercultural understanding and helping students to shift their perspectives on intercultural issues. They articulate this potential by stating, *"I believe the Tools, could be useful in any venue or any classroom where the instructor is intending to get students to think about intercultural learning or to change their point of view, or to focus on any of the AAC&U VALUE rubrics for intercultural learning. I also believe that these Tools are an excellent starting point for developing intercultural competence."* This recognition emphasizes the utility of the *Toolbox* in helping students to become interculturally aware. Further emphasizing the key features of the *Toolbox*, Participant 3 shared their preference for Thiagi *"Jolts:"* quick and engaging activities that swiftly introduce new concepts or perspectives. Further, Participant 3, like Participant 2 also described their favorite activity as the *Clock on the Ceiling*. They preferred this activity because it is effective in capturing attention and setting a foundation for deeper learning: *"It's done very quickly. It's active. It grabs people's attention because you can get them to stand up or move. Some people are not really enthused to do anything, but some are, and little 2-minute exercises like that I think set a foundation for whatever else you're going to do next."* This activity is valued for its ability to actively engage participants and facilitate a transition into more extensive discussions or learning activities.

Participant 3 also shared other activities that they frequently use in their sessions, such as Human Values Continuum and Space Odyssey, highlighting how these exercises are especially effective in eliciting diverse responses from students and generating discussions that are crucial for creating and enriching

the learning experience stating: *"Oftentimes, the diversity of the answers that students present are very interesting and insightful, if everyone has kind of the same answers, it's not as helpful."* They further add, *"The varied responses serve to highlight the dynamic and interactive nature of intercultural learning."* Moreover, Participant 3 discusses how they have adapted an activity known as *The Parable*, and used it in various educational settings, including international contexts such as a study abroad program in Peru. They appreciate this exercise for its ability to explore values and judgments, fundamental aspects of intercultural education: *"It leaves room for interpretation, but it also leaves room to explore values and judgments that we might make about the characters."*

Despite these positive attributes, Participant 3 acknowledges the difficulties they encounter with the HubICL user interface when searching for specific activities, as they may not know the exact name of the activity. For example they said, *"Sometimes I get lost in the activities as there are so many, I would not know the name of each activity so it is better to arrange them with some common search terms. Such as all teamwork activities under one heading."* Participant 3's insights on the HubICL *Toolbox* provides examples of the various activities that could be used by educators in variety of context including STEM education to enhance the intercultural competence of students.

d) **Participant 4:** Participant 4 is also a STEM educator with more than 15 years of experience. They have extensive experience in teaching and training STEM students on intercultural competence. Participant 4 considers the HubICL to be an important resource for STEM educators as it has a collection of activities that can be used by STEM educators to help their students to understand various intercultural concepts and develop these life skills. For instance, they say, *"Yes, I think it's a great resource and very beneficial for STEM educators, especially if we're trying to have more of an inclusive or more interactive classroom setting, and teaching intercultural competence to our students."* Participant 4 acknowledges that instructors may need to sometimes curate the activity to fit their class time or size. They also believe that curation is not easy, but instructors can develop the ability over time and with frequency of usage. Participant 4 narrates their strategy to curate an activity, *"I look at the activity and see what it offers, for example you can see the objectives or goals it meets, so one goal may be communication, one may be understanding differences and so I try to take that and look at the specific goal that activity meets and say OK, maybe I can use this in the course that I'm teaching on communication and different styles of speaking or power dynamics."* Participant 4 exemplifies this with an activity they find beneficial: *"So one is like Shipwrecks... I use it for when I'm putting students into groups and I want them to learn about different communication styles or leadership styles."* Furthermore, Participant 4 also shared their experiences with teaching soft skills to STEM students. They acknowledge that it is not easy to convince STEM students to learn non-technical

concepts, so it is important to contextualize the need for this knowledge: *“So one thing about STEM students, they prefer concise and direct communication, right? So I think for STEM, we need to tell them why we’re teaching them the soft skills and when they will need them, for example, whenever they’re gonna be working with teams, whenever they’re looking to go through interviews for something like that.”* Participant 4 finds the HubICL to be a great resource that could be beneficial for STEM instructors in a variety of ways, but as a HubICL user themselves, they suggest some improvement to make the user experience better: *“I think some activities are too long...they are 2 hours long, so the instructor might teach an hour-long class and will not go for an activity that is too long. So it would be great if you can come up with shorter version of the activities that are fifteen to ten minutes long, that could be easy to implement within the time frame.”* Overall Participant 4 offered insights on how to curate the activities and use them in classroom. They also highlighted the need for educating STEM students about the need for intercultural competence.

V. DISCUSSION AND CONCLUSION

The integration of the HubICL into various educational contexts showcases its adaptability and crucial role in enhancing intercultural competencies. The study interviewed four participants with varied experiences, and the common theme that emerged from the interview was that the **HubICL can be used as a tool** for integrating intercultural learning in the classroom. Through interviews, we learned how activities from the HubICL can be tailored and used in a variety of STEM and non-STEM contexts. For example, Participant 1 is an experienced language educator and an active HubICL user. They use the platform extensively across different facets of their professional activities—from teaching and curriculum design to assessments. Participant 1 also emphasized the “debrief” feature of HubICL activities and mentioned that effective debriefing fosters deeper reflection and critical thinking among students—an approach supported by experiential learning theories [11]. Similarly, Participant 2 recognizes the HubICL as an important resource that can be used by STEM educators to enhance intercultural competence among STEM students. Moreover, STEM as a field recognizes the importance of soft skills alongside technical expertise [12], [13]. The HubICL provides a repository of activities that enhance professional skills such as communication, teamwork in multicultural settings, and empathy, key skills linked to intercultural competence. These activities address a significant educational requirement, suggesting the HubICL’s potential as a transformative tool for STEM educators. Participant 2 appreciates the diversity of activities available, which range from simple exercises to complex group tasks, demonstrating the HubICL’s adaptability to varied educational needs. Participant 3 adds to the discussion by illustrating how the *Toolbox* component of the HubICL facilitates quick, engaging activities (Thiagi “Jolts”) that effectively capture students’ attention and prepare them for deeper exploration. The effectiveness of such activities in fostering dynamic and interactive

learning environments aligns with Participant 3’s pedagogical strategies and enhances the educational impact, particularly in settings that require rapid engagement and focus from the participants. Meanwhile, Participant 4’s insights focus on the practical application of the HubICL in delivering intercultural content within STEM contexts. The adaptation of activities like *“Shipwrecks”* for teaching communication and leadership styles illustrates the platform’s versatility in meeting specific educational goals. Yet, the need for shorter activities reflects a broader educational trend towards microlearning, which accommodates the constraints of typical classroom settings and learning environments.

However, participants have also highlighted challenges, particularly regarding the platform’s usability. For example, Participant 2 described the interface as difficult to navigate. This suggests the necessity for a more intuitive navigation to enhance user engagement and accessibility. Issues with navigation have been identified as a common challenge of educational technology platforms [14]. This feedback is crucial for ongoing platform development, emphasizing the need for a user-centered design that simplifies and eases the educator’s interactions with the platform. However, some improvements suggested by participants can be addressed in already-existing features of the HubICL that some users may not be aware of or may not take full advantage of. For example Participant 3 experienced some challenges when looking for activities. This issue can be overcome by using the *Tags* feature of the HubICL. The *Tags* feature allows users to search for activities based on common terms. For instance, if someone is looking for an activity on teamwork they can use the *Tag* for teamwork and look for all relevant activities. Similarly, the concern raised by Participant 4 regarding the need for shorter activities is something HubICL team is already working on. The filter option in the HubICL makes it possible for users to find shorter activities. Users can search by a minimum and maximum time constraint, depending on the needs of their learners. For example, currently, 205 *Tools* are available between 5 and 20 minutes long.

In light of this helpful and important feedback, it is important to remember that, as previously discussed in this paper, the HubICL is built on a library model which chronicles the history of the field. The founders of the field did not necessarily uphold time constraints as a main priority and the HubICL is a resource for not only for STEM educators, but also for consultants, educators of other disciplines, and other leaders. However, HubICL curators are aware that users have varying priorities and, keeping users in mind, they regularly add *Tools*, *Courses*, and other resources to the HubICL to continuously provide relevant and representative materials to the ever-growing and diverse range of stakeholders.

While HubICL curators created this resource, the responsibility of maintaining and contributing to the HubICL is a shared one. A key feature of science gateways, mentioned previously in this paper, is that they are maintained and sustained by the communities of practice that use them. To foster and encourage communal ownership of the platform,

HubICL users have the ability to create new and/or adapted *Tools* to benefit not only themselves, but others in the HubICL science gateway community of practice. Users can also leave reviews on each *Tool* page in the HubICL, in which they may offer alternative ways of facilitating the activities or relevant information about how best to facilitate an activity based on context. The feedback and suggestions received from our participants are the voices of HubICL users and carry important merit. To the extent that the HubZero platform can accommodate necessary changes, HubICL curators consistently work to address and incorporate feedback, provide customized solutions to backend user issues, and regularly consider enhancements within the platform as well as new ways to link to resources outside of the platform. Users may also consider that solutions within the HubICL may already be present within the platform, such as the search filter or *Collections* features. Together, HubICL curators, the HubZero team, and users themselves can work to find innovative solutions to user experience issues and can utilize the platform's established methods for connecting communities to share resources and adaptations to make the HubICL an even more valuable tool in the educational technology field.

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